SITTIG'S HANDBOOK OF TOXIC AND HAZARDOUS CHEMICALS AND CARCINOGENS

Sixth Edition

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Preface

For more than a quarter century, *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has continued to gather an ever-widening audience of users because it has been proven to be among the most reliable, easy to use, and essential reference works on hazardous materials. The 6th edition has been updated and expanded to keep pace with world events and to answer continuing and expanded need for information.

The 4th edition of *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* was published in 2001, shortly before the tragic events of the morning of September 11, 2001. Following 9/11, the United States established the Department of Homeland Security and enacted laws such as the *Chemical Facilities Security Act of 2003* and released the DHS list of Chemicals of Concern, *Appendix to Chemical Facility Antiterrorism Standards; Final Rule, November 20, 2007.* These actions were prompted by concerns about infrastructure protection and the anticipation of another attack, possibly on the nation's chemical facilities or by using trucks or tank cars that transport highly dangerous and possibly lethal chemicals.

These facilities are found around the country in industrial parks, in seaports, and near the major population centers. Dangerous chemicals routinely travel along our highways, inland waterways, and on railcars that pass through the heart of major cities including Washington, D.C., just a short distance from Capitol Hill. Terrorist attacks on the US chemical industry have the potential to kill tens of thousands of Americans and seriously injure many more. In many instances, these attacks hold the potential for having a cascading effect across other infrastructures, particularly in the energy and transportation sectors. This is both because of the damage that can be caused by the attack, and the enormous expense and effort associated with the clean-up to an affected area in its aftermath.[83]

To put it more simply, using the same low tech/high concept approach that turned passenger planes into missiles, terrorists do not need to produce or amass chemical weapons or smuggle them into the United States in order to produce great damage.

"Commercial chemical incidents occur tens of thousands of times each year, often with devastating and exorbitantly expensive consequences. They are indiscriminate in their effects. Workers, companies, the public, emergency response organizations, and all levels of government pay the figurative and literal price. Yet, until now and with few exceptions, chemical incidents have been invisible. Perhaps it is due to their pervasiveness, or to the common tendency to overlook what is taken for granted."[84] This quote is from the highly publicized *600K Report* prepared by the Chemical Safety and Hazard Investigation Board (CSB), an independent, nonpartisan, quasi-legislative US government agency. The CSB described our nation's lack of definitive knowledge of the "big picture" surrounding chemical incidents as "... the industrial equivalent of two 737 airplanes 'crashing' year after year, killing all passengers (256 people) without anyone seeming to notice."[84]

More than 30 years ago, the United States Government Accounting Office (GAO) estimated that 62,000 chemicals were in commercial use. Today, that number has grown to beyond 82,000.

Each year, in the United States, over 2 billion tons of hazardous and toxic chemicals are manufactured. Including imports, more than 3 billion tons are transported employing 800,000 shipments each day. It is estimated that 1.3 billion tons are moved by truck and hundreds of billions of pounds of these hazardous materials are transported through populated areas. The average American household generates approximately 15 lb of hazardous waste per year. Nearly 5 million poisonings occur in the United States annually, resulting in thousands of deaths. Based on 2004, TRI data (publically released April 2006), over 4 billion pounds of toxic chemicals are released into the nation's environment each year, including 72 million pounds of recognized carcinogens from nearly 24,000 industrial facilities. The toxic chemicals problem in the United States; and, indeed, in all the world is frightening to many people. And, over the years, these fears are heightened by news stories about an oil field explosion in Mississippi (2006), a 48,000-lb chlorine release in Missouri (2002), Love Canal in New York, the Valley of the Drums in Kentucky, the Valley of Death in Brazil, major chemical spills, including Bhopal, India, terrorist attacks in Japan...and the like. All of these incidents generate emotional responses, often from people uninformed about science or technology. On the other hand, one encounters some industrialists who tell us that toxic chemicals are present in nature and that industrial contributions are just the price we have to pay for progress. There is little argument about the chemical industry's critical place in the nation's economy. The United States is the number one chemical producer in the world, generating more than $550 billion a year and employing more than 5 million people. So somewhere in between lies the truth—or at least an area in which we can function. Information is vital in a world where virtually every aspect of our lives is touched by chemical hazards.

Given the reality of problems related to chemical hazards, including accidents and spills, the advent of new threats to our way of life, and the challenges of communicating complex data, it is the goal of this book to provide data so that responsible decisions can be made by all who may have contact with chemicals in this reference work. With this in mind, the work can be used by those in the following professions:

- Chemicals manufacturers
- Emergency response personnel
- Protective safety equipment producers
- Environmental management
- Transportation managers
- Toxicologists
- Industrial hygienists
- Industrial safety engineers
- Lawyers
- Occupational doctors and nurses
- Chemists
- Industrial waste disposal operators
- Enforcement officials
- Special, technical, and university librarians
- Legislators
- Homeland security planners

The chemicals chosen for inclusion are officially recognized substances, defined as carcinogens, as belonging to some designated category of hazardous or toxic materials, with numerically defined safe limits in air in the workplace, ambient air, water, waste effluents. For the most part, these are materials of commerce that are heavily used and many are transported in bulk.

The 6th edition contains more regulated chemicals and expanded data on each material. Some material and appendices from the previous edition has been eliminated or moved to more appropriate sections. This was done to limit the work to a pair of handy volumes.

All of this has been done to make the work more relevant, more inclusive, and easier to use. The utility of the work has been enhanced by the addition of three appendices. Additionally there is a table that cross indexes the materials by chemical and trade names and CAS Registry Number.

Appendix 1: the list of oxidizing materials has been expanded. Appendix 2 contains many new confirmed and suspected carcinogens. Also, this edition allows the user to search the carcinogen list by name or CAS Number. Appendix 3 is a glossary of chemical, health, safety, medical, and environmental terms used in the handbook. The glossary was completely reviewed and many narrow interest medical terms were removed. More and new germane terms were added. The Introduction was replaced with the more accurate title, *How to Use this Book.* Following the use section is a revised *Key to the Abbreviations and Acronyms* used in the handbook.

In keeping with the broad changes originally initiated with the 4th edition, contents of the 6th edition are focused on the concept of "regulated chemicals." The carcinogen potential of each chemical was compared to listings and reports from eminent authorities as the International Agency for Research on Cancer (IARC) and the National Toxicology Progam (NTP).

The "Regulatory Authority and Advisory Bodies" section contains new items including, where available, EPA Gene-Tox Program findings, and many of the individual listings now contain useful advice sought after by the regulated community. As a result, the new volume should be even more practical for those users of specific chemicals and to those concerned with both adherence to and enforcement of regulations.

Data is furnished, to the extent currently available, in a uniform multisection uniform format to make it easy for users who must find information quickly and/or compare the data contained within records, in any or all of these important categories:

Chemical Description
Code Numbers (including CAS, DOT, RTECS, EC)
Synonyms
Regulatory Authority and Advisory Bodies (summary)
Description
Potential Exposure
Incompatibilities
Permissible Exposure Limits in Air
Determination in Air
Permissible Concentration in Water
Determination in Water
Routes of Entry
Short Term Exposure
Long Term Exposure
Points of Attack
Medical Surveillance
Decontamination (selected records)
First Aid
Decontamination (CWAs or WMDs)
Personal Protective Methods
Respirator Selection
Storage
Shipping
Spill Handling
Fire Extinguishing
Disposal Method Suggested
References
The 6th edition of Sittig has new and updated information in nearly every section, including the following: Synonyms, CAS Numbers, UN/NA & ERG (Emergency Response Guide) Number, EC Numbers (Annex I Index Numbers

added where assigned), Regulatory Authority and Advisory Bodies (added Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]; List of Stockholm Convention POPs: Annex A; European/International Hazard Symbol, Risk phrases, Safety phrases; WGK (German Aquatic Hazard Class); Annex II Rotterdam Convention List information; hundreds of Department of the US Homeland Security Chemicals of Interest along with their Screening Threshold Quantities (STQs) [from the US Code of Federal regulations (6CFR Part 27 Appendix A]; California Proposition 65 Carcinogen and Reproduction Toxins; Description, Incompatibilities, Exposure Limits [now includes US Department of Energy (DOE) Protection Action Criteria (PACs)]. Short Term Exposure, Long Term Exposure, First Aid, Decontamination (especially, chemical warfare agents and weapons of mass destruction), Personal Protective Methods, Respirator Selection, Storage, Shipping, Spill Handling [more and updated Initial Isolation and Protective Distances (including both Imperial and Metric) from the *US DOT Emergency Response Guide*], Fire Extinguishing, Disposal. Specifically, additions include regulatory information, identifiers, chemical and physical properties, including explosive limits, NFPA (National Fire Protection Association)-type hazard ratings (based on NFPA-704 M Rating System), water solubility and hazard levels, exposure limits, odor thresholds, DOT isolation and protective distances, and full text of NIOSH respirator recommendations. Many records contain special warnings, including notes and reminders to Emergency Management Service (EMS) personnel, and other health-care professionals.

Although every effort has been made to produce an accurate and highly useful handbook, the author appreciates the need for constant improvement. Any comments, corrections, or advice from users of this book are welcomed by the author who asks that all correspondence be submitted in writing and mailed to the publisher who maintains a file for reprints and future editions.

A Brief history of this work

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens was first published 30 years ago. This work continues to provide first responders and occupational and environmental health and safety professionals with an accessible and portable reference source. The 6th edition of his handbook contains data on more than 2200 toxic and hazardous chemicals (up from nearly 600 in the first edition, nearly 800 in the second edition, nearly 1300 in the third edition, and 1500 in the 4th edition).

According to the Library of Congress, the history of the project is as follows: 1st edition published in 1981; 2nd edition published in 1985; 3rd edition published in 1991; 4th edition published in 2001; 5th edition published in 2008; 6th edition published in 2011.

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How to Use This Book

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens focuses on critical data for more than 2200 commercially important and/or regulated and monitored substances, and many associated substances. Many of these chemicals or substances are found in the workplace; a few are found in the medical and research fields. Importance is defined by inclusion in official, regulatory, and advisory listings. Much of this information, found in US government sources, has been supplemented by a careful search of publications from various countries and other sources including United Nations and World Health Organization (WHO) publications.

This handbook is becoming more encyclopedic in nature. When one looks at most handbooks, one simply expects to find numerical data. Here, we have tried, wherever possible, to provide literature references to review documents which hopefully opens the door for users to a much broader field of published materials. It is recommended that this book be used as a guide. This book is not meant to be a substitute for workplace hazard communication programs required by regulatory bodies such as OSHA, and/or any other US, foreign, or international government agencies. If data are required for legal purposes, the original source documents and appropriate agencies, which are referenced, should be consulted.

In the pages which follow, the following categories of information will be discussed with reference to scope, sources, nomenclature employed, and the like. Omission of a category indicates a lack of available information.

Chemical name: Each record is arranged alphabetically by a chemical name used by regulatory and advisory bodies. In a very few cases the name may be a product name or trade name.

Formula: Generally, this has been limited to a commonly used one-line empirical or atomic formula. In the *Molecular Formula* field, the Hill system has been used showing number of carbons (if present), number of hydrogens (if present), and then alphabetically by element. Multiple carbon−carbon (double and triple) bonds have been displayed where appropriate.

Synonyms: This section contains scientific, product, trade, and other synonym names that are commonly used for each hazardous substance. Some of these names are registered trade names. Some are provided in other major languages other than English, including Spanish, French, and German. In some cases, "trivial" and nicknames (such as MEK for methyl ethyl ketone) have been included because they are commonly used in general communications and in the workplace. This section is important because the various "regulatory" lists published by federal, state, international, and advisory bodies and agencies do not always use the same name for a specific hazardous substance. Every attempt has been made to ensure the accuracy of the synonyms and trade names found in this volume, but errors are inevitable in compilations of this magnitude. Please note that this volume may not include the names of all products currently in commerce, particularly mixtures that may contain regulated chemicals.

The synonym index contains all synonym names listed in alphabetical order. It should be noted that organic chemical prefixes and interpolations, such as (α-) alpha-, (β-) beta-, (γ-) gamma-, delta- (δ-), (*o*-) *ortho*-, (*m*-) *meta*-; (*p*-) *para*-; *sec*- (*secondary*-), *trans*-, *cis*-, (*n*-) *normal*-, and numbers (1-; 1,2-), are not used when searching for a chemical name. In other words, these prefixes are not treated as part of the chemical name for the purposes of alphabetization. Users should use the substance name without the prefix. For example, to locate *n*-Butane, search for Butane; to locate 3,3′-Dichlorobenzidine, search for Dichlorobenzidine; and to locate α-Cyanotoluene or alpha-Cyanotoluene, search for Cyanotoluene.

CAS Number: The CAS number is a unique identifier assigned to each chemical registered with the Chemical Abstracts Service (CAS) of the American Chemical Society. This number is used to identify chemicals on the basis of their molecular structure. CAS numbers are given in the format nnn (...)-nn-n [two or more numeric characters (dash) two numeric characters (dash) followed by a single numeric check digit]. CAS numbers should always be used in conjunction with substance names to insure positive identification and avoid confusion with like-sounding names, i.e., benzene (71-43-2) and benzine (8032-32-4). This 6th edition contains some alternate CAS numbers that may now be considered related, retired, obsolete, and/or widely and incorrectly used in the literature. In this section, the first CAS number(s), before the word "alternate," is considered (based on several sources) to be the correct CAS number(s). Ultimately, it is the responsibility of the user to find and use the correct number.

RTECS®Number: The RTECS® numbers (Registry of Toxic Effects of Chemical Substances) are unique identifiers assigned and published by NIOSH. The RTECS® number in the format "AAnnnnnnn" (two alphabetic characters followed by seven numeric characters) may be useful for online searching for additional toxicologic information on specific substances. It can, for example, be used to provide access to the MEDLARS® computerized literature retrieval services of the National Library of Medicine (NLM) in Washington, DC. The RTECS number and the CAS number can serve to narrow down online searches.

DOT ID: The DOT hazard ID number is assigned to the substance by the US Department of Transportation (DOT). The DOT ID number format is "UNnnnn" or "NA nnnn." This ID number identifies substances regulated by DOT and must appear on shipping documents, the exterior of packages, and on specified containers. Identification numbers containing a UN prefix are also known as United Nations numbers and are authorized for use with all international shipments of hazardous materials. The "NA" prefix is used for shipments between Canada and the United States only, and may not be used for other international shipments.

EC Number: The European Commission number is a 7-digit identification code used by the European Union (EU) for commercially available chemical substances within the EU. An identification number from *European Inventory of Existing Commercial Chemical Substances*, published by the European Environment Agency, Copenhagen, Denmark. Use of these identification numbers for hazardous materials will (a) serve to verify descriptions of chemicals; (b) provide for rapid identification of materials when it might be inappropriate or confusing to require the display of lengthy chemical names on vehicles; (c) aid in speeding communication of information on materials from accident scenes and in the receipt of more accurate emergency response information; and (d) provide a means for quick access to immediate emergency response information in the "*North American Emergency Response Guidebook*."[31] In this latter volume, the various compounds have assigned "ID" numbers (or identification numbers) which correspond closely, but not always precisely, to the UN listing.[20] The EC number supercedes the outmoded EINECS, ELINCS, and NLP numbers. This section also includes Annex I, Index number for the Export and Import of Dangerous Chemicals found in Annex I of Regulation (EC) No. 689/2008.

Regulatory Authority and Advisory Bodies:

This section contains a listing of major regulatory and advisory lists containing the chemical of concern, including OSHA, US EPA, DFG, US DOT, ACGIH, IARC, NTP, WHMIS (Canada), and the EEC. Many law or regulatory references in this work have been abbreviated. For example, Title 40 of the Code of Federal Regulations, Part 261, subpart 32 has been abbreviated as 40CFR261.32. The symbol "§" may be used as well to designate a "section" or "part."

- European/International Hazard Symbols, Risk Phrases, and Safety Phrases. Explanation of these symbols and phrases can be found in the new Appendix 4. In the interim between the 6th and 7th edition, it is expected that the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) will be phased in by many countries. Hazard statements are an essential element under the GHS, and will eventually replace the risk phrases (R-phrases) described earlier in the paragraph. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will contain, where necessary, one or multiple pictograms, a signal word such as "Warning" or "Danger," and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer. Each hazard statement contains a four-digit code, starting with the letter H (in the form Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four-digit code is for reference only; however, following the code is exact *phrase* as it should appear on labels and MSDS.
- A carcinogen (the agency making such a determination, the nature of the carcinogenicity—whether human or animal and whether positive or suspected, are given in each case). These are frequently cited by IARC (International Agency for Research on Cancer),[12] and are classified as to their carcinogenic risk to humans by IARC as follows: Group 1: Human Carcinogen; Group 2A: Probable Human Carcinogen; Group 2B: Possible Human Carcinogen. Chemicals are classified as to their carcinogenic risk to humans by NTP as follows: Group K: Known Human Carcinogens; Group R: Reasonably Anticipated Human Carcinogens, or the NTP (US National Toxicology Programs).[10] It should be noted that the DFG have designated some substances as carcinogens not so classified by other agencies.
- A banned or severely restricted product as designated by the United Nations[13] or by the US EPA Office of Pesticide Programs under FIFRA (The Federal Insecticide, Fungicide, and Rodenticide Act).[14]
- A substance cited by the World Bank.[15]
- A substance with an air pollutant standard set or recommended by OSHA and/or NIOSH,[58] ACGIH,[1] DFG,[3] or HSE.[33] The OSHA limits are the enforceable pre-1989 PELs. The transitional limits that were vacated by court order have not been included. The NIOSH and ACGIH airborne limits are recommendations that do not carry the force of law.
- A substance whose allowable concentrations in workplace air are adopted or proposed by the American Conference of Government Industrial Hygienists (ACGIH),[1] DFG [Deutsche Forschungsgemeinschaft (German Research Society)].[3] Substances whose allowable concentrations in air and other safety considerations have been considered by OSHA and NIOSH.[2] Substances which have limits set in work-place air, in residential air, in water for domestic purposes, or in water for fishery purposes as set forth by the former USSRUNEP/IRPTC Project.[43]
- Substances that are specifically regulated by OSHA under 29CFR1910.1001 to 29CFR1910.1050.
- Highly hazardous chemicals, toxics, and reactives regulated by OSHA's "*Process Safety Management of Highly Hazardous Chemicals*" under 29CFR1910.119, Appendix A. Substances that are Hazardous Air Pollutants (Title I, Part A, § 112) as amended under 42USC7412. This list provided for regulating at least 189 specific substances using technology-based

standards that employ Maximum Achievable Control Technology (MACT) standards; and, possibly health-based standards if required at a later time. § 112 of the Clean Air Act (CAA) requires emission control by the EPA on a source-by-source basis. Therefore, the emission of substances on this list does not necessarily mean that a firm is subject to regulation.

- Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention. These appear as Accidental Release Prevention/Flammable Substances, Clean Air Act (CAA) §112(r), Table 3, TQ (threshold quantity) in pounds and kilograms under 40 CFR68.130. The accidental release prevention regulations applies to stationary sources that have present more than a threshold quantity of a CAA § 112(r) regulated substance.
- Clean Air Act (CAA) Public Law 101−549, Title VI, *Protection of Stratospheric Ozone*, Subpart A, Appendix A, class I and Appendix B, Class II, Controlled Substances, (CFCs) Ozone-depleting substances under 40CFR82.
- Clean Water Act (CWA) Priority toxic water pollutants defined by the US Environmental Protection Agency for 65 pollutants and classes of pollutants which yielded 129 specific substances.[6]
- Chemicals designated by EPA as "Hazardous Substances"[4] under the Clean Water Act (CWA) 40CFR116.4, Table 116.4A.
- Clean Water Act (CWA) § 311 Hazardous Materials Discharge Reportable Quantities (RQs). This regulation establishes reportable quantities for substances designated as hazardous (see §116.4, above) and sets forth requirements for notification in the event of discharges into navigable waters. Source: 40CFR117.3, amended at 60FR30937.
- Clean Water Act (CWA) § 307 List of Toxic Pollutants. Source: 40CFR401.15.
- Clean Water Act (CWA) § 307 Priority Pollutant List. This list was developed from the List of Toxic Pollutants classes discussed above and includes substances with known toxic effects on human and aquatic life, and those known to be, or suspected of being, carcinogens, mutagens, or teratogens. Source: 40CFR423, Appendix A.
- Clean Water Act, § 313 Water Priority Chemicals. Source: 57FR41331.
- RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic with Regulatory levels in mg/L. Source: 40CFR261.24.
- RCRA Hazardous Constituents. Source: 40CFR261, Appendix VIII. Substances listed have been shown, in scientific studies, to have carcinogenic, mutagenic, teratogenic, or toxic effects on humans and other life forms. This list also contains RCRA waste codes. The term "waste number not listed" appears when a RCRA number is NOT provided in Appendix VIII.

Characteristic Hazardous Wastes

Ignitability	A nonaqueous solution containing less than 24% alcohol by volume and having a closed cup flashpoint below 60°C/140°F using Pensky-Martens tester or equivalent. An ignitible compressed gas. A nonliquid capable of burning vigorously when ignited or causes fire by friction, moisture absorption, spontaneous chemical changes at standard pressure and temperature. An oxidizer. See §261.21.
Corrosivity	Liquids with a pH equal to or less than 2 or equal to or more than 12.5 or which corrode steel at a rate greater than 6.35 mm (0.25 in) per year at 55°C/130°F. See §261.22.
Reactivity	Unstable substances that undergo violent changes without detonating. Reacts violently with water or other substances to create toxic gases. Forms potentially explosive mixtures with air. See §261.23.
Toxicity	A waste that leaches specified amounts of metals, pesticides, or organic chemicals using Toxicity Characteristic Leaching Procedure (TCLP). See §261, Appendix II, and §268, Appendix I. **Listed Hazardous Wastes**.
"F" wastes	Hazardous wastes from nonspecific sources §261.31.
"K" Wastes	Hazardous wastes from specific sources §261.32.
"U" Wastes	Hazardous wastes from discarded commercial products, off-specification species, container residues §261.34. Covers some 455 compounds and their salts and some isomers of these compounds.
"P" Wastes	Acutely hazardous wastes from discarded commercial products, off-specification species, container residues §261.33. Covers some 203 compounds and their salts plus soluble cyanide salts.

Note: If a waste is not found on any of these lists, it may be found on state hazardous waste lists.

RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic. Source: 40CFR261.24, Table I. These are listed with regulatory level in mg/L and "D" waste numbers representing the broad waste classes of ignitability, corrosivity, and reactivity.

EPA Hazardous Waste code(s), or RCRA number, appears in its own field. Acute hazardous wastes from commercial chemical products are identified with the prefix "P." Nonacutely hazardous wastes from commercial chemical products are identified with the prefix "U."

RCRA Universal Treatment Standards. Lists hazardous wastes that are banned from land disposal unless treated to meet standards established by the regulations. Treatment standard levels for wastewater (reported in mg/L) and nonwastewater [reported in mg/kg or mg/L TCLP (Toxicity Characteristic Leachability Procedure)] have been provided. Source: 40CFR268.48 and revision, 61FR15654.

RCRA Ground Water Monitoring List. Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, and contains test methods suggested by the EPA (see Report SW-846) followed by the Practical Quantitation Limit (PQL) shown in parentheses. The regulation applies only to the listed chemical; and, although both the test methods and PQL are provided, they are *advisory only*. Source: 40CFR264, Appendix IX.

Safe Drinking Water Act (SDWA) Maximum Contaminant Level Goals (MCLGs) for Organic Contaminants. Source: 40CFR141 and 40CFR141.50, amended 57FR31776.

- Maximum Contaminant Levels (MCLs) for Organic Contaminants. Source: 40CFR141.61.
- Maximum Contaminant Level Goals (MCLGs) for Inorganic Contaminants. Source: 40CFR141.51.
- Maximum Contaminant Levels (MCLs) for Inorganic Contaminants. Source: 40CFR141.62.
- Maximum Contaminant Levels for Inorganic Chemicals. The maximum contaminant level for arsenic applies only to community water systems. Compliance with the MCL for arsenic is calculated pursuant to §141.23. Source: 40CFR141.11.
- Secondary Maximum Contaminant Levels (SMCLs). Federal advisory standards for the states concerning substances that effect physical characteristics (i.e., smell, taste, color, etc.) of public drinking water systems. Source: 40CFR143.3.
- CERCLA Hazardous Substances (“RQ” Chemicals). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.
- Releases of CERCLA hazardous substances in quantities equal to or greater than their reportable quantity (RQ) are subject to reporting to the National Response Center under CERCLA. Such releases are also subject to state and local reporting under §304 of SARA Title III (EPCRA). CERCLA hazardous substances, and their reportable quantities, are listed in 40CFR302, Table 302.4. RQs are shown in pounds and kilograms for chemicals that are CERCLA hazardous substances. For metals listed under CERCLA (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc), no reporting of releases of the solid is required if the diameter of the pieces of solid metal released is 100 μm (0.004 in.) or greater. The RQs shown apply to smaller particles.
- EPCRA §302 Extremely Hazardous Substances (EHS). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. The presence of Extremely Hazardous Substances in quantities in excess of the Threshold Planning Quantity (TPQ) requires certain emergency planning activities to be conducted. The Extremely Hazardous Substances and their TPQs are listed in 40CFR355, Appendices A & B. For chemicals that are solids, there may be two TPQs given (e.g., 500/10,000). In these cases, the lower quantity applies for solids in powder form with particle size less than 100 μm; or, if the substance is in solution or in molten form. Otherwise, the higher quantity (10,000 pounds in the example) TPQ applies.
- EPCRA §304 Reportable Quantities (RQs). In the event of a release or spill exceeding the reportable quantity, facilities are required to notify State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.
- EPCRA § 313 Toxic Chemicals. From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. Chemicals on this list are reportable under §313 and §6607 of the Pollution Prevention Act. Some chemicals are reportable by category under §313. Category codes needed for reporting are provided for the EPCRA§313 categories. Information and Federal Register references have been provided where a chemical is subject to an administrative stay, and not reportable until further notice.
- From “*Toxic Chemical Release Inventory Reporting Form R and Instructions, Revised 2005 Version,*” EPA document 260-B-06-001 was used for *de minimis* concentrations, toxic chemical categories.
- Chemicals which EPA has made the subject of Chemical Hazard Information Profiles or “CHIPS” review documents.
- Chemicals which NIOSH has made the subject of “Information Profile” review documents on “Current Intelligence Bulletins.”
- Carcinogens identified by the National Toxicology Program of the US Department of Health and Human Services at Research Triangle Park, NC.[10]
- Substances regulated by EPA[7] under the major environmental laws: Clean Air Act, Clean Water Act, Safe Drinking Water Act, RCRA, CERCLA, EPCRA, etc. A more detailed list appears above. Substances with environmental standards set by some international bodies including those in Europe and Canada.[43]
- New to the 6th edition: United States Department of Homeland Security Chemicals of Interest from the

Federal Register, Appendix A, including all provisions of 6 CFR Part 27, including § 27.210(a)(1)(i). In developing the list, the DHS looked to existing expert sources of information including other federal regulations related to chemicals, including the following: Chemicals covered under the Environmental Protection Agency's Risk Management Program. Chemicals included in the Chemical Weapons Convention. Hazardous materials, such as gases, that are poisonous by inhalation. Explosives regulated by the Department of Transportation. The Department of Homeland Security has identified three security issues related to chemicals: *Release*—Toxic, flammable, or explosive chemicals or materials that, if released from a facility, have the potential for significant adverse consequences for human life or health. *Theft or Diversion*—Chemicals or materials that, if stolen or diverted, have the potential to be misused as weapons or easily converted into weapons using simple chemistry, equipment or techniques, in order to create significant adverse consequences for human life or health. *Sabotage or Contamination*—Chemicals or materials that, if mixed with readily available materials, have the potential to create significant adverse consequences for human life or health. Also considered were these security issues as well as to determine their potential future inclusion in Appendix A and/or coverage under Chemical Facility Anti-Terrorism Standards: *Critical to Government Mission*—Chemicals or facilities, the loss of which could create significant adverse consequences for national security or the ability of the government to deliver essential services, and *Critical to National Economy*—Chemicals or facilities, the loss of which could create significant adverse consequences for the national or regional economy.

- Chemicals on California's Proposition 65 List, revised as of January 7, 2011. The Safe Drinking Water and Toxic Enforcement Act of 1986 requires that the Governor revise and republish at least once per year the list of chemicals known to the State to cause cancer or reproductive toxicity.
- Also new in the 6th edition are the water hazard classifications from the German Federal Water Management Act on Water Hazard Classification, *Verwaltungsvorschrift Wassergefährdende Stoffe* (VwVwS). This law requires all chemical substances be evaluated for their detrimental impact on the physical, chemical, or biological characteristics of water. Substances can be classified as nonhazardous to water (*nwg, nicht wassergefährdende*) or assigned to one of three numeric water hazard classes, WGK: 1—low hazard to waters (low polluting to water), WGK: 2—hazard to waters (water pollutant), or WGK: 3—severe hazard to waters (severe pollutant). The English acronym for WGK is WHC (water hazard class). This work uses the German acronym "WGK" so there is no confusion as to its source. Material Safety Data Sheets (MSDS) that use these water hazards also use the German acronym.

Description: This section contains a quick summary of physical properties of the substance including state (solid, liquid, or gas), color, odor description, molecular weight, density, boiling point, freezing/melting point, vapor pressure, flash point, autoignition temperature, explosion limits in air, Hazard Identification (based on NFPA-704 M Rating System) in the format: Health (ranked 1−4), Flammability (ranked 1−4), Reactivity (ranked 1−4) (see also below for a detailed explanation of the System and Fire Diamond), and solubility or miscibility in water. This section may also contain special and relevant comments about the substance. Terms in this section are also defined in the glossary.

Odor threshold: This is the lowest concentration in air that most humans can detect by smell. Some value ranges are reported. The value cannot be relied on to prevent overexposure, because human sensitivity to odors varies over wide limits, some chemicals cannot be smelled at toxic concentrations, odors can be masked by other odors, and some compounds rapidly deaden the sense of smell.

Molecular weight: The MW as calculated from the molecular formula using standard elemental molecular weights (e.g., carbon = 12.1).

Boiling point at 1 atm: The value is the temperature of a liquid when its vapor pressure is 1 atm. For example, when water is heated to 100°C/212°F its vapor pressure rises to 1 atm and the liquid boils. The boiling point at 1 atm indicates whether a liquid will boil and become a gas at any particular temperature and sea-level atmospheric pressure.

Melting/Freezing point: The melting/freezing point is the temperature at which a solid changes to liquid or a liquid changes to a solid. For example, liquid water changes to solid ice at 0°C/32°F. Some liquids solidify very slowly even when cooled below their melting/freezing point. When liquids are not pure (e.g., saltwater) their melting/freezing points are lowered slightly.

Flash point: This is defined as the lowest temperature at which vapors above a volatile combustible substance will ignite in air when exposed to a flame. Depending on the test method used, the values given are either Tag Closed Cup (cc) (ASTM D56) or Cleveland Open Cup (oc) (ASTM D93). The values, along with those in *Flammable Limits in Air* and *Autoignition temperature* below, give an indication of the relative flammability of the chemical. In general, the open cup value is slightly higher (perhaps 10−15°F higher) than the closed cup value. The flash points of flammable gases are often far below 0° (F or C) and these values are of little practical value, so the term "flammable gas" is often used instead of the flash point value.

Autoignition Temperature: This is the minimum temperature at which the material will ignite without a spark or flame being present. Values given are only approximate and may change substantially with changes in geometry, gas, or vapor concentrations, presence of catalysts, or other factors.

Flammable Limits in Air: The percent concentration in air (by volume) is given for the LEL (lower explosive flammable limit in air, % by volume) and UEL (upper explosive flammable limit in air, % by volume), at room temperature, unless other specified. The values along with those in "Flash point" and "Autoignition temperature" give an indication of the relative flammability of the chemical.

NFPA Hazard Classifications: The NFPA 704 Hazard Ratings (Classifications) are based on those found in "*Fire Protection Guide to Hazardous Materials*," 2001 edition, National Fire Protection Association, Quincy, MA, ©1994. The classifications are defined in Table 1 below.

Table 1. Explanation of NFPA Hazard Classifications

Classification	*Definition*
HEALTH HAZARD (blue)	
4	Materials which on very short exposure could cause death or major residual injury (even though prompt medical treatment was given), including those that are too dangerous to be approached without specialized protective equipment.
3	Materials which on short exposure could cause serious temporary or residual injury (even though prompt medical treatment was given), including those requiring protection from all bodily contact.
2	Materials that, on intense or continued (but not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of protective clothing that has an independent air supply.
1	Materials which on exposure would cause irritation but only minor residual injury, including those requiring the use of an approved air-purifying respirator.
0	Materials that, on exposure under fire conditions, offer no hazard beyond that of ordinary combustible material.
FLAMMABILITY (red)	
4	This degree includes flammable gases, pyrophoric liquids, and Class IA flammable liquids. Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.
3	Includes Class IB and IC flammable liquids and materials that can be easily ignited under almost all normal temperature conditions.
2	Materials that must be moderately heated before ignition will occur and includes Class II and Class IIIA combustible liquids and solids and semisolids that readily give off ignitable vapors.
1	Materials that must be preheated before ignition will occur, such as Class IIIB combustible liquids, and solids and semisolids whose flash point exceeds 200°F/93.4°C, as well as most ordinary combustible materials.
0	Materials that will not burn.
REACTIVITY (yellow)	
4	Materials that, in themselves, are readily capable of detonation, explosive decomposition, or explosive reaction at normal temperatures and pressures.
3	Materials that, in themselves, are capable of detonation, or explosive reaction, but require a strong initiating source or heating under confinement. This includes materials that are sensitive to thermal and mechanical shock at elevated temperatures and pressures and materials that react explosively with water.
2	Materials that are normally unstable and readily undergo violent chemical change, but are not capable of detonation. This includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures. This also includes materials that may react violently with water or that may form potentially explosive mixtures in water.
1	Materials that are normally stable, but that may become unstable at elevated temperatures and pressures and materials that will react with water with some release of energy, but not violently.
0	Materials that are normally stable, even under fire exposure conditions, and that do not react with water.
OTHER (white)	
₩	Materials which react so violently with water that a possible hazard results when they come in contact with water, as in a fire situation. Similar to Reactivity Classification 2.Oxy—Oxidizing material; any solid or liquid that readily yields oxygen or other oxidizing gas, or that readily reacts to oxidize combustible materials.

It should be noted that OSHA and DOT have differing definitions for the term "flammable liquid" and "combustible liquid." DOT defines a flammable liquid as one which, under specified procedures, has a flashpoint of 140°F/60°C or less. A combustible liquid is defined as "having a flashpoint above 140°F/60°C and below 200°F/93°C." OSHA defines a combustible liquid as having a flash point above 100°F/37.7°C.

Potential Exposure: A brief indication is given of the nature of exposure to each compound in the industrial environment. Where pertinent, some indications are given of background concentration and occurrence from other than industrial discharges such as water purification plants. Obviously in a volume of this size, this coverage must be very brief. It is of course recognized that nonoccupational exposures may be important as well. This 6th edition contains a brief summary called a Compound Description (Toxicity evaluation),[77] such as Agricultural Chemical, Mutagen, Tumorigen, Mutagen, Reproductive Effector, Primary Irritant, Human Data, etc. Compound descriptors define the types of toxicity data found in a record or uses or applications of the chemical if they are recognized by NIOSH. The Compound Descriptor does not represent an evaluation of the toxicity of a substance, nor are the descriptors all-inclusive (i.e., there may be some substances that should be, but are not, coded as belonging to certain application classes). The codes must be interpreted only in conjunction with the other information found in each record.[77]

Incompatibilities: Potentially hazardous incompatibilities of each substance are listed where available. Where a hazard with water exists, it is described. Reactivity with other materials are described including structural materials such as metal, wood, plastics, cement, and glass. The nature of the hazard, such as severe corrosion formation of a flammable gas, is described. This list is by no means complete or all inclusive. In some cases a very small quantity of material can act as a catalyst and produce violent reactions such as polymerization, disassociation, and condensation. Some chemicals can undergo rapid polymerization to form sticky, resinous materials, with the liberation of much heat. The containers may explode. For these chemicals the conditions under which the reaction can occur are given.

Permissible Exposure Limits in Air: The permissible exposure limit (PEL) has been cited as the federal standard where one exists. Inasmuch as OSHA has made the decision to enforce only pre-1989 PELs, we decided to use these values rather than the transitional limits that were vacated by court order. Except where otherwise noted, the PELs are 8-h work-shift time-weighted average (TWA) levels. Ceiling limits, Short-Term Exposure Limits (STELs), and TWAs that are averaged over other than full work shifts are noted.

The Short-Term Exposure Limit (STEL) values are derived from NIOSH,[58] ACGIH,[1] and HSE[33] publications. This value is the maximal concentration to which workers can be exposed for a period up to 15 min continuously without suffering from: irritation; chronic or irreversible tissue change; or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 min between exposure periods, and provided that the daily TWA also is not exceeded. The "Immediately Dangerous to Life or Health" (IDLH) concentration represents a maximum level from which one could escape within 30 min without any impairing symptoms or any irreversible health effects. However, the 30-min period is meant to represent a MARGIN OF SAFETY and is NOT meant to imply that any person should stay in the work environments any longer than necessary. In fact, every effort should be made to exit immediately. The concentrations are reported in either parts per million (ppm) or milligrams per cubic meter (mg/m^3).

Most US specifications on permissible exposure limits in air have come from ACGIH[1] or NIOSH.[2] In the United Kingdom, the Health and Safety Executive has set forth Occupational Exposure Limits.[33] In Germany, the DFG has established Maximum Concentrations in the workplace[3] and the former USSR-UNEP/IRPTC project has set maximum allowable concentrations and tentative safe exposure levels of harmful substance in work-place air and residential air for many substances.[43] This section also contains numerical values for allowable limits of various materials in ambient air[60] as assembled by the US EPA. Where available, this field contains legally enforceable airborne Permissible Exposure Limits (PELs) from OSHA. It also contains recommended airborne exposure limits from NIOSH, ACGIH, and international sources and special warnings when a chemical substance is a Special Health Hazard Substance. Each are described below. TLVs have not been developed as legal standards and the ACGIH does not advocate their use as such. The TLV is defined as the time-weighted average (TWA) concentration for a normal 8-h workday and a 40-h workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. A ceiling value (TLV-C) is the concentration that should not be exceeded during any part of the working exposure. If instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over a 15-min period except for those substances that may cause immediate irritation when exposures are short. As some people become ill after exposure to concentrations lower than the exposure limits, this value cannot be used to define exactly what is a "safe" or "dangerous" concentration. ACGIH threshold limit values (TLVs) are reprinted with permission of the American Conference of Governmental Industrial Hygienists, Inc., from the booklet entitled, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.* This booklet is revised on an annual basis. No entry appears when the chemical is a mixture; it is possible to calculate the TLV for a mixture only when the TLV for each component of the mixture is known and the composition of the mixture by weight is also known. According to ACGIH, "Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition" is necessary to fully interpret and implement the TLVs.

OSHA Permissible Exposure Limits (PELs) are found in Tables Z-1, Z-2, and Z-3 of OSHA, "General Industry Air Contaminants Standard (29CFR1910.1000)" that were effective on July 1, 2001 and which are currently enforced by OSHA.

Unless otherwise noted, PELs are the Time-Weighted Average (TWA) concentrations that must not be exceeded during any 8-h shift of a 40-h workweek. An OSHA ceiling concentration must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-min TWA exposure. In addition, there are a number of substances from Table Z-2 that have PEL ceiling values that must not be exceeded except for a maximum peak over a specified period (e.g., a 5-min maximum peak in any 2 h).

NIOSH Recommended Exposure Limits (RELs) are Time-Weighted Average (TWA) concentrations for up to a 10-h workday during a 40-h workweek. A ceiling REL should not be exceeded at any time. Exposure limits are usually expressed in units of parts per million (ppm), i.e., the parts of vapor (gas) per million parts of contaminated air by volume at 25°C/77°F and one atmosphere pressure. For a chemical that forms a fine mist or dust, the concentration is given in milligrams per cubic meter (mg/m^3).

Protective Action Criteria (PAC) are emergency exposure limits developed by the US Department of Energy (DOE) for 3388 chemicals in revision 26, published September 2010. These exposure limits can be used to estimate the consequences of the uncontrolled release of hazardous materials and to plan for emergency response. These PACs have been added to the 6th edition of Sittig because other well-established exposure limits in air are available for only a limited number of chemicals from other governmental and advisory sources. PAC values are given in parts per million (ppm) for volatile liquids and gases; in milligrams per cubic meter (mg/m^3) for solids, particulates, and nonvolatile liquids. Chemicals for which TEELs (Temporary Emergency Exposure Limits) are available have their values displayed using a regular (non-bold) font. Chemicals for which Acute Emergency Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs) have their values displayed in **bold** font. TEELs are intended for use until AEGLs or ERPGs are adopted for chemicals.

PAC Definitions:[SCAPA]

There are subtle difference in the definitions of AEGLs, ERPGs, and TEELs and major differences in how they are developed and issued. Differences in their definitions include: AEGLs pertain to the "general population, including susceptible individuals," but ERPGs and TEELs pertain to "nearly all individuals."

AEGLs are defined as the level "above which" certain health effects are expected, while ERPGs and TEELs are defined as the level "below which" certain health effects are not expected.

Acute Emergency Guideline Levels (AEGLs) are defined as follows:

- *AEGL-1:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- *AEGL-2:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- *AEGL-3:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

Emergency Response Planning Guidelines (ERPGs) are defined as follows:

- *ERPG-1*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 h without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- *ERPG-2*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 h without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- *ERPG-3*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 h without experiencing or developing life-threatening health effects.

Temporary Emergency Exposure Limits (TEELs) are defined as follows:

- *TEEL-0*: the threshold concentration below which most people will experience no adverse health effects.
- *TEEL-1:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- *TEEL-2:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- *TEEL-3:* the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.
- TEELs are intended for use until AEGLs or ERPGs are adopted for chemicals.

Additional information on PAC values, TEEL values, and links to other sources of information can be found on the webpage for the *Subcommittee for Consequence Assessment and Protective Action (SCAPA)*: http://orise.orau.gov/emi/scapa/teels.htm

The German MAK (DFG MAK) values are conceived and applied as 8-h time-weighted average (TWA) values.[3]

Short-Term Exposure Limits (15-min TWA): This field contains Short-Term Exposure Limits (STELs) from ACGIH, NIOSH, and OSHA. The parts of vapor (gas) per million parts of contaminated air by volume at 25°C/77°F and one atmosphere pressure is given. The limits are given in milligrams per cubic meter (mg/m^3) for chemicals that can form a fine mist or dust. Unless otherwise specified, the STEL is a 15-min TWA exposure that should not be exceeded at any time during the workday.

Determination in Air: The citations to analytical methods are drawn from various sources, such as the *NIOSH Manual of Analytical Methods.*[18] In addition, methods have been cited in the latest US Department of Health and Human Services publications including the *"NIOSH Pocket Guide to Chemical Hazards"* August, 2006.

Permissible Concentrations in Water: The permissible concentrations in water are drawn from various sources also, including: The National Academy of Sciences/National Research Council, Safe Drinking Water Committee Board on Toxicology and Environmental Health Hazards, *Drinking Water and Health,* 1980.[16]

The priority toxic pollutant criteria published by US EPA 1980.[6]

The multimedia environmental goals for environmental assessment study conducted by EPA.[32] Values are cited from this source when not available from other sources.

The US EPA has come forth with a variety of allowable concentration levels:

For allowable concentrations in "California List" wastes.[38] The California List consists of liquid hazardous wastes containing certain metals, free cyanides, polychlorinated biphenyls (PCBs), corrosives with a pH of less than or equal to 2.0, and liquid and nonliquid hazardous wastes containing halogenated organic compounds (HOCs).

For regulatory levels in leachates from landfills.[37]

For concentrations of various materials in effluents from the organic chemicals and plastics and synthetic fiber industries.[51]

For contaminants in drinking water.[36]

For National Primary and Secondary Drinking Water Regulations.[62]

In the form of health advisories for 16 pesticides,[47] 25 organics,[48] and 7 inorganics.[49]

For primary drinking water standards starting with a priority list of 8 Volatile Organic Chemicals.[40]

State drinking water standards and guidelines[61] as assembled by the US EPA.

Determination in Water: The sources of information in this field have been primarily US EPA publications including the test procedures for priority pollutant analysis[25] and later modifications.[42]

Routes of Entry: The toxicologically important routes of entry of each substance are listed. In other words, the way in which the people or experimental animals were exposed to the chemical is listed, e.g., eye contact, skin contact, inhalation, intraperitoneal, intravenous. Many of these are taken from the *NIOSH Pocket Guide,*[2] but are drawn from other sources as well.

Harmful Effects and Symptoms: These are primarily drawn from NIOSH, EPA publications, and New Jersey and New York State fact sheets on individual chemicals, and are supplemented from information from the draft criteria documents for priority toxic pollutants[26] and from other sources. The other sources include:

EPA Chemical Hazard Information Profiles (CHIPS) cited under individual entries.

NIOSH Information Profiles cited under individual entries.

EPA Health and Environmental Effect Profiles cited under individual entries.

Particular attention has been paid to cancer as a "harmful effect" and special effort has been expended to include the latest data on carcinogenicity. See also "Regulatory Authority and Advisory Bodies" section.

Short Term Exposure: These are brief descriptions of the effects observed in humans when the vapor (gas) is inhaled, when the liquid or solid is ingested (swallowed), and when the liquid or solid comes in contact with the eyes or skin. The term LD_{50} signifies that about 50% of the animals given the specified dose by mouth will die. Thus, for a Grade 4 chemical (below 50 mg/kg), the toxic dose for 50% of animals weighing 70 kg (150 lb) is $70 \times 50 = 3500$ mg = 3.5 g, or less than 1 teaspoonful; it might be as little as a few drops. For a Grade 1 chemical (5−15 g/kg), the LD_{50} would be between a pint and a quart for a 150-lb man. All LD_{50} values have been obtained using small laboratory animals such as rodents, cats, and dogs. The substantial risks taken in using these values for estimating human toxicity are the same as those taken when new drugs are administered to humans for the first time.

Long Term Exposure: Where there is evidence that the chemical can cause cancer, mutagenic effects, teratogenic effects, or a delayed injury to vital organs such as the liver or kidney, a description of the effect is given.

Points of Attack: This category is based, in part, on the "Target Organs" in the *NIOSH Pocket Guide*[2] but the title has been changed as many of the points of attack are not organs (e.g., blood). This is human data unless otherwise noted.

Medical Surveillance: This information is often drawn from a NIOSH publication[27] but also from *New Jersey State Fact Sheets*[70] on individual chemicals. Where additional information is desired in areas of diagnosis, treatment, and medical control, the reader is referred to a private publication[28] which is adapted from the products of the NIOSH Standards Completion Program.

First Aid: Guides and guidance to first aid found in this work should not be construed as authorization to emergency personnel to perform the procedures or activities indicated or implied. Care of persons exposed to toxic chemicals must be directed by a physician or other recognized professional or authority. Simple first aid procedures are listed for response to eye contact, skin contact, inhalation, and ingestion of the toxic substance as drawn to a large extent from the *NIOSH Pocket Guide*[2] but supplemented by information from recent commercially available volumes in the United States,[29] in the United Kingdom, and in Japan[24] as well as from state fact sheets. They deal with exposure to the vapor (gas), liquid, or solid and include inhalation, ingestion (swallowing), and contact with eyes or skin. The instruction "Do NOT induce vomiting" is given if an unusual hazard is associated with the chemical being sucked into the lungs (aspiration) while the patient is vomiting.

"*Seek medical attention*" or "*Call a doctor*" is recommended in those cases where only competent medical personnel can treat the injury properly. In all cases of human exposure, seek medical assistance as soon as possible. In many cases, medical advice has been included for guidance only.

Personal Protective Methods: This information is drawn heavily from NIOSH publications[2, 77] and supplemented by information from the United States,[29] the United Kingdom, and Japan.[24] There are indeed other "personal protective methods" which space limitations prohibit describing here in full. One of these involves limiting the quantities of carcinogens to which a worker is exposed in the laboratory. The items listed are those recommended by (a) NIOSH and/or OSHA, (b) manufacturers, either in technical bulletins or in material safety data sheets (MSDS), (c) the Chemical Manufacturers Association (CMA), or (d) the National Safety Council (NSC), for use by personnel while responding to fire or accidental discharge of the chemical. They are intended to protect the lungs, eyes, and skin.

Respirator Selection: The 6th edition, like its predecessors, presents respirator selection with a full text description. For each line a maximum use concentration (in ppm, mg/m^3, μg/m^3, fibers/m^3, or mppcf) condition (e.g., escape) followed by the NIOSH code and full text related to respirator recommendations. All recommended respirators of a given class can be utilized at any concentration equal to or less than the class's listed maximum use concentration. Respirator selection should follow recommendations that provide the greatest degree of protection. Respirator codes found in the *NIOSH Pocket Guide* have been included to ease updating.

All respirators selected must be approved by NIOSH under the provisions of 42CFR84. The current listing of NIOSH/MSHA-certified respirators can be found in the *NIOSH Certified Equipment List*, which is available on www.cdc.gov/niosh/npptl/topics/respirators/cel (NIOSH Web site).

For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive-pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*. In the case of chemical warfare agents, use only SCBA Respirator certified by NIOSH for CBRN environments. CBRN stands for "Chemical, Biological, Radiological, and Nuclear."

Pesticides are not identified as such in the respirator selection tables. For those substances that are pesticides, the recommended air-purifying respirator must be specifically approved by NIOSH/MSHA. Specific information on choosing the appropriate respirator will be provided on pesticide labels. Approved respirators will carry a "TC" number prefix, which signifies they have been tested and certified for a specific level of protection. New respirators may carry a "TC-84A" prefix in compliance with 42CFR84 for testing and certifying nonpowered, air-purifying, particulate-filter respirators. The new Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume, and mist [DFM], spray paint, and pesticide) certified under 30CFR11.

Additionally, a complete respirator protection program should be implemented including all requirements in 29CFR1910.134 and 42CFR84. At a minimum, a respirator protection program should include regular training, fit-testing, periodic environmental monitoring, maintenance inspection, and cleaning. The selection of the actual respirator to be used within the classes of recommended respirators depends on the particular use situation, and should only be made by a knowledgeable person. Remember, air-purifying respirators will not protect from oxygen-deficient atmospheres. For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive-pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*.

Storage: The 6th edition now provides, as general guidance, a color-coded classification system similar to those often found in commerce and laboratories. It is the objective of any chemical storage classification system to prevent accidental combination of two or more incompatible materials that might be stored in the same space. To prevent an unwanted and possibly dangerous reaction, chemicals must be separated by space and/or physical barriers. Chemical storage areas should be appropriately labeled. Users must be careful to check the MSDS for both additional and specific information. Some chemical entries contain multiple storage codes because the chemical profile fits more than a single category.

Code	***Hazard***
Red	Flammables (flash point <100°F)
Blue	Health hazards/toxics/poisons
Yellow	Reactives/oxidizers
White	Contact hazards
Green*	General storage

*For general storage, the colors Gray and Orange are also used by some companies.

- Chemical containers that are not color coded should contain hazard information on the label.
- Check the MSDS to learn what personal protective equipment is required when using the substance
- *Red*: Flammability Hazard: Store in a flammable (liquid or materials) storage area or approved cabinet away from ignition sources and corrosive and reactive materials.
- *Blue*: Health Hazard/Toxics/Poisons: Store in a secure poison location.
- *Yellow*: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles.
- *White*: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location.
- *Green (or Gray or Orange)*: General storage may be used. Generally, for flammability, health, and corrosivity with an NFPA rating of no higher than "2."

- Chemicals with labels that are colored and diagonally striped may react with other chemicals in the same hazard class. See MSDS for more information.
- *Red Stripe*: Flammability Hazard: Store separately from all other flammable materials. Example: sodium metal.
- *Yellow Stripe*: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. *Example*: reducing agents.
- *White stripe*: Contact Hazard; not compatible with materials in solid white category. Store separately. *Exampl*e: Bases.

Other data in this field are drawn from, or based on, various resources, including the NFPA,[17] Japanese sources,[24] and publications such as the *Hazardous Substance Fact Sheets* published by the New Jersey Department of Health and Senior Services.[70]

Shipping: The shipping guidance offered herein does not replace the training requirements of the Department of Transportation and in no way guarantees that you will be in full compliance with the Department of Transportation Regulations. *Labeling*: This section refers to the type label or placard required by regulation on any container or packaging of the subject compound being shipped. In some cases a material may require more than one hazardous materials label. *Quantity limitation:* This section lists quantities of material that may be shipped on passenger aircraft, rail, and cargo aircraft. Materials in certain hazard classes may be shipped under the small quantities exception (see 49CFR173.4) with specific approval from the Associate Administrator for Hazardous Materials Safety, Department of Transportation. *Hazard class or division:* This number refers to the division number or hazard class that must appear on shipping papers. This information is drawn from DOT publications[19] as well as UN publications[20] and also NFPA publications.[17] The US Department of Transportation[19] has published listings of chemical substances which give a hazard classification and required labels. The US DOT listing now corresponds with the UN listing[20] and specifies first a hazard class of chemicals as defined in the following table, and then a packing group (I, II, or III) within each of the classes. These groups are variously defined depending on the hazard class but in general define materials presenting: I—a very severe risk (great danger); II—a serious risk (medium danger); and III—a relatively low risk (minor danger).

HAZARD CLASSIFICATION SYSTEM

The hazard class of dangerous goods is indicated either by its class (or division) number or name. For a placard corresponding to the primary hazard class of a material, the hazard class or division number must be displayed in the lower corner of the placard. However, no hazard class or division number may be displayed on a placard representing the subsidiary hazard of a material. For other than Class 7 or the OXYGEN placard, text indicating a hazard (e.g., “CORROSIVE”) is not required. Text is shown only in the United States. The hazard class or division number must appear on the shipping document after each shipping name.

Class 1—Explosives
Division 1.1: Explosives with a mass explosion hazard
Division 1.2: Explosives with a projection hazard
Division 1.3: Explosives with predominantly a fire hazard
Division 1.4: Explosives with no significant blast hazard
Division 1.5: Very insensitive explosives with a mass explosion hazard
Division 1.6: Extremely insensitive articles
Class 2—Gases
Division 2.1: Flammable gases
Division 2.2: Nonflammable, nontoxic* gases
Division 2.3: Toxic* gases
Class 3—Flammable liquids [and Combustible liquids (US)]
Class 4—Flammable solids; Spontaneously combustible materials; and Dangerous when wet materials/Water-reactive substances
Division 4.1: Flammable solids
Division 4.2: Spontaneously combustible materials
Division 4.3: Water-reactive substances/Dangerous when wet materials
Class 5—Oxidizing substances and Organic peroxides
Division 5.1: Oxidizing substances
Division 5.2: Organic peroxides
Class 6—Toxic* substances and Infectious substances
Division 6.1: Toxic* substances
Division 6.2: Infectious substances
Class 7—Radioactive materials
Class 8—Corrosive substances
Class 9—Miscellaneous hazardous materials/Products, Substances, or Organisms
*The words “poison” or “poisonous” are synonymous with the word “toxic.”

Spill Handling: Spill or leak information provided is intended to be used only as a guide. The term *Issue warning* is used when the chemical is a poison, has a high flammability, is a water contaminant, is an air contaminant (so as to be hazardous to life), is an oxidizing material, or is corrosive. *Restrict access* is used for those chemicals that are unusually and immediately hazardous to personnel unless they are protected properly by appropriate protective clothing, eye protection, and respiratory protection equipment. *Evacuate area* is used primarily for unusually poisonous chemicals or those that ignite easily. *Mechanical containment* is used for water-insoluble chemicals that float and do not evaporate readily. *Should be removed* is used for chemicals that cannot be allowed to disperse because of potentially harmful effects on humans or on the ecological system in general. The term is not used unless there is a reasonable chance of preventing dispersal, after a discharge or leak, by chemical and physical treatment. *Chemical and physical treatment* is recommended for chemicals that can be removed by skimming, pumping, dredging, burning, neutralization, absorption, coagulation, or precipitation. The corrective response may also include the use of dispersing agents, sinking agents, and biological treatment. *Disperse and flush* is used for chemicals that can be made nonhazardous to humans by simple dilution with water. In a few cases the response is indicated even when the compound reacts with water because, when proper care is taken, dilution is still the most effective way of removing the primary hazard. This material safety data sheet information is drawn from a variety of sources including New Jersey Department of Health and Senior Services *Hazardous Substance Fact Sheets*[70] and EPA *Profiles on Extremely Hazardous Substances.*[82]

Fire Extinguishing: Fire information provided is intended to be used only as a guide. Certain extinguishing agents should not to be used because the listed agents react with the chemical and have the potential to create an additional hazard. In some cases they are listed because they are ineffective in putting out the fire. Many chemicals decompose or burn to give off toxic and irritating gases. Such gases may also be given off by chemicals that vaporize in the heat of a fire without either decomposing or burning. If no entry appears, the combustion products are thought to be similar to those formed by the burning of oil, gasoline, or alcohol; they include carbon monoxide (poisonous), carbon dioxide, and water vapor. The specific combustion products are usually not well known over the wide variety of conditions existing in fires; some may be hazardous. This information is drawn from NFPA publications,[17] FEMA,[78] and other sources. Any characteristic behavior that might increase significantly the hazard involved in a fire is described. The formation of flammable vapor clouds or dense smoke, the possibility of polymerization, and explosions is stated in this section and/or the incompatibility section. Unusual difficulty in extinguishing the fire is noted.

Disposal Method Suggested: The disposal methods for various chemical substances have been drawn from various sources, including government documents and a UN publication.[22, 79]

References: The general bibliography for this volume follows immediately. It includes both general reference sources and references dealing with analytical methods. The references at the end of individual chemical records are generally restricted to: references dealing only with that particular compound; and references which, in turn, contain bibliographies giving references to the original literature on toxicological and other behavior of the substance in question.

Key to Abbreviations and Acronyms

α	the Greek letter *alpha*; used as a prefix to denote the carbon atom in a straight chain compound to which the principal group is attached.
as-	prefix for asymmetric
ACGIH	American Conference of Governmental Industrial Hygienists
AEGL	Acute Emergency Guideline Level, developed by the EPA
AIHA	American Industrial Hygiene Association
approx.	approximately
asym-	prefix for asymmetric
atm.	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
β	the Greek letter *beta*
BEI	Biological Exposure Indices (ACGIH in the USA; South Africa; New Zealand)
BLV	Biological Limit Values
BP	boiling point
°C	degrees Centigrade
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAMEO	Computer-Aided Management of Emergency Operations (NOAA)
carc.	carcinogen
CAS	Chemical Abstract Service
cc	cubic centimeter
cc	closed cup (Flash point)
CDC	US Center for Disease Control
CEPA	Canadian Environmental Protection Act
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CFCs	chlorofluorocarbons
CFR	*Code of Federal Regulations*
cis-	(Latin: on this side). Indicating one of two geometrical isomers in which certain atoms or groups are on the same side of a plane
CMA	Chemical Manufacturers Association
CPR	Cardiopulmonary Resuscitation
CWA	Clean Water Act
cyclo-	(Greek, circle). Cyclic, ring structure; as cyclohexane
Δ or δ	Greek letter *delta*
DFG	Deutsche Forschungs-gemeinschaft
DOE	US Department of Energy
DOT	US Department of Transportation
DOT ID	Department of Transportation Identification Numbers
EEC or EC	European Economic Community
EEGL	Emergency Exposure Guidance Level
EHS	Extremely Hazardous Substances
EINECS	European Inventory of Existing Commercial Chemical Substances
ε	Greek letter *epsilon*
EPA (US)	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESLI	End of Service Life Indicator
EU	European Union
°F	degrees Fahrenheit
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FR	*Federal Register*
γ	Greek letter *gamma*
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
h	hour(s)
HCFC	hydrochlorofluorocarbons
HCS	Hazard Communication Standard
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life or Health
ILO	International Labor Office
IRIS	Integrated Risk Information System (EPA)
iso-	(Greek, equal, alike). Usually denoting an isomer of a compound
kg	kilogram(s)
l	liter(s)
lb	pound(s)
LC_{50}	The concentration of a substance in air that kills 50% of the test population.
LC_{Lo}	The lowest concentration of a substance in air that has been shown to cause death in a test population.
LD_{50}	The dose of a substance administered by any route (other than inhalation) that causes death to 50% of the test population.
LD_{LO}	The lowest dose of a substance administered by any route (other than inhalation) that has been shown to cause death in a test population.
LEL	Lower explosive (flammable) limit in air, % by volume at room temperature or other temperature as noted
LEPC	Local Emergency Planning Committees
LTEL	Long-Term Exposure Limit (UK)
m-	an abbreviation for "*meta-*," a prefix used to distinguish between isomers or nearly related compounds
m^3	cubic meter

MACT	Maximum Achievable Control Technology (CAA)
MAK	airborne exposure limit "Maximale Arbeitsplatz-Konzentration" (maximum workplace concentration) from the Deutsche Forschungs-gemeinschaft (DFG), German Research Foundation.
MCL	Maximum Contaminant Level (SDWA)
MCLG	Maximum Contaminant Level Goal (SDWA)
mg	milligram(s)
μ	micro
μg	microgram(s)
min	minute(s)
mmHg	millimeters of mercury (non-SI symbol for pressure). Also known as "torr"
mppcf	million particles per cubic foot
MSDS	Material Safety Data Sheets
n-	abbreviation for "normal," referring to the arrangement of carbon atoms in a chemical molecule prefix for normal
N-	Symbol used in some chemical names, indicating that the next section of the name refers to a chemical group attached to a nitrogen atom. The bond to the nitrogen atom
NCI	National Cancer Institute (USA)
NFPA	National Fire Protection Association (USA)
NIOSH	National Institute for Occupational Safety and Health (USA)
NLM	National Library of Medicine (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOAEL	No Observed Adverse Effect Level
NOS	not otherwise specified
NPRI	National Pollutant Release Inventory (Canada)
NTIS	National Technical Information Service (USA)
NTP	National Toxicology Program (USA)
o-	*ortho-*, a prefix used to distinguish between isomers or nearly related compounds
OEL	Occupational Exposure Limit
ω	Greek letter *omega*
oc	open cup
OSHA	Occupational Safety and Health Administration (USA)
Oxy	Oxidizer or oxidizing agent
p-	an abbreviation for "*para-*," a prefix used to distinguish between isomers or nearly related compounds
PAC	Protective Action Criterion (US DOE)
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PE	polyethylene
PEL	Permissible Exposure Limit (USA, Japan, Mexico)
PNOS	Particulates Not Otherwise Specified
POTW	Publicly Owned Treatments Works
PP	polypropylene
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical Quantitation Limit (RCRA)
prim-	prefix for primary
REL	Recommended Exposure Limits (NIOSH)
RQ	Reportable Quantity
RTECS	Registry of Toxic Effects of Chemical Substances
RTK	Right-to-Know
SARA	Superfund Amendments and Reauthorization Act
s. carc.	Suspected Carcinogen
SCAPA	Subcommittee on Consequence Assessment and Protective Actions (DOE)
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
sec-	prefix for secondary
SERC	State Emergency Response Commissions
SMCL	Secondary Maximum Contaminant Levels (SDWA)
STEL	Short-Term Exposure Limit
sym-	abbreviation for "symmetrical," referring to a particular arrangement of elements within a chemical molecule
t-	prefix for tertiary
TC_{Lo}	The lowest concentration of a substance in air that has been shown to produce toxic effects in a test population.
TD_{Lo}	The lowest dose of a substance that has been shown to produce toxic effects in a test population
TEEL	Temporary Emergency Exposure Limit
TRK	Technical Guiding Concentrations (DFG) for workplace control of carcinogens
tert-	abbreviation for "tertiary," referring to a particular arrangement of elements within a chemical molecule
TLV®	Threshold Limit Value (ACGIH)
TQ	Threshold Quantity
trans-	(Latin: across). Indicating that one of two geometrical isomers in which certain atoms or groups are on opposite sides of a plane
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average. Often shown as TWA—8 h
UEL	Upper Explosive (flammable) Limit in air, % by volume at room temperature or other temperature as noted
UN	United Nations
unsym-	prefix for asymmetric

USDA	US Department of Agriculture
USCG	US Coast Guard
VOCs	Volatile Organic Compounds
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)
>	symbol for “greater than”
<	symbol for “less than”
≤	symbol for “less than or equal to”
≥	symbol for “greater than or equal to”
°	degrees of temperature
%	percent

A

Abrin A:0025

Molecular Formula: None
Synonyms: Abrins; *Abrus precatorius* seed; Agglutinin; Aivoeiro; Arraccu-mitim; Buddhist rosary bead; Carolina muida; Crab's eyes; Deadly crab's eye; Indian bead; Indian licorice seed; Jequirite; Jequirity bean; John Crow bead Jumble bead; Juquiriti; Lectin protein; Love bean; Lucky bean; Mienie-Mienie; Phytotoxin *(Abrus precatorius* seed); Prayer bead; Precatory bean; Rosary beads; Rosary Pea; Ruti; Seminole bead; Tentos da America (Spanish); Tentos dos mundos (Spanish); Toxalbumin; Vegetable Toxalbumin; Weather plant; Wild licorice
CAS Registry Number: 1393-62-0
RTECS® Number: AA5250000
UN/NA & ERG Number: UN3462 (Toxin, extracted from living sources, solid)/153; UN3172 (Toxins, extracted from living sources, n.o.s.)/153
EC Number: Not assigned
Regulatory Authority and Advisory Bodies
Report any release of WMD to National Response Center 1-800-424-8802.
European/International Regulations: Hazard Symbol: T; Risk phrases: R26/27/28; R42/43; Safety phrases: S23; S28; S36/37; S45 (see Appendix 4).
WGK (German Aquatic Class): No value assigned. However, *based on toxicity the following may apply*: 3—Severe hazard to waters.
Description: Abrin is a lethal, delayed-action cytotoxin/biotoxin. It is stable under ambient conditions and can persist in the environment for a long time despite extreme conditions and temperatures. Abrin is a yellowish-white powder. Molecular weight = (approx.) 63,000−67,000 Da; Boiling point = decomposes at 80°C (most of the toxicity is lost in 30 min); Volatility = negligible; Vapor pressure = negligible at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4; Flammability -; Reactivity 0. Sparingly soluble in water; solubility = 160 mg/L.
Detection: The BTA® (BioThreat Alert®) test strips (Tetracore Inc., 9901 Belward Campus Drive, Rockville, MD; Telephone: 240/268-5400) allows for screening of Abrin. Abrin is detectable in urine, plasma, and environmental samples. Instant Chek Abrin/Ricin Detection Kit, Catalog Number: IC-RA-003-10 Kit Contents: 10 test units each test contains two tests (1 Abrin and 1 Ricin) per unit, lyophilized reagent, reconstitution buffer, wash buffer, transfer pipettes, instruction booklet. EY Laboratories, Inc., 107 N. Amphlett Blvd, San Mateo, CA 94401, USA, Toll Free (North America) 1-800-821-0044; Telephone: 1-650-342-3296, Option 2 or 3; Fax: +1 (650) 342 2648.
History of the Material: Abrin has not been known to have been used as a biological weapon in any wars or terrorist attacks. Rosary pea vines, or *Abrus precatorius*, are perennial plants that are native to India and other tropical areas throughout the world. The vines can grow up to 10−20 feet, producing small, colored flowers ranging in color from pink to red and purple bean-bearing legume pods that are 1−1.5 inches in length. Rosary peas or jequirity beans are uniform in size and weight and are an attractive bright red color with black spots on one end. Rosary pea vines are capable of growing in warm climates around the world, including the United States, where they are established in Florida. The beans, in Florida, are called "Seminole beads." Dangerous to both people and pets, these invasive plants should be professionally removed to prevent both spreading and accidental poisonings.
Potential Exposure: Abrin is a lectin, plant glycoprotein, and cytotoxin that is present in the rosary pea (*Abrus precatorius*). The poison in Abrin binds and agglutinates animal cells. Abrin is among the most potent and lethal substances known to humankind. A single seed can be fatal; a single milligram is capable of killing an adult within a few days. When the seeds of the rosary pea are damaged, these drilled beads (drilled with holes for making beaded jewelry or rosaries/prayer beads) can be fatally dangerous if swallowed. The dust inside the beads remains stable, and years following collection some people can be poisoned if the beads are broken and the dust is inhaled, ingested, gets in the eyes, or comes in contact with broken skin. Many, perhaps most, cases of *Abrus* seed poisonings are unintentional and in children who are attracted to the colorful looking beans. The severity of an exposure is often dependent on how much Abrin is released when the seeds are chewed or masticated, releasing poisonous vegetable *toxalbumins*. Some cases of *Abrus* exposure, even after ingestion of large amounts of plant material, may result in little or no clinical effects. This situation may reflect variations in toxicity and/or poor GI absorption. If the seeds of these plants are *not chewed and swallowed whole*, symptoms are much less likely to occur. Due to the hard shell, it is possible for the seeds to pass through the gastrointestinal tract without incident.

This relatively inexpensive, accessible, natural source may allow for easy preparation of large and dangerous quantities of Abrin. It can be made in various forms: as a powder or mist that can be inhaled; in the form of a pellet for injection in the skin; or a powder which can be dissolved in water and ingested. One can also be exposed by touching surfaces on which Abrin particles or droplets of Abrin have landed; or if particles or droplets of Abrin land on injured or broken skin or in the eyes. Abrin can contaminate water and food and it can be released into outdoor air as an aerosol which has the potential to contaminate agricultural products.

Abrin is much more poisonous than a related cytotoxin, Ricin [LD_{50} = (Ricin) 3 μg/kg; (Abrin) 0.04 μg/kg in laboratory mice]. Abrin poisoning is not contagious and does not spread from person to person. Because Abrin is not a living

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00001-1

thing but rather a chemical made by living things, it probably would NOT make as effective a military weapon such as viruses or bacteria (i.e., ebola virus or anthrax). Nevertheless, it would make an effective terrorist weapon because it is both easy to make and use. With no known antidote, vaccine, or other effective therapy available for Abrin poisoning, the threat of this agent being released into the environment as an aerosol, or added to the food or water supply, could be catastrophic.

Leaves and roots of the rosary pea vine have been used as a herbal remedy in traditional or folk medicine. It should be noted that although Abrin has the potential to be used as a terrorist weapon, it also has some potential medical uses. In modern medicine, Abrin may be used in medical research and to kill malignant cells in cancer treatment. Ricin is extremely hazardous when freeze-dried, forming a light, easily-dispersed powder. For this reason, researchers are directed to avoid freeze-drying Ricin. Abrin potentially has similar properties and dangers.

Incompatibilities: Toxic proteins of Abrin are resistant to digestive enzymes but are destroyed in cooking. The toxic portion of Abrin is heat stable at ambient temperatures and begins to decompose at 60°C/140°F. At 80°C/176°F, most of the toxicity is lost in about 30 min. Avoid contact with strong oxidizers. When heated to decomposition, Abrin releases toxic nitrogen oxides.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC), not determined/established.

ChemWatch®: 0.00006 mg/m^3 Ceiling limit (sensitizer).[CDC]

Determination in Air: No NIOSH or OSHA methods available.

Permissible Concentration in Water: Unknown.

Routes of Entry: Abrin can be absorbed by all routes of exposure but normally enters the body by ingestion. Aerosolized Abrin can enter the body by inhalation. The toxin attaches to cell surfaces of various tissues, particularly the stomach lining if ingested; or in the moist, upper respiratory tissues if inhaled.

Harmful Effects and Symptoms

Abrin inhibits protein synthesis by penetrating the body's cells and block the body's ability to regenerate essential proteins in vital organs of the body such as the liver, central nervous system (CNS), kidneys, and adrenal glands. The toxin A-chain is an *N-glycosidase* protein that removes an adenine residue from 28S RNA, which disrupts protein synthesis throughout the body. Once this cellular protein synthesis mechanism is disrupted, within hours the body's systems begins to shut down and die due to multisystem organ failure. EXTREMELY TOXIC—estimated human fatal dose after oral consumption by humans is approximately 0.005–0.007 mg/kg.[NIOSH] LD_{50} = (oral-mice) about 3 g/kg by injection or aerosol; LD_{50} = (oral-mice) 0.04 μg/kg.

The major symptoms of Abrin poisoning are dependent on the purity, route, and level (dose) of exposure (inhalation, ingestion, or injection) though multiple organs may be affected in severe cases. Initial symptoms of Abrin poisoning by inhalation may occur within 8 h of exposure. The American Medical Association's *Quick Reference Guide to Biological Weapons* estimates "8–24 h (acute symptoms may appear as early as 4–8 h following exposure)." Following ingestion of Abrin, initial symptoms may occur in less than 6 h but are often delayed for 1–3 days. Intravenous or intramuscular injection (parenteral administration) of Abrin is of greatest concern because a high fatality rate is normally expected. Although symptoms may be delayed for several days, patients frequently develop the gastrointestinal effects within 6 h.[TOXNET] It is possible for death from Abrin poisoning to take place within 36–72 h of exposure. Within several days, the person's liver, spleen, and kidneys might stop working and the person will die. If death has not occurred after 5 days following symptoms of exposure, without complications, it is possible that the victim may not die and recovery is possible.

When directly exposed, toxalbumins (poisonous vegetable matter) in Abrin can cause severe gastrointestinal lesions with irritation of the area of the throat, at the back of the mouth (oropharynx), esophagus, or stomach. Although clinically similar to alkaline caustic burns, they are usually delayed two or more hours following exposure. This exposure can be severe and life threatening, particularly in those locales not having advanced health care systems. There are a a few reported cases of Abrin causing an acute and diffuse inflammation of the brain and spinal cord usually caused by a hypersensitivity response to tissue surrounding a blood vessel.

Short Term Exposure: The following lists do not convey prioritization or indicate specificity. *Ingestion*: Generally within a few hours symptoms will appear, including nausea, profuse vomiting, abdominal pain and cramping, watery diarrhea (possibly bloody), later vomiting of blood (hematemesis) and stools or vomit stained black by blood pigment or dark blood products melena (melena), hemagglutination (the agglutination of red blood cells caused by an antibody either for red blood cell antigens or for antigens that coat red blood cells, or by the presence of viruses or other microbes), lowered blood pressure, hallucinations, seizures, tetany, gastrointestinal bleeding, pancreatitis, tachycardia, low or no urinary output, dilation of the pupils, hallucinations, drowsiness, fever, thirst, sore throat, headache, dilated pupils, vascular collapse, and shock. *Note*: abnormal liver function tests (elevated liver enzymes), multiple ulcerations, and hemorrhages of gastric and small-intestinal mucosa on endoscopy. Severe vomiting and diarrhea may result from severe dehydration (hypovolaemic-shock) followed by low blood pressure and multisystem organ failure. Within 36–72 h following exposure, organs (liver, spleen, and kidneys) might stop working and the victim may die. *Inhalation*: Within a few hours of inhaling significant amounts of Abrin, the likely symptoms would be respiratory distress, difficult or labored breathing; shortness of breath; chest tightness, hypoxemia, fever, cough, nausea, sweating, aching muscles. Heavy sweating may follow as noncardiogenic pulmonary edema develops.* This would make breathing even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by X-ray or by listening to the chest with a stethoscope. Finally, low blood pressure, blue skin, multisystem organ failure, respiratory failure may occur, and possible death. *Skin*: It is generally believed that the risk of Abrin toxicity is low from contact with unbroken skin; however, it may be absorbed through irritated, damaged, abraded, wounded, or injured skin; or through normal skin when Abrin is dissolved in solvents such as hydrocarbons or petroleum products. If enough Abrin gets through the skin, the symptoms will be similar to those described for ingestion. If Abrin is injected, the muscles and lymph nodes near the injection site would die. This could lead to possible seizures, liver and kidney failure, cardio-collapse, and death. *Eyes:* Abrin in the powder or mist form can cause redness and pain of the skin and the eyes. Tearing, swelling of the eye-lids, pain, redness, corneal injury, fever, fatigue, weakness, muscle pain, dehydration, possible seizures, cardio-collapse, and death. Like Ricin, urinary excretion of Abrin is probably slow and limited, with the estimated half-life being about 8 days. *Late phase complications*: based on Ricin, it is expected that complications are related to Abrin's cell killing (cytotoxic) effects on the liver, central nervous, kidneys, and adrenal glands, typically 2−5 days after exposure. The patient may be asymptomatic (showing no symptoms of exposure) during the preceding 1−5 days.[CDC]

*Based on Ricin, Abrin-induced pulmonary edema would be expected to occur much later (1−3 days postexposure) compared to that induced by other agents such as phosgene (about 6 h postexposure).

Long Term Exposure: Based on its similarity to Ricin, repeated exposure to Abrin may cause allergic/asthma-like symptoms with congestion of nose and throat; itchy, watery eyes; hives; tightness of the chest; and in acute cases, wheezing. May affect kidneys, liver, pancreas. Based on exposure of Ricin to animals, Abrin may be capable of causing severe lung damage in humans. Information about carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to Abrin is unknown at this time.

Points of Attack: Lungs, eyes, skin (primarily through cuts and bruises). The risk of toxicity from unbroken skin exposure to Abrin is low but there may still be a danger of allergic skin reactions.

Medical Surveillance: Unfortunately Abrin symptoms resemble those that are similar to other diseases, especially the common flu. Laboratory testing might include metabolic acidosis, increased liver function tests, increased renal function tests, hematuria, leukocytosis (2- to 5-fold higher than normal).

First Aid: No antidote exists for Abrin. Make all exposed people go to the nearest hospital emergency department. Make all potentially exposed people shower and change clothes. In case you have gotten Abrin on your skin or your clothing, immediately shower and change clothes. See a doctor as soon as possible: since it can take only a day and a half for symptoms to appear, all exposed persons should get to a doctor that same day. If exposure includes contact with Abrin, remove it *off or out* of the body as quickly as possible. Treatment needs to be provided in a hospital setting. Make the doctors and nurses aware of the potential for exposure so that they can protect themselves; and provide the most appropriate treatments and therapies. If you have to wait for medical assistance, make the victim comfortable. If Abrin has been ingested, the airway must be secured and stomach pumping (gastric lavage) may be considered. Gastric lavage is recommended only if it can be done shortly after ingestion (generally within 1 h). Risk of aggravating injury to the lining of the gastrointestinal (GI) tract must be considered.

To minimize the effects of the poisoning and to keep the patient stable, Abrin poisoning is treated through supportive therapy. The types of supportive medical care would depend on several factors, such as the route by which victim(s) were poisoned (i.e., whether poisoning was by inhalation, ingestion, eye, or skin exposure). Do not induce vomiting. Rinse mouth, flush stomach with activated charcoal* (if the Abrin has been very recently ingested), washing out the victim's eyes with water, especially if the eyes are red and irritated. Supportive care could include intravenous fluid input and support of circulation and respiration; giving medications to treat conditions such as seizure and low blood pressure. Fluid input is critical, as fluid losses of up to 2½ L are probable. If individual is drowsy or unconscious, do not give anything by mouth. In the event of vomiting, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. Fluid and electrolyte balance should be monitored and restored if abnormal. Early and aggressive IV fluid and electrolyte replacement. If the victim's lungs fill with fluid, you administer oxygen if his breathing is difficult or labored.

*Superactivated charcoal may be of little value for large molecules such as Abrin and Ricin.[USAMRICD]

Decontamination: When Abrin symptoms appear and you know the location of the attack, the area should be decontaminated with responders wearing level A (fully encapsulated suit with SCBA). Otherwise, stay away. Move as fast as possible; extra minutes before decontamination might make a big difference. If the Abrin attack was by small particles floating in the air (aerosol), and you have the equipment, (*this is very important*) then you have to decontaminate as soon as you can. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. If possible, place all clothing in a labeled durable 6-mil polyethylene bag. If the victim cannot move, decontaminate, if possible, without touching and without entering the hot zone. To prevent spreading the agent, be certain that victims are decontaminated as much as possible before allowing them to leave the area. During the decontamination process, be careful not to break the patient/victim's skin and take care to cover all open wounds. The CDC recommends a decontamination procedure solution of detergent and water (with a pH value in the alkaline range of more than 8 but less than 10.5). Soft brushes should be available to remove contamination from the personal protective equipment. Also recommended for cleanup of people and surfaces is household bleach. Use a fresh (made daily) solution of 0.5% sodium hypochlorite [diluted household bleach (10%, or one part bleach to nine parts water)]. Contact time: 15 min. Do not get bleach solution in the victim's eyes, open wounds (especially of the abdomen, spinal cord, or brain), or mouth. Wash off the diluted bleach solution after 15 min. Labeled, durable 6-mil polyethylene bags should be available for disposal of clothing and contaminated personal protective equipment. In the absence of pH adjusted solutions, wash the victim with lots of warm water with soap. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing (at least down to undergarments), begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: the idea is to immediately wash with water, then have the victim (not the responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction.

Personal Protective Methods: Level A (Fully encapsulated suit with SCBA) protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level A (fully encapsulated suit with SCBA) protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. Recommenced protective clothing and materials include Tychem® BR or Responder® CSM. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

Respirator Selection: Pressure demand, self-contained breathing apparatus [SCBA; Chemical, Biological, Radiological, Nuclear (CBRN), if available] is recommended in response to nonroutine emergency situations.

Storage: Color Code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked poison location. Store in a cool, dry, well-ventilated area and away from food stuff containers.

Shipping: Toxin, extracted from living sources, solid. Label "POISON (TOXIC)." This falls in Hazard Class: 6.1(a), Packing Group: I.

Spill Handling:. You must be careful! Avoid generating dust. Since an Abrin attack may be by small particles of Abrin floating in the air (aerosol), do not breathe it or get it on you. Remember that the victim's clothes or body may have Abrin; touch them and you can become a victim. If you think Abrin particles might be in the area, stay out until you are equipped with level A (fully encapsulated suit with SCBA), proper personal protective equipment (PPE), including protective clothing and respiratory protection. Shut off heating, ventilation, and air conditioning (HVAC) systems to prevent the tiny aerosolized (floating in the air) Abrin droplets from spreading throughout the building. Keep the public away. Immediately call for medical assistance. For those contaminated by Abrin, do not allow anyone to leave the hot zone. The Abrin chemical does not dissipate quickly and "survives" in clothing and bedding for long periods of time. Consequently, people as well as "things" must be quarantined and decontaminated. Do not allow anyone to leave until medical people examine them. Do not breathe, touch, or eat anything that might be contaminated with Abrin. Notify the federal authorities, local health, and pollution/environmental agencies. See Decontamination.

Fire Extinguishing: If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi (800 m) in all directions; also, consider initial evacuation for 0.5 mi (800 m) in all directions.[CDC] On fire, use foam, dry chemical powder, BCF [bromochlorodiflouromethane (Halon 1211)] where regulations permit, carbon dioxide, water spray or fog—large fires only. When heated to decomposition, Abrin emits toxic nitrogen oxides. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested: Do not clean up or dispose of Abrin, except under supervision of a specialist. Disposal of spillage in sealed 6-mil polyethylene or polypropylene containers.

References

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Acenaphthene A:0050

Molecular Formula: $C_{12}H_{10}$

Common Formula: $C_{10}H_6(CH_2)_2$

Synonyms: Acenafeno (Spanish); Acenaphthylene, 1,2-dihydro; 1,8-Dihydroacenaphthalene; 1,2-Dihydroacenaphthylene;

1,8-Dihydroacenaphthylene; 1,8-Ethylenenaphthalene; Ethylenenaphthalene; Naphthyleneethylene; Periethylenenaphthalene

CAS Registry Number: 83-32-9

RTECS® Number: AB0000000

UN/NA & ERG Number: UN3077/171

EC Number: 201-469-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles.

Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total.

Listed on the TSCA inventory.

Toxic Organics, 40CFR423, Priority Pollutants; as polynuclear aromatic hydrocarbons (PAH).

RCRA 40CFR258, Appendix 2.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as coal tar pitch volatiles.

Mexico, Drinking Water, Criteria (Ecological): 0.02 mg/L; wastewater: organic toxic pollutant.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S26; S37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acenaphthene is a white combustible, crystalline solid. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 154.07; Density = 1.02; Boiling point = 277.5−279°C; Freezing/Melting point = 93.6−97°C; Vapor pressure = 2.8×10^{-3} mmHg at 20°C; Flash point = 135°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability 1; Reactivity 0. Practically insoluble in water; solubility = 3.45−7.38 mg/L at 25°C.

Potential Exposure: Acenaphthene occurs naturally in coal tar and in coal tar produced during the high-temperature carbonization or coking of coal; coal tar distilling; petroleum processing; shale oil processing. It is used as an intermediate for dyes, fungicides, insecticides, herbicides, pharmaceuticals, plant growth hormones; 1,8 naphthalic acid; in the manufacture of some plastics; and, has been detected in cigarette smoke and gasoline exhaust condensates; a constituent of coal tar creosote, asphalt, and diesel fuel. It has been used as an polyploidy agent.

Incompatibilities: Ozone and strong oxidizing agents, including perchlorates, chlorine, fluorine, and bromine.

Permissible Exposure Limits in Air

Except for TEEL (shown below), no specific standards have been established for acenaphthene.

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene, soluble fraction). OSHA defines “coal tar pitch volatiles” in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (*cyclohexane-extractable fraction*). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.4 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 250 mg/m^3

DFG MAK: Category 1, human carcinogen.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 1700 μg/L. *To protect saltwater aquatic life:* on an acute basis 970 μg/L and on a chronic basis 520 μg/L. *To protect human health:* 20.0 μg/L (based on organoleptic data).[6] See also Regulatory Authority for United States and Mexico regulatory levels.

Determination in Water: Gas chromatography or high-performance liquid chromatography (EPA Method 610) or gas chromatography and mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 3.8−4.43.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Acenaphthene is irritating to eyes, skin, and respiratory tract, causing coughing and wheezing. May cause vomiting if swallowed in large quantities. LD_{50} = (ipr-rat) 600 mg/kg

Long Term Exposure: Although acenaphthene has not been identified as a carcinogen, it should be handled with care as several related polycyclic aromatic hydrocarbons (PACs) are carcinogens. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (Category 1) in animal studies. Repeated or high exposures may cause lung irritation, bronchitis with cough, phlegm, and/or shortness of breath. Acenaphthene may affect the liver and kidneys. The most thoroughly investigated effect of acenaphthene is its ability to produce nuclear and cytological changes in microbial and plant species. Most of these changes, such as an increase in cell size and DNA content, are associated with disruption of the spindle mechanism during mitosis and the biological impact of acenaphthene on mammalian cells. These effects are reported here because they are the only substantially investigated effects of acenaphthene. Reported to be a mutagen.[11]

Points of Attack: Skin, respiratory system, bladder, liver, kidneys.

Medical Surveillance: Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace. Complete blood count, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis [cytology, hematuria], liver, kidney, and bladder function tests recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get immediate medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *NIOSH* (as coal tar pitch volatiles): *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. May be isolated using bentonite lined dam.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration or permanganate oxidation.

References

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New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substance Fact Sheet: Acenaphthene*. Trenton, NJ

Acenaphthylene A:0075

Molecular Formula: $C_{12}H_8$
Synonyms: Acenaftelen (Spanish); Cyclopenta(d,e)-naphthalene (French)
CAS Registry Number: 208-96-8
RTECS® Number: AB1254000; AB1254200
UN/NA & ERG Number: UN3077/171
EC Number: 205-917-1
Regulatory Authority and Advisory Bodies
Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total Toxic Organics, 40CFR423, Priority Pollutants, as polynuclear aromatic compounds [PAH].
RCRA 40CFR258, Appendix 2, List of Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.
RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10).
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).
Mexico: Wastewater, Organic Toxic Pollutant.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% *as coal tar pitch volatiles*; Class D2B; NDSL list.
European/International Regulations: Hazard Symbols: Xi; Risk phrases: R36/37/38; Safety phrases: S26; S37/39 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Acenaphthylene is a flaky yellow solid. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 152.20; Boiling Point = 275−280°C; Freezing/Melting point = 88−90°C; 92−93°C; Vapor pressure = 9.12×10^{-4} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Water soluble; solubility = 16 mg/L at 25°C.
Potential Exposure: In coal tar processing.
Incompatibilities: Ozone and strong oxidizing agents, such as perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine.
Permissible Exposure Limits in Air
NIOSH IDLH: 80 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.06 mg/m^3
PAC-1: 0.2 mg/m^3
PAC-2: 1.5 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: Category 1, human carcinogen.
Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.
Permissible Concentration in Water: Kansas[61] has set a guideline for drinking water of 0.03 μg/L.
Determination in Water: Use EPA Method #610. Octanol−water coefficient: Log K_{ow} = 3.94−4.07.
Routes of Entry: Ingestion, inhalation, eye and/or skin contact. Absorbed through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Acute systemic toxin: short-term high hazard effects.[SCAPA]
Long Term Exposure: May cause dermatitis. May cause lung irritation; bronchitis may develop. May be a potential occupational carcinogen based on being a PAH compound. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (Category 1) in animal studies.
Points of Attack: Skin, respiratory system, bladder, liver, kidneys as PAH.
Medical Surveillance: Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace. Complete blood count, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles.[2]
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.
Personal Protective Methods: Good particulate emission controls are the indicated engineering control scheme. Contact lenses should not be worn when working with coal tar pitch volatiles. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when

working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *NIOSH* (as coal tar pitch volatiles): *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Irritating and toxic fumes, including carbon dioxide and carbon monoxide are produced in fire. Use foam, dry chemical, and carbon dioxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Product residues and sorbent media may be packaged in epoxy-lined drums, then destroyed by incineration, permanganate oxidation, or microwave plasma treatment. The US EPA has investigated chemical precipitation for wastewater treatment.

References

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Eller, P. M., Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods* (NMAM®) (4th ed.), 2nd Supplement, DHHS (NIOSH), Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health

Acetal A:0100

Molecular Formula: $C_4H_{14}O_2$

Common Formula: $CH_3CH(OC_2H_5)_2$

Synonyms: Acetal (Spanish); Acetaldehyde diethyl acetal; Acetal diethylique (French); Acetehyde; 1,1-Diaethoxyaethan (German); Diethyl acetal; 1,1-Diethoxyethane; Diethyl acetal; Ethane, 1,1-diethoxy-; Ethylidene diethyl ether

CAS Registry Number: 105-57-7

RTECS® Number: AB2800000

UN/NA & ERG Number: UN1088/127

EC Number: 203-310-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: Not listed. However, similar aldehydes are known to be carcinogenic.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36/38; Safety phrases S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Acetal, an aldehyde, is a clear, volatile liquid with an agreeable odor. Molecular weight: 118.2[A2]; Boiling point = 102°C at 1 atm[A2]; Melting/Freezing point = − 100°C[A2]; Vapor pressure: (Reid) 1.1 psia; 10 mm at 8°C[A2]; Flash point = − 21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability 3; Reactivity, 0. Explosive limits: LEL = 1.6%; UEL = 10.4%. Slightly water soluble.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Primary Irritant. Used as a solvent; in synthetic perfumes, such as jasmine, cosmetics, flavors, in organic synthesis.

Incompatibilities: Oxidizing materials. Presumed to form explosive peroxides on contact with air and light. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria established.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of the eyes with redness and pain. Inhalation can cause coughing, headache, and dizziness. Skin contact can cause irritation with redness and pain. Ingestion can cause stomach pain, nausea, sleepiness, and high exposure can cause unconsciousness. Affects the central nervous system; acts as a narcotic or hypnotic.

Long Term Exposure: A narcotic; may be addictive.

Medical Surveillance: Test for narcotic effects.

Points of Attack: Inhalation, ingestion; skin and/or eye contact.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3, Packing Group II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use dry chemicals, alcohol-resistant foam, carbon dioxide. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substance Fact Sheet: Acetal*. Trenton, NJ

Acetaldehyde A:0110

Molecular Formula: C_2H_4O

Common Formula: CH_3CHO

Synonyms: Acetaldehido (Spanish); Acetaldehyd (German); Acetehyde; Acetic aldehyde; Aldehyde acetique (French); Ethanal; Ethyl aldehyde

CAS Registry Number: 75-07-0

RTECS® Number: AB1925000

UN/NA & ERG Number: UN1089/129

EC Number: 200-836-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NTP: 11th Report on Carcinogens, Reasonably anticipated to be a human carcinogen; US EPA Gene-Tox Program, Positive: *E. coli polA* without S9; *In vitro* SCE—nonhuman; Positive/dose response: *In vitro* SCE—human lymphocytes; Positive/dose response: *In vitro* SCE—human; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant standard set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Clean Air Act: 42USC7412; Title I, Part A, §112 hazardous pollutants; Accidental Release Prevention/Flammable.

Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: 40CFR116.4A, hazardous substances, 40CFR413.02, Total Toxic Organics.

RCRA 40CFR266, Appendix 5, Air concentrations.

RCRA Land Ban Restrictions.

US EPA Federal Water Pollution Control Act.

US EPA Hazardous Waste Number (RCRA No.): U001.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

California Proposition 65 Chemical: Cancer 4/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; National Pollutant Release Inventory (NPRI); DSL list.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbols: Xn, F + ; Risk phrases: R12; R36/37; R40; Safety phrases: S2; S16; S33; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetaldehyde is a flammable, volatile, colorless liquid or gas with a characteristic, penetrating, fruit odor. Odor threshold = 0.067 ppm. Molecular weight = 44.06; Density = 0.788 at 16; Boiling point = 20.4°C; Melting/Freezing point = − 123°C; Electrical conductivity = 1.2×10^8 pS/m; Flash point = − 38°C (oc); Autoignition temp. 185−193°C. Heat of combustion = − 5890 cal/g[A2]; Maximum ignition energy = 0.37 mJ; Vapor pressure = 740 mmHg at 20°C; Specific gravity (H_2O:1) = 0.804. Flammable limits: LEL = 4.1%, UEL = 60%; Hazard Identification (based on NFPA-704 M Rating System): Health 4; Flammability 2; Reactivity 2. Freely soluble in water.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Acetaldehyde can be reduced or oxidized to form acetic acid, acetic anhydride, acrolein, aldol, butanol, chloral, paraldehyde, and pentaerythritol. It is used as an intermediate for the synthesis of other chemicals, including acetic acid, acetic anhydride, butanol, ethyl acetae, etc.; in plating; the manufacture of disinfectants, drugs, dyes, explosives, flavorings, lacquers, mirrors (silvering), perfume, photographic chemicals, phenolic and urea resins, rubber accelerators and antioxidants, varnishes, vinegar, and yeast. It is also used as a pesticide intermediate. Acetaldehyde is the product of most hydrocarbon oxidations; it is a normal intermediate product in the respiration of higher plants; it occurs in all ripe fruits and may form in wine and other alcoholic beverages after exposure to air. Acetaldehyde is an intermediate product in the metabolism of sugars in the body and hence occurs in traces in blood. It has been reported in fresh leaf tobacco as well as in tobacco smoke and in automobile and diesel exhaust. It has been found in 5 of 10 water supplies surveyed by EPA with the highest concentrations in Philadelphia and Seattle at 0.1 μg/L.

Incompatibilities: Reacts with air to form unstable peroxides which can explode. Contact with air causes acetaldehyde to chemically degrade to acetic acid. Strong oxidizers, acids, bases, alcohols, ammonia, amines, halogens, phenols, acid anhydrides, ketones, hydrogen cyanide, hydrogen sulfide. May dissolve rubber. Slightly corrosive to mild steel. May explode without warning when exposed to heat, dust, corrosives, or oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 200 ppm/360 mg/m^3 TWA.

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 25 ppm/45 mg/m^3 Ceiling Concentration, confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 25 ppm

PAC-1: **45** ppm

PAC-2: **270** ppm

PAC-3: **840** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 50 ppm/91 mg/m^3 TWA; Peak Limitation Category I [a momentary value of 100 ml/m^3/180 mg/m^3 should not be exceeded]; Carcinogen Category 5; Pregnancy risk Group C.

Arab Republic of Egypt: (TWA) 100 ppm (180 mg/m^3), 1993; Australia: (TWA) 100 ppm (180 mg/m^3); STEL 150 ppm, 1993; Austria: MAK 50 ppm (90 mg/m^3), suspected carcinogen, 1999; Belgium: (TWA) 100 ppm (180 mg/m^3); STEL 150 ppm (270 mg/m^3), 1993; Denmark: (TWA) 25 ppm (45 mg/m^3), 1999; Finland: (TWA) 50 ppm (90 mg/m^3); STEL 75 ppm (135 mg/m^3), 1993; France: VME 100 ppm (180 mg/m^3), continuous; carcinogen, 1999; the Netherlands: MAC-TGG 180 mg/m^3, 2003; India: (TWA) 100 ppm (180 mg/m^3); STEL 150 ppm (270 mg/m^3), 1993; Japan: 50 ppm (90 mg/m^3), 2B carcinogen, 1999; the Philippines: (TWA) 200 ppm (360 mg/m^3), 1993; Poland: MAC: (TWA) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 5 mg/m^3 [skin] 1993; Sweden: NGV 25 ppm (45 mg/m^3), KTV 50 ppm (90 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 50 ppm (90 mg/m^3), KTV 100 ppm (180 mg/m^3), 1999; Turkey: (TWA) 200 ppm (360 mg/m^3), 1993; United Kingdom: (TWA) 20 ppm (37 mg/m^3); STEL 50 ppm (92 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®[1]: 25 ppm Ceiling Concentration.

Determination in Air: NIOSH Analytical Method, #1994: Acetaldehyde by GC, #2538; by HPLC, #3507; Aldehydes, screening, #2539; OSHA ANALYTICAL METHOD ID-68.

Permissible Concentration in Water: Human exposure to acetaldehyde probably antedates recorded history, inasmuch as acetaldehyde is the major metabolite of ethyl alcohol. An additional source of widespread human exposure is tobacco smoke. The pharmacology and toxicology of acetaldehyde have been studied most extensively in its relationship to alcohol toxicity and human metabolism. Because of this background of human and laboratory experience, there appears to be no need to establish limits for acetaldehyde in drinking water.[32] However, EPA has set an ambient environmental goal of 2480 μg/L for acetaldehyde on a health basis. This compares with a standard of 0.2 mg/L for domestic water supplies set by Russia.[43]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.39$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

LD_{50} = (oral-rat) 50 g/kg.

Short Term Exposure: This chemical can cause intense irritation and cause severe eye burns. Inhalation can irritate the nose, throat and lungs, causing coughing and/or shortness of breath. When the victim is removed from exposure, the symptoms may clear up. Higher exposure can affect the central nervous system causing symptoms similar to acute alcoholic intoxication, sleepiness, dizziness, and possible unconsciousness. High levels may cause pulmonary edema, a medical emergency, which may be delayed.

Long Term Exposure: Acetaldehyde may be a carcinogen in humans since it has been shown to cause cancer in animals and may be a teratogen in humans since it has been shown to be a teratogen in animals. Exposure to acetaldehyde has produced nasal tumors in rats and laryngeal tumors in hamsters. Exposure to malonaldehyde has produced thyroid gland and pancreatic islet cell tumors in rats. NIOSH therefore recommends that acetaldehyde be considered a potential occupational carcinogen in conformance with the OSHA carcinogen policy. This chemical may cause dermatitis and skin allergy. If allergy develops, very low future exposure can cause itching and skin rash. Repeated exposure may cause chronic irritation of the eyes leading to permanent damage. May affect the central nervous system, respiratory tract, and kidneys, causing chronic alcohol-like intoxication. See also "*NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes*" [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system, kidneys, central nervous system, reproductive system. Cancer site in animals: nasal cavity.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air; urine (chemical/metabolite), during exposure. Consideration should be given to skin, eyes, and respiratory tract in any preplacement or periodic examinations. Lung function tests are recommended. If symptoms develop or overexposure is suspected consider chest X-ray and evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes remove any contact lenses at once and irrigate immediately for at least 30 min, ocassionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing. Immediately wash area with large amounts of soap and water. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. Transfer promptly to medical facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact; **8 h** (More than 8 h of resistance to breakthrough >0.1 micron->g/cm^2/min): Butyl rubber (gloves, suits, boots), Responder™ suits; Trychem 1000™ suits; **4 h** (At least 4 but<8 h of resistance to breakthrough >0.1 micron->g/cm^2/min.): Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves. Wear eye protection to prevent any potential for eye contact. Employees should wash promptly when skin is wet. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. See Incompatibilities. Acetaldehyde should be stored in tightly closed airtight containers in a cool, dark, well-ventilated area. Nitrogen or other inert gas should be used as an "inert gas blanket" over liquid acetaldehyde in storage containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of acetaldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers.

Shipping: Should be labeled "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.[19, 20]

Spill Handling: *Liquid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar noncombustible absorbent material and deposit in sealed containers. Keep liquid out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Fire Extinguishing: Acetaldehyde is a flammable and reactive liquid or gas. Poisonous gases, including carbon monoxide are released in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use dry chemicals, alcohol-resistant foam, CO_2. Water or regular foam may be ineffective on fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Acetaldehyde* (Preliminary). Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Acetaldehyde: Health and Environmental Effects Profile No. 1*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (November/December 1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 25−26 (1980) and 3, No. 6, 23−27

US Environmental Protection Agency. (April 29, 1983). *Chemical Hazard Information Profile Draft Report: Acetaldehyde*. Washington, DC

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substance Fact Sheet: Acetaldehyde.* Trenton, NJ

Acetaldehyde ammonia A:0120

Molecular Formula: C_2H_7NO

Common Formula: $C_2H_4O \cdot H_3N$

Synonyms: Acetaldehidato amonico (Spanish); Acetaldehyde, Amine salt; Aldehyde ammonia; 1-Aminoethanol; α-Aminoethyl alcohol; Ethanol, 1-amino-

CAS Registry Number: 75-39-8

RTECS® Number: AB1950000

UN/NA & ERG Number: UN1841/171

EC Number: 200-868-2

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbols: XI; Risk phrases: R36/37/38; Safety phrases: S26; S37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetaldehyde ammonia is a combustible, colorless, white, yellow, or brown crystalline solid. Molecular weight = 61.12; Melting/Freezing point = 97°C; Flash point = 55°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Freely soluble in water.

Potential Exposure: Acetaldehyde ammonia is used to make acetaldehyde and other chemicals, organic synthesis, and to vulcanize rubber.

Incompatibilities: Keep away from strong oxidizing agents such as chlorine, bromine, and fluorine and strong acids such as hydrochloric, sulfuric, and nitric since violent reactions occur.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact with acetaldehyde ammonia can irritate and may burn eyes and skin. Inhalation can irritate the nose, throat, and lungs, causing coughing and/or shortness of breath.

Long Term Exposure: Repeated exposure may cause bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Skin, lungs.

Medical Surveillance: If illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing and wash contaminated skin with large amounts of water immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Prevent repeated or prolonged skin contact. Wear impact-resistant eye protection with side shields or goggles when eye exposure is reasonably probable. Wash skin and change clothing upon contamination. Eyewash fountains should be provided in the immediate work area for emergency use. If there is the potential for skin exposure, emergency shower facilities should be provided. Do not eat, smoke, or drink where this chemical is handled, processed or stored. Use vacuum or wet method to reduce dust during cleanup. Do not dry sweep.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Should be labeled "CLASS 9." Symbol: AW. "The letter "A" restricts the application of requirements of this subchapter to materials offered or intended for transportation by aircraft, unless the material is a hazardous substance or a hazardous waste. The letter "W" restricts the application of requirements of this subchapter to materials offered or intended for transportation by vessel, unless the material is a hazardous substance or a hazardous waste." It falls in Hazard Class 9 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including acetaldehyde, ammonia, nitrogen oxides, and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substance Fact Sheet: Acetaldehyde Ammonia*. Trenton, NJ

Acetaldehyde oxime A:0130

Molecular Formula: C_2H_5NO

Common Formula: $CH_3CH{=}NOH$

Synonyms: β-Acetaldehyde oxime; Acetaldoxime; β-Acetaldoxime; Aldoxime; Ethanal oxime; Ethylidenehydroxylamine

CAS Registry Number: 107-29-9

RTECS® Number: AB2975000

UN/NA & ERG Number: UN2332/129

EC Number: 203-479-6

Regulatory Authority and Advisory Bodies

Canada: WHMIS: Class B3; NDSL list.

European/International Regulations: Hazard Symbols: N/A; Risk phrases: R10; R20/21/22; R40; Safety phrases: S16; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetaldehyde oxime is an extremely flammable, colorless liquid or crystalline solid; low melting crystalline compound. Molecular weight = 59.12; Boiling point = 115°C (decomposes); Freezing/Melting point = 46.5°C (α-); 12°C (β-); Vapor pressure = 9.8 mmHg at 20°C; 9.9 mmHg at 26°C; Specific gravity (H_2O:1) = 0.97; Flash point = 38−40°C (pure); <22°C (technical grade). Hazard Identification Health 2; Flammability 3[NJDHSS]; Reactivity, 0. Soluble in water.

Potential Exposure: Used as a chemical intermediate and as an antioxidant and radical scavenger with applications in many industries, including detergents, pharmaceuticals, plastics, paints and lacquers, rubber, and textiles.

Incompatibilities: Oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric). Vapor forms explosive mixture with air. The *beta* form is able to form unstable peroxides.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate nose, throat, and respiratory tract.

Long Term Exposure: Chronic health effects are unknown at this time.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preemployment and regular physical exams are recommended. For those with frequent or high exposure, lung function tests are recommended.

First Aid: Immediately remove any contact lenses and flush eyes with water for 15 min, occasionally lifting upper and lower lids. Quickly remove contaminated clothing. Immediately wash contaminated skin with soap and water. Remove person from exposure area and begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear impact- and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of acetaldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.[19, 20]

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetaldehyde oxime out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Poisonous gases, including nitrous oxides, and carbon monoxide are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Acetaldehyde Oxime*. Trenton, NJ

Acetamide A:0140

Molecular Formula: C_2H_5NO

Common Formula: CH_3CONH_2

Synonyms: Acetamido (Spanish); Acetic acid amide; Acetimidic acid; Ethanamide; Methanecarboxamide; NCI-C02108

CAS Registry Number: 60-35-5

RTECS® Number: AB4025000

UN/NA & ERG Number: UN3077/171

EC Number: 200-473-5 [*Annex I Index No.:* 616-022-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 2B.

Clean Air Act: 42USC7412; Title I, Part A, §112 hazardous pollutants,

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

TSCA 40CFR704.225(a), CAIR list reporting required.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada: WHMIS: Class D2A.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R40; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Acetamide is a colorless to yellow, deliquescent, crystalline solid. Odorless if pure, "mousy" odor if impure. Odor threshold = 140−160 mg/m^3. Molecular weight = 59.1; Density = 1.16 g/cm^3; Boiling point = 221.2°C; Freezing/Melting point = 81°C; Vapor pressure = 133 Pa at 65°C; Specific gravity (H_2O:1) = 1.16. Autoignition: 558°C. Flammable limits: LEL = 36,000 ppm, UEL = unknown; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Decomposes slowly in cold water; solubility in water = 200 g/100 mL.

Potential Exposure: Used as a stabilizer, plasticizer, wetting agent; solvent in plastics, lacquers, explosive; soldering flux ingredient; and chemical manufacturing.

Incompatibilities: Reacts with strong acids, such as hydrochloric, sulfuric, and nitric, strong oxidizers; strong bases; strong reducing agents; ammonia, isocyanates, phenols, cresols. Contact with water causes slow hydrolyzation to ammonia and acetate salts.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 25 mg/m^3

PAC-1: 75 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Carcinogen Category 3B (2004).

Austria: suspected carcinogen, 1999; Finland: carcinogen, 1993; Sweden: TWA 10 ppm (23 mg/m^3); STEL 25 ppm

(60 mg/m^3), carcinogen, 1999; the Netherlands: MAC-TGG 25 mg/m^3, 2003.

New York State has set 0.03 μg/m^3 for ambient air.[60]

Determination in Air: Not listed.

Permissible Concentration in Water: No criteria set; not very toxic to fish but increases BOD.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -1.25; -1.16$.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Powdered form irritates eyes and respiratory tract. Acute systemic toxin: short-term high hazard effects.[SCAPA] LD_{50} = (oral-rat) 7000 mg/kg.

Long Term Exposure: Acetamide may be a carcinogen in humans since it has been shown to cause cancers in animals. May cause injury to the liver, kidney, and brain. Reproductive toxin.[SCAPA]

Points of Attack: Cancer site in animals: liver and lymph.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Should be stored in cool, well-ventilated area. Store in a dry area away from water because of deliquescent properties. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Material is very water soluble and hydrolyzes slowly to ammonia and acetate salts. May be removed from alkaline solutions with adsorbent carbon. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This substance is a combustible solid. Poisonous gases are produced in fire, including nitrogen oxides and carbon monoxide. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to alcohol or benzene as a flammable solvent and incinerate; oxides of nitrogen produced may be scrubbed out with alkaline solution. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (November/December 1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 20−21 (1981) and 3, No. 6, 29−31

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Acetamide*. Trenton, NJ

Acetanilide A:0150

Molecular Formula: C_8H_9NO

Synonyms: Acetamide, *N*-phenyl-; Acetamidobenzene; Acetanil; Acetanilid; Acetic acid anilide; Acetoanilide; Acetylaminobenzene; *N*-Acetylaniline; Acetylaniline; AN; Aniline, *N*-acetyl-; Antifebrin; Benzenamine, *N*-acetyl; *N*-Fenilacetamida (Spanish); Phenalgene; Phenalgin; *N*-Phenylacetamide

CAS Registry Number: 103-84-4

RTECS® Number: AD7350000

EC Number: 203-150-7

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in analgesic drugs) (Japan).[13]

Canada: WHMIS Class D2B; DSL list.

European/International Regulations: Hazard Symbols: Xn; Risk phrases: R22; R36 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetanilide is odorless, orthorhombic plates or scales; or white, shining, crystalline solid or powder. Molecular weight = 135.17; Density = 1.2190 at 15°C; Boiling point = 304°C at 760 mmHg; Freezing/Melting point = 113.7°C; Vapor pressure = 1 mmHg at 114.0°C, Vapor density = 4.65; Flash point = 169°C (oc); Autoignition temperature = 530°C; Specific gravity (H_2O:1) = 1.21 at 4°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Sinks in water; slightly soluble; solubility = 0.541 g/mL; <1 mg/mL at 22°C.

Potential Exposure: In rubber industry as accelerator, in plastics industry as cellulose ester stabilizer, in pharmaceutical manufacture, stabilizer for hydrogen peroxide, azo dye manufacture.

Incompatibilities: Alkyl nitrates, alkalis (liberate aniline), chloral hydrate, phenols, ferric salts.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.4 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 50 mg/m^3

Permissible Concentration in Water: Russia MAC is 0.004 mg/L in water bodies used for fishery purposes.[43]

Determination in Water: Log K_{ow} = 1.16 at 23°C.

Routes of Entry: Ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if ingested; may cause hallucinations, sleepiness, cyanosis, respiratory, kidney damage, cyanosis, blood toxin: methemoglobinemia, decreased body temperature. Acute respiratory irritant and may be toxic. LD_{50} = (oral-rat) 800 mg/kg. Animals tolerate doses of 200−400 mg/kg for many weeks.[11] Has been lethal to man at 59 mg/kg.

Long Term Exposure: May cause kidney damage, skin allergy, eczema. An allergen. Causes contact dermatitis; inhalation or ingestion can cause eczema and cyanosis and methemoglobinemia.

Points of Attack: Skin and blood stream.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Note to physician: If warranted, treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear skin protection. Avoid dust inhalation (see respirator selection below).

Respirator Selection: Wear filter mask unless high vapor concentrations are encountered; then use NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Solids may be dredged. Carbon adsorbent may be used on dissolved portion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrous oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to flammable solvents (alcohol or benzene) and incinerate. Oxides of nitrogen may be scrubbed from combustion gases with alkaline solution.[22]

References

Sax, N. I. (Ed.). (November/December 1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 21–23 (1981) and 3, No. 6, 27–29

Acetic acid A:0160

Molecular Formula: $C_2H_4O_2$

Common Formula: CH_3COOH

Synonyms: 777 etch; Acetic acid (aqueous solution); Acetic acid, glacial; Acide acetique (French); Acido acetico (Spanish); Aluminum etch 16-1-1-2; Aluminum etch 82-3-15-0; As-1; As-1400; As-18CZ10A; As-18CZ6E; As-1CE; As-5CE; As-CZ5E; CEA-100 micro-chrome etchant; Copper, brass brite DIP 1127; Copper, brass brite DIP 127; Dazzlens cleaner; EPF B20 fixer; Essigsaeure (German); Ethanoic acid; Ethylic acid; Freckle etch; Glacial acetic acid (pure compound); Glass etch; Kodak 33 stop bath; Kovar bright DIP (412X); KTI aluminum etch I/II; Lens cleaner M6015; Mae etchants; Metal etch; Methane carboxylic acid; Mixed acid etch (5-2-2); Mixed acid etch (6-1-1); Pad etch; PFC; Poly etch 95%; Processor fixer concentrate; Rapid film fix; RDH lime solvent; Silicon etch solution; Stress relief etch; Vinegar (4–6% solution in water); Vinegar acid; Wet K-etch; Wright etch

CAS Registry Number: 64-19-7

RTECS® Number: AF1225000

UN/NA & ERG Number: UN2789 (glacial or >80% acid, by mass)/132; UN2790 (10–80% acid, by mass)/153

EC Number: 200-580-7 [*Annex I Index No.:* 607-002-00-6]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada WHMIS Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R10; R35; Safety phrases: S1/2; S23; S25; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetic acid is a colorless liquid or crystals with a sour, vinegar-like odor. Pure compound is a solid below 17°C. Often used in an aqueous solution. Odor threshold = 0.016 ppm. Glacial acetic acid contains 99% acid. Molecular weight = 60.08[A2]; Specific gravity (H_2O:1) = 1.051at 20°C (aqueous solution)[A2]; Boiling point = 117.9°C[A2]; Melting/Freezing point = 16.7°C[A2]; Electrical conductivity = 6×10^5 pS/m; Critical pressure = 57.1 atm; Heat of combustion = − 3136 cal/g[A2]; Vapor pressure = 11 mmHg at 20°C[A2]; Flash point = 39°C[NFPA] (glacial); Autoignition temperature = 463°C (glacial).[NFPA] Explosive limits: LEL = 4.0%; UEL = 19.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2 Freely soluble in water.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Primary Irritant. Acetic acid is widely used as a chemical feedstock for the production of vinyl plastics, acetic anhydride, acetone, acetanilide, acetyl chloride, ethyl alcohol, ketene, methyl ethyl ketone, acetate esters, and cellulose acetates. It is also used alone in the dye, rubber, pharmaceutical, food preserving, textile, and laundry industries. It is utilized, too in the manufacture of Paris green, white lead, tint rinse, photographic chemicals, stain removers, insecticides, and plastics.

Incompatibilities: Vapor forms explosive mixture with air. Violent reaction with oxidizers, organic amines, and bases, such as hydroxides and carbonates. Incompatible with strong acids; aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin, acetaldehyde, 2-aminoethanol, ammonia, ammonium nitrate, chlorosulfonic acid, chromic acid; ethylene diamine, ethyleneimine, halides, peroxides, perchlorates, perchloric acid, permanganates, phosphorus isocyanate, phosphorus trichloride, potassium *tert*-butoxide, and xylene. Attacks cast iron, stainless steel, and other metals forming flammable/explosive hydrogen gas. Will attack many forms of rubber or plastic.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.46 mg/m^3 at 25°C & 1 atm

OSHA PEL: 10 ppm/25 mg/m^3 TWA

NIOSH REL: 10 ppm/25 mg/m^3 TWA; 15 ppm/37 mg/m^3 STEL

ACGIH TLV®[1]: 10 ppm/25 mg/m^3 TWA; 15 ppm/37 mg/m^3 ppm STEL

Protective Action Criteria (PAC)*

TEEL-0: 5 ppm

PAC-1: **5** ppm

PAC-2: **35** ppm

PAC-3: **250** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 10 ppm/25 mg/m^3 TWA; Peak Limitation Category I(2).
NIOSH IDLH: 50 ppm.
Australia: TWA 10 ppm (25 mg/m^3); STEL 15 ppm, 1993; Austria: MAK 10 ppm (25 mg/m^3), 1999; Belgium: TWA 10 ppm (25 mg/m^3); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (25 mg/m^3), 1999; Finland: TWA 10 ppm (25 mg/m^3); STEL 15 ppm (37 mg/m^3) [skin] 1993; France: VLE 10 ppm (25 mg/m^3), 1999; Hungary: TWA 10 mg/m^3; STEL 20 mg/m^3, 1993; the Netherlands: MAC-TGG 25 mg/m^3, 2003; Japan; 10 ppm (25 mg/m^3), 1999; Norway: TWA 10 ppm (25 mg/m^3), 1999; the Philippines: TWA 10 ppm (25 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 35 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 5 mg/m^3 [skin] 1993; Sweden: NGV 5 ppm (13 mg/m^3), KTV 10 ppm (25 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (25 mg/m^3), KZG-W 20 ppm (50 mg/m^3), 1999; Thailand: TWA 10 ppm (25 mg/m^3), 1993; Turkey: TWA 10 ppm (25 mg/m^3), 1993; United Kingdom: TWA 10 ppm (25 mg/m^3); STEL 15 ppm (37 mg/m^3), Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm. Russia[43] MAC for ambient air in residential areas is 0.2 mg/m^3 on a momentary basis and 0.06 mg/m^3 on a daily average basis. Several states have set guidelines or standards for acetic acid in ambient air.[60] They range from 0.25 mg/m^3 (North Dakota) to 0.4 mg/m^3 (Virginia) to 0.5 mg/m^3 (Connecticut and South Dakota) to 0.595 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #1603, OSHA Analytical Method 186SG.

Permissible Concentration in Water: No US limit has been established. However, EPA, [32] has proposed an ambient environmental goal of 345 μg/L based on health effects.

Determination in Water: Acetic acid in water may be determined by titration. Harmful to aquatic life. Octanol–water coefficient: Log $K_{ow} = -0.2$ to -0.31.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can cause severe irritation, burns, and permanent eye damage. Skin contact can cause severe irritation and burns. Breathing can cause irritation of the mouth, nose, and throat; coughing; and shortness of breath. Higher exposures can cause bronchopneumonia and pulmonary edema, a medical emergency.

Long Term Exposure: Repeated exposure may cause bronchitis to develop, with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause thickening and cracking of the skin, particularly the skin of the hands. Chronic exposure may result in pharyngitis and catarrhal bronchitis. Ingestion, though not likely to occur in industry, may result in penetration of the esophagus, bloody vomiting, diarrhea, shock, hemolysis, and hemoglobinuria which is followed by anuria. Repeated or prolonged exposure to acetic acid may cause darkening, irritation of the skin, erosion of the exposed front teeth, and chronic inflammation of the nose, throat, and bronchi.

Points of Attack: Respiratory system, skin, eyes, teeth.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure. Consideration should be given to the skin, eyes, teeth, and respiratory tract in placement or periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. If this chemical has been inhaled, remove from exposure, begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. If swallowed, do not induce vomiting. Transfer promptly to a medical facility. Medical observation recommended for 24–48 h following inhalation overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Contact lenses should not be worn when working with acetic acid. Prevent skin contact; **8 hr** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Butyl rubber (gloves, suits, boots), Teflon™ gloves, suits, boots; Viton™, 4H™, and Silver Shield™ gloves, Responder™ suits; Trychem 1000™ suits; **4 hr** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min.) Neoprene™, Barricade®. Remove clothing immediately if wet or contaminated with liquids containing 50% and promptly remove if liquid contains 10–49% acetic acid. Provide emergency eyewash if liquids containing >5% acetic acid are involved, drench if >50% acetic acid is involved.

Respirator Selection: NIOSH/OSHA *50 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Should be stored in cool dry place away from heat and incompatible substances listed above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: *Acetic acid >80%:* Should be labeled "CORROSIVE, FLAMMABLE LIQUID." Hazard Class 8. Shipping Group II.[19, 20] *Acetic acid 10−80%:* Should be labeled "CORROSIVE," shipped in glass and polyethylene carboys, metal drums aluminum tank cars and wooden barrels. It falls in Hazard Class 8. Do not transport with human food or animal feedstuffs.

Spill Handling: Warn other workers of spill. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, or similar material and deposit in sealed containers and transport to outdoor location. With expert help, cautiously neutralize spilled liquid with lime or sodium bicarbonate. Wash away remainder with plenty of water (extra personal protection: chemical protection suit including self-contained breathing apparatus). Alternatively cover with soda ash and then flush to sewer with water.[24] Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Points of Attack: Use water spray, dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Wear goggles and self-contained breathing apparatus when fighting fires. Poisonous gases are produced in fire, including carbon monoxide. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed). (November/December 1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 23−25 (1981) and 3, No. 6, 31−35

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Acetic Acid.* Trenton, NJ

New York State Department of Health. (March 1986). *Bureau of Toxic Substances Assessment Chemical Fact Sheet: Acetic Acid.* Albany, NY

Acetic anhydride A:0170

Molecular Formula: $C_4H_6O_3$

Common Formula: $(CH_3CO)_2O$

Synonyms: Acetic acid, anhydride; Acetic oxide; Acetyl anhydride; Acetyl ether; Acetyl oxide; Anhidrido acetico (Spanish); Anhydride acetique (French); Essigsaeureanhydrid (German); Ethanoic anhydrate; Ethanoic anhydride

CAS Registry Number: 108-24-7

RTECS® Number: AK1925000

UN/NA & ERG Number: UN1715/137

EC Number: 203-564-8 [*Annex I Index No.:* 607-008-00-9]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Singapore) (UN).[13]

FDA, Controlled Substance Act, Essential Chemicals.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

Controlled Subststance Act (FDA): TV (domestic and import/export) = 250 gallons (1023 kg weight)

Canada, WHMIS, Ingredient Disclosure Concentration: 1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R10; R20/22; R34; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetic anhydride is a combustible, colorless, strongly refractive, liquid which has a strongly irritating odor. Odor threshold = 0.14 ppm. Molecular weight = 102.09[A2]; Boiling point at 1 atm = 139°C[A2]; Melting/Freezing point = −69 to −73°C[A2]; Critical temperature = 296°C[A2]; Critical pressure = 679 psia = 46.2 atm = 4.68 MN/m^2[A2]; Vapor pressure = 3.8 mmHg at 20°C; 4.9 mmHg at 25°C; 6.8 mmHg at 30°C. Flash point = 49.4°C (cc); Heat of combustion = −7058 Btu/lb = −3921 cal/g[A2]; Autoignition temperature = 316°C. Explosive limits: LEL = 2.7%, UEL = 10.3%. Specific gravity (H_2O:1) = 1.08[A2]; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩; Soluble in water; violent reaction.

Potential Exposure: Acetic anhydride is used as an acetylating agent or as a solvent in the manufacture of cellulose acetate, acetanilide, aspirin, synthetic fibers, plastics, explosives, resins, perfumes, and flavorings; and it is used in the textile dyeing industry. It is widely used as a pharmaceutical intermediate and as a pesticide intermediate.

Incompatibilities: Water, alcohols, strong acids; strong oxidizers; chromic acid (violent reaction), amines, strong caustics; finely divided metals. Contact with water forms acetic acid and liberates a large amount of heat. Corrosive to iron, steel, and other metals.

Permissible Exposure Limits in Air

OSHA PEL: 5 ppm/20 mg/m^3 TWA.

NIOSH REL: 5 ppm/21 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 5 ppm TWA.

NIOSH IDLH: 200 ppm.

Temporary Emergency Exposure Limits (DOE).

TEEL-0: 0.5 ppm

PAC-1: 0.5 ppm

PAC-2: 15 ppm

PAC-3: 100 ppm

DFG MAK: 5 ppm/21 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

Austria: MAK 5 ppm (20 mg/m^3), 1999; Denmark: TWA 5 ppm (20 mg/m^3), 1999; France: VLE 5 ppm (20 mg/m^3), 1999; Japan: 5 ppm (21 mg/m^3), 1999; Poland: TWA 10 mg/m^3, 1999; Sweden: Ceiling 5 ppm (20 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; United Kingdom: TWA 0.1 ppm (0.5 mg/m^3); STEL 0.4 ppm (2 mg/m^3), 2000. Several states have set guidelines or standards for acetic anhydride in ambient air[60] ranging from 67 μg/m^3 (NY) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (North Dakota) to 400 μg/m^3 (Connecticut) to 476 μg/m^3 (Nevada) to 500 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #3506,[18] OSHA Analytical Methods 82, 102.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.2$ (measured).[V]

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can cause severe skin and eye irritation. Permanent damage to the eyes may result from exposure to high concentrations. Breathing acetic anhydride can irritate the respiratory tract and high concentrations can cause severe lung damage and/or coughing and shortness of breath. In high concentrations, vapor may cause conjunctivitis, photophobia, lacrimation, and severe irritation of the nose and throat. Liquid acetic anhydride does not cause a severe burning sensation when it comes in contact with the skin. If it is not removed, the skin may become white and wrinkled, and delayed severe burns may occur. Both liquid and vapor may cause conjunctival edema and corneal burns, which may develop into temporary or permanent interstitial keratitis with corneal opacity due to progression of the infiltration. Contact and, occasionally, hypersensitivity dermatitis may develop. Immediate complaints following concentrated vapor exposure include conjunctival and nasopharyngeal irritation, cough, and dyspnea. Necrotic areas of mucous membranes may be present following acute exposure. Inhalation may cause pulmonary edema, a medical emergency. Medical observation recommended for 24−48 h following inhalation overexposure, as pulmonary edema may be delayed.

Long Term Exposure: Prolonged or repeated exposure to this chemical may cause skin disorders or allergy. If allergy develops, very low future exposure can cause itching and a skin rash.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately with large amounts of water. If this chemical contacts the skin, quickly remove clothing and immediately wash area with large amounts of water. If a person breathes this chemical, move the exposed person to fresh air at once and perform (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if hearth action has stopped. When this chemical has been swallowed, get medical attention immediately. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron- >g/cm^2/min): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade®, Trellchem HPS™ suits;

Trychem 1000™ suits; **4 h** (At least 4 but<8 h of resistance to breakthrough >0.1 micron>g/cm^2/min.): Teflon™ gloves, suits, boots. Contact lenses should not be worn when working with this chemical. Wear splash proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *200 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister] or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferred. Store in tightly closed containers in a cool, well-ventilated place, away from moisture, sources of ignition, and heat. Avoid pits, depressions, and basements. Separate from other storage. Inside storage should be in a standard flammable liquids storage room or cabinet. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This chemical requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." It falls in Hazard Class 8, Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Cover with vermiculite, dry sand, earth, or similar absorbent material and neutralize with lime or sodium bicarbonate. Deposit absorbent material in sealed containers. Alternatively cover with soda ash and then flush away with water.[24] Ventilate area of spill or leak after cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetic anhydride out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. You may want to seek assistance from EPAs Environmental Response Team at (908) 548−8730. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Poisonous gases, including carbon monoxide and acetic acid, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use water spray to disperse vapors only, as water contact will form acetic acid. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[24]

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 32−35

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Acetic Anhydride*. Albany, NY: Bureau of Toxic Substances Assessment

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: Acetic Anhydride*. Trenton, NJ

Acetone A:0180

Molecular Formula: C_3H_6O
Common Formula: CH_3COCH_3
Synonyms: Aceton (German); Acetona (Spanish); Dimethylformaldehyde; Dimethylformehyde; Dimethylketal; Dimethyl ketone; Ketone; Ketone, dimethyl; Ketone propane; β-Ketopropane; Methyl ketone; 2-Propanone; Propanone; Pyroacetic acid; Pyroacetic ether
CAS Registry Number: 67-64-1
RTECS® Number: AL3150000
UN/NA & ERG Number: UN1090/127
EC Number: 200-662-2
Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Gene-Tox Program, Negative: SHE—clonal assay; Cell transform.—mouse embryo; Negative: Cell transform.—RLV F344 rat embryo; Negative: *In vitro* cytogenetics—nonhuman; Negative: Histidine reversion—Ames test; *In vitro* SCE—nonhuman.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA, Controlled Substance Act, Essential Chemicals.

Safe Drinking Water Act, 40CFR148.10, solvent waste prohibitions.

US EPA Hazardous Waste Number (RCRA No.): U002.

RCRA 40CFR258, Appendix 1, constituents for detection monitoring.

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents.

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8240 (100).

RCRA Land Ban Substance.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

TSCA: 40CFR799.5000; 40CFR716.120(d)1 as aldehydes.

Canada WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%; B2, D2B.

European/International Regulations: Hazard Symbol: Xi, F; Risk phrases:R11; R36; R66; R67; R37; R42/43; Safety phrases: S9; S16; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetone is a highly flammable, colorless liquid with a sweet, mint-like odor. Odor threshold = 4.58 ppm; AIHA geometric mean air odor threshold is 62 ppm (detectable); 130 ppm (recognizable). Molecular weight: 58.08; Boiling point = 56.1°C; Melting/Freezing point = − 94.7°C; Critical temperature = 235°C[A2]; Critical pressure = 682 psia = 46.4 atm = 4.70 MN/m^2[A2]; Specific gravity (H_2O:1) = 0.791 at 20°C (liquid)[A2]; Relative vapor density (air = 1) = 2.0[A2]; Ratio of specific heats of vapor (gas) = 1.127; Latent heat of vaporization = 122 cal/g[A2]; Heat of combustion = − 12,250 Btu/lb = − 6808 cal/g[A2]; Heat of fusion = 23.42 cal/g[A2]; Vapor pressure = 179 mmHg[A2]; Minimum ignition energy = 1.15 mJ; Electrical Conductivity = 4.9×10^5 pS/m; Autoignition temperature = 465°C; Flash point = − 18°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 2. Explosive limits: LEL = 2.5%, UEL = 12.8%. Freely soluble in water.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. It is used as a solvent in nail polish remover and many other chemicals. Used in the production of lubricating oils and as an intermediate in the manufacture of chloroform and of various pharmaceuticals and pesticides.

Incompatibilities: May explode when mixed with chloroform, chromic anhydride. Incompatible with acids, bases, and oxidizing materials, such as peroxides, chlorates, perchlorates, nitrates, and permanganates. Unstable peroxides formed with strong oxidizers. May accumulate static electrical charges and may cause ignition of its vapors. Dissolves most rubber, resins, and plastics.

Permissible Exposure Limits in Air

OSHA PEL: 1000 ppm/2400 mg/m^3 TWA.

NIOSH REL: 250 ppm/590 mg/m^3 TWA.

ACGIH TLV®[1]: 500 ppm/1188 mg/m^3 TWA; 750 ppm/1782 mg/m^3 STEL; not classifiable as a human carcinogen; BEI: 50 mg[Acetone]/L in urine/end-of-shift.

NIOSH IDLH is 2500 ppm [10% LEL].

Protective Action Criteria (PAC)*
TEEL-0: 200 ppm
PAC-1: **200** ppm
PAC-2: **3200** ppm
PAC-3: **5700** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

MAK: 500 ppm/1200 mg/m^3; Peak Limitation Category I (2); BAT: 80 mg[acetone]/L in urine/end-of-shift; Pregnancy Risk Group D; (2006).

Australia: TWA 500 ppm (1185 mg/m^3); STEL 1000 ppm, 1993; Austria: MAK 750 ppm (1780 mg/m^3), 1999;

Belgium: TWA 750 ppm (1780 mg/m^3); STEL 1000 ppm, 1993; Denmark: TWA 250 ppm (600 mg/m^3), 1999; Finland: TWA 500 ppm (1200 mg/m^3); STEL 625 ppm (1500 mg/m^3), 1993; France: VME 750 ppm (1800 mg/m^3), 1999; Hungary: TWA 600 mg/m^3; STEL 1200 mg/m^3, 1993; the Netherlands: MAC-TGG 1780 mg/m^3, 2003; Japan; 200 ppm (470 mg/m^3), 1999; Norway: TWA 125 ppm (295 mg/m^3), 1999; the Philippines: TWA 1000 ppm (2400 mg/m^3), 1993; Poland: MAC (TWA) 600 mg/m^3, MAC (STEL) 1800 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 200 mg/m^3, 1993; Sweden: NGV 250 ppm (600 mg/m^3), KTV 500 ppm (1200 mg/m^3), 1999; Switzerland: MAK-W 500 ppm (1200 mg/m^3); STEL 1000 ppm (2400 mg/m^3), 1999; Turkey: TWA 1000 ppm (2400 mg/m^3), 1993; United Kingdom: TWA 750 ppm (1810 mg/m^3); STEL 1500 ppm (3620 mg/m^3); Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 750 ppm. Several states have set guidelines or standards for acetone in ambient air[60] ranging from 8 mg/m^3 (Massachusetts) to 11.8 mg/m^3 (Connecticut and South Dakota) to 17.8−23.75 mg/m^3 (North Dakota) to 30 mg/m^3 (Virginia) to 35.6 mg/m^3 (Florida and New York) to 42.4 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300, #2555, #3800,[1, 18] OSHA Analytical Method 69.

Permissible Concentration in Water: Massachusetts has set a guideline of 250 μg/L and Maryland a guideline of 3600 μg/L.[61]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.23$.

Routes of Entry: Skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin. Exposure can irritate the eyes and respiratory tract. Exposure to high concentrations can cause dizziness, lightheadedness, and unconsciousness. Alcohol consumption exacerbates toxic effects.

Long Term Exposure: Repeated skin exposure can cause dryness and skin cracking. This chemical has not been adequately evaluated to determine whether brain or nerve damage could occur with repeated exposure. However, many solvents and other petroleum-based chemicals have been shown to cause such damage. Effects may include reduced memory and concentration; personality changes (withdrawal, irritability) and fatigue; sleep disturbances; reduced coordination; and/or effects on the nerves to the arms and legs (weakness, "pins and needles").

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); expired exposure, during exposure; pulmonary function tests; urine (chemical/metabolite); end-of-shift. Evaluation for brain effects, such as changes in memory, concentration, sleeping patterns and mood, as well as headaches and fatigue. Consider evaluations of the cerebellar, autonomic, and peripheral nervous systems. Positive and borderline individuals should be referred for neuropsychological testing. See also NIOSH Criteria Document: 78-173 *Ketones*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately with large amounts of water for at least 15 min. If this chemical contacts the skin, quickly remove contaminated clothing and wash with large amounts of soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron->g/cm^2/min): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade®, CPF3™ suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, *2500 ppm:* CcrFOv* (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The required US DOT shipping designation is "FLAMMABLE LIQUID." It falls in Hazard Class 3, Packing Group II.[19, 20]

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep acetone out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acetone is a highly flammable liquid. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.[22]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard. Occupational Exposure to Ketones*, NIOSH Publication No. 78-173. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 25−27

New York State Department of Health (1986). *Chemical Fact Sheet: Acetone*. Albany, NY: Bureau of Toxic Substance Assessment.

New Jersey Department of Health and Senor Services. (December 2005). *Hazardous Substances Fact Sheet: Acetone*. Trenton, NJ

Acetone cyanohydrin A:0190

Molecular Formula: C_4H_7NO

Common Formula: $(CH_3)_2C(OH)CN$

Synonyms: Acetoncyanhydrin (German); Acetonecyanhydrine (French); Acetone cyanohydrin; Cianhidrina de acetona (Spanish); Cyanhydrine d'acetone (French); 2-Cyano-2-proponal; α-Hydroxyisobutyronitrile; 2-Hydroxyisobutyronitrile; Hydroxy isobutyronitrite; 2-Hydroxy-2-methylpropionitrile; 2-Methylactonitrile; 2-Propane cyanohydrin; Propanenitrile, 2-hydroxy-2-methyl-

CAS Registry Number: 75-86-5

RTECS® Number: OD9275000

UN/NA & ERG Number: UN1541/155

EC Number: 200-909-4 [*Annex I Index No.:* 608-004-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): P069.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Chemical.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/27/28; R50/R53; Safety phrases: S1/2; S7/9; S27; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Acetone cyanohydrin is a very flammable, colorless to light yellow liquid with an almond-like odor. Molecular weight = 85.10[A2]; Density (H_2O:1) = 0.9267 at 25°C; Boiling point = 95°C at 760 mmHg; Freezing/Melting point = − 19°C[A2]; Specific gravity (H_2O:1) = 0.925 at 25°C (liquid)[A2]; Vapor pressure = 0.8 mmHg at 20°C[A2]; Relative vapor density (air = 1) = 2.93[A2]; Ratio of specific heats of vapor (gas) = (estimate) 1.074[9]. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 2; Flash point = 74°C; Autoignition temperature = 688°C. LEL = 2.2%, UEL = 12.0%. Freely soluble in water but decomposes, forming hydrogen cyanide.

Potential Exposure: Used in the manufacture of insecticides and making other chemicals, such as methyl methacrylate.

Incompatibilities: Forms explosive mixture with air. Not compatible with strong reducers, strong bases, strong oxidizers and strong acids, such as hydrochloric, sulfuric (explosive), and nitric. Contact with strong acid and strong bases may cause explosions. Slowly decomposes to acetone and hydrogen cyanide gas at room temperatures; rate is accelerated by and increase in pH, contact with water, or temperature.

Permissible Exposure Limits in Air

Conversion 1 ppm = 3.48 mg/m^3.

OSHA PEL: None.

NIOSH REL: 1 ppm/4 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 Ceiling Concentration [skin].

AIHA WEEL: 2 ppm TWA; 5 ppm STEL [15 min.] [skin].

Protective Action Criteria (PAC)*

TEEL-0: 1.44 ppm

PAC-1: **2** ppm

PAC-2: **7.1** ppm

PAC-3: **15** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm TWA; 5 ppm STEL; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group C.

Hungary: STEL 0.9 mg/m^3, carcinogen, 1993; Russia: STEL 0.9 mg/m^3 [skin] 1993; the Netherlands: MAC-TGG 3.5 mg/m^3 [skin] 2003.

Determination in Air: Solid sorbent tube: Porapak® QS, 100 mg/50 mg tube; Ethyl acetate; Gas chromatography/nitrogen/phosphorus (thermionic) detection; NIOSH Analytical Method 2506.[18]

Permissible Concentration in Water: Russia set a MAC of 0.001 mg/L for water used for domestic purposes.

Determination in Water: The substance is very toxic to aquatic organisms. Avoid release to the environment in circumstances different to normal use.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. May be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation. Breathing this chemical can irritate the respiratory tract causing wheezing and shortness of breath. Slows down tissue respiration. High exposure can cause sudden death without warning. Symptoms of exposure include weakness, headache, confusion, nausea, vomiting, and a pounding heart. High exposure can cause liver and kidney damage. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long Term Exposure: Can cause thyroid gland to enlarge and interfere with normal thyroid function. May cause kidney and liver injury. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, kidneys, gastrointestinal tract.

Medical Surveillance: Test for urine thiocyanate and blood cyanide levels.

First Aid: Move victim to fresh air; call emergency medical care. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing and wash with large amounts of water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. When this chemical has been swallowed, get medical attention immediately. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility. If not breathing, give artificial respiration (avoid mouth to mouth resuscitation). If breathing is difficult, give oxygen. If heart has stopped, begin CPR. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Avoid contact with contaminated skin. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be available within 1−2 min of exposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH, *10 ppm:* Sa (APF = 10) (any supplied-air respirator); *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *50 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece); *250 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Do not store for long periods of time; toxic fumes may form in closed container. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Outside storage and separated storage is preferred.

Shipping: Acetone cyanohydrin requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group I.[19, 20]

Spill Handling: Issue poison warning. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial Isolation and Protective Action Distances.

when spilled in water

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 800/2500
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.9/3.1

Fire Extinguishing: Acetone cyanohydrin is a combustible liquid. Poisonous gases, including hydrogen cyanide and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Note: Water may cause frothing if it gets below surface of liquid and turns to steam. Water fog gently applied to surface will cause frothing which may extinguish fire.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Add with stirring to strong alkaline calcium hypochlorite solution. Alternatively dissolve in flammable solvent and burn in incinerator with afterburner and scrubber.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Acetone cyanohydrin*. Washington, DC: Chemical Emergency Preparedness Program

National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard: Occupational Exposure to Nitriles*. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report,* 4, No. 1, 41−43

New Jersey Department of Health and Senor Services. (June 2003). *Hazardous Substances Fact Sheet: Acetone Cyanohydrin*. Trenton, NJ

Acetone thiosemicarbazide A:0200

Molecular Formula: $C_4H_9N_3S$
Synonyms: Acetone, thiosemicarbazone; Hydrazinecarbothioamide, 2-(1-methylethylidene); Thiosemicarbazone acetone; Tiosemicarbazida de la acetona (Spanish)
CAS Registry Number: 1752-30-3
RTECS® Number: AL7350000
UN/NA & ERG Number: UN2811/154
EC Number: 217-137-9
Regulatory Authority and Advisory Bodies
CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).[7]
Note: The lower quantity applies for solids in powder form with particulate size less than 100 μm. Otherwise the 10,000 lb TPQ applies.
European/International Regulations: Hazard Symbol: T; Risk phrases: R21; R25; R26; Safety phrases: S2; S28; S36/37/39 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Acetone thiosemicarbazide is a combustible, white to yellow crystalline solid. Molecular weight = 131.19; Freezing/Melting point = 172−175 °C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. No reaction with water.
Potential Exposure: Acetone thiosemicarbazone is used as an intermediate in the manufacture of pharmaceuticals and pesticides.
Incompatibilities: Contact with strong oxidizers may cause fire and explosions.
Permissible Exposure Limits in Air
DOE Temporary Emergency Exposure Limits (TEELs)
TEEL-0: 20 mg/m^3
PAC-1: 60 mg/m^3
PAC-2: 100 mg/m^3
PAC-3: 100 mg/m^3
Routes of Entry: Ingestion.
Harmful Effects and Symptoms
High oral toxicity reported. The LD_{low}oral (rat) = 10 mg/kg (highly toxic). LD_{50} = (oral-rat) 48.5 mg/kg.
Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system; liver, kidneys, gastrointestinal tract.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.
Personal Protective Methods: Contact lenses should not be worn when working with this chemical. Wear splash proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: For emergency situations, wear a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.
Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.
Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: When heated to decomposition, it emits very toxic fumes of nitrogen oxide and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position.
Reference
US Environmental Protection Agency (1987). *Chemical Hazard Information Profile: Acetone Thiosemicarbazide*. Washington, DC: Chemical Emergency Preparedness Program.

Acetonitrile A:0210

Molecular Formula: C_2H_3N
Common Formula: CH_3CN
Synonyms: Acetonitril (German); Acetonitrilo (Spanish); Cyanomethane; Cyanure de methyl (French); Ethanenitrile;

Ethyl nitril; Ethylnitrile; Methanecarbonitril; Methanecarbonitrile; Methane, cyano-; Methyl cyanide

CAS Registry Number: 75-05-8

RTECS® Number: AL7700000

UN/NA & ERG Number: UN1648/127

EC Number: 200-835-2 [*Annex I Index No.:* 608-001-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis studies (inhalation); equivocal evidence: rat, no evidence: mouse.

EPA-CBD;D.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 hazardous pollutants.

Clean Water Act: 40CFR116.4A, hazardous substances, 40CFR413.02, Total Toxic Organics.

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 1.8.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8015 (100).

RCRA 40CFR266, Appendix 4, air Concentrations List.

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste.

RCRA Land Ban Waste Restrictions.

US EPA Hazardous Waste Number (RCRA No.): U003.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada WHMIS Ingredients Disclosure List Concentration Reporting Level: 0.1%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; R36; Safety phrases: S2; S16; S/36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Acetonitrile is an extremely flammable, colorless liquid with an ether-like odor. Odor threshold = 40 ppm; irritating: 875 mg/m^3. Molecular weight = 41.06; Specific gravity = 0.78745 at 15°C; Boiling point at 1 atm = 81.6°C[9]; Melting/Freezing point = −45.7°C[9]; Critical temperature = 274.7°C[9]; Critical pressure = 47.7 atm; Specific gravity (H_2O:1) = 0.787 at 20°C (liquid)[9]; Relative vapor density (air = 1) = 1.4[9]; Ratio of specific heats of vapor (gas) = 1.192[9]; Ionization potential = 12.20 eV; Latent heat of vaporization = 313 Btu/lb = 174 cal/g; Heat of combustion = −13,360 Btu/lb = −7420 cal/g[9]; Vapor pressure = 73.7 mmHg at 20°C[9]; 9.60 kPa at 20°C; Electrical conductivity = 6×10^4 pS/m. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2; Flash point = 6°C (oc)[NFPA]; 12.8°C (cc); Autoignition temperature = 524°C. Explosive limits LEL = 3.0%, UEL = 16.0%. Freely soluble in water.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Acetonitrile is used as an extractant for animal and vegetable oils, as a solvent; particularly in the pharmaceutical industry, and as a chemical intermediate in pesticide manufacture; making batteries and rubber products. It is present in cigarette smoke.

Incompatibilities: Strong oxidizers, such as chlorine, bromine, and fluorine, chlorosulfonic acid, oleum, or sulfuric acid. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.68 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 40 ppm/70 mg/m^3 TWA.

NIOSH REL: 20 ppm/34 mg/m^3 TWA.

ACGIH TLV®[1]: 20 ppm/34 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 13 ppm

PAC-1: **13** ppm

PAC-2: **320** ppm

PAC-3: **670** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 20 ppm/34 mg/m^3; [skin]; Peak Limitation Category II(2); Pregnancy Risk Group C (2006).

Arab Republic of Egypt: TWA 40 ppm (70 mg/m^3) [skin] 1993; Australia: TWA 40 ppm (70 mg/m^3); STEL 60 ppm [skin] 1993; Austria: MAK 40 ppm (70 mg/m^3), 1999; Belgium: TWA 40 ppm (67 mg/m^3); STEL 60 ppm (101 mg/m^3) [skin] 1993; Denmark: TWA 40 ppm (70 mg/m^3), 1999; Finland: TWA 40 ppm (70 mg/m^3); STEL 60 ppm (105 mg/m^3), 1993; France: VME 40 ppm (70 mg/m^3) [skin] 1999; the Netherlands: MAC-TGG 70 mg/m^3, 2003; Norway: TWA 30 ppm (50 mg/m^3), 1999; the Philippines: TWA 40 ppm (70 mg/m^3), 1993; Poland: TWA 70 mg/m^3; STEL 140 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Sweden: TWA 30 ppm (50 mg/m^3); STEL 50 ppm (100 mg/m^3), 1999; Switzerland: MAK-W 500 ppm (1200 mg/m^3); STEL 1000 ppm (2400 mg/m^3), 1999; Turkey: TWA 40 ppm (70 mg/m^3), 1993; United Kingdom: TWA 40 ppm (68 mg/m^3); STEL 60 ppm (102 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 60 ppm. Several states have set guidelines or standards for acetonitrile in ambient air[60]: California TWA PEL 40 ppm (70 mg/m^3) 0.68 mg/m^3 (Connecticut) to 0.70−1.05 mg/m^3 (North Dakota) to 1.1 mg/m^3 (Virginia) to 1.4 mg/m^3 (Florida and New York) to 1.67 mg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method 1606.[18]

Permissible Concentration in Water: Acetonitrile is infinitely soluble and stable in water. No criteria have been set, but EPA has proposed[32] an ambient environmental goal of 970 μg/L based on health effects. Russia[43] set a MAC of 0.7 mg/mL for water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.3$.

Routes of Entry: Inhalation, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Exposure can cause fatal cyanide poisoning. Symptoms include flushing of the face, chest tightness, headache, nausea, and vomiting, weakness, and shortness of breath. These reactions may begin hours following overexposure.

Long Term Exposure: Repeated exposure may cause the thyroid gland to enlarge and cause permanent damage. Acetonitrile may cause damage to the developing fetus. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Kidneys, liver, lungs, skin, eyes, central nervous system, cardiovascular system.

Medical Surveillance: Consider the lung, skin, respiratory tract, heart, central nervous system, renal and liver function in placement and periodic examinations. A history of fainting spells or convulsive disorders might present an added risk to persons working with toxic nitriles. Blood cyanide test and/or urine thiocyanate test. Blood cyanide over 0.1 mg/L or urine thiocyanate over 20 mg/L indicate overexposure. Maintain close medical monitoring. Slow release of cyanide from absorbed acetonitrile may cause delayed symptoms. Blood plasma, expired air, urine (chemical/metabolite).

First Aid: Acetonitrile can cause fatal cyanide poisoning. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be available within 1−2 min. In the event of overexposure and/or symptoms: move victim to fresh air; call emergency medical care. Give Amyl Nitrate capsules (as directed, by trained personnel only). If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing and wash with large amounts of water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. When this chemical has been swallowed, get medical attention immediately. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility. If not breathing, give artificial respiration (avoid mouth to mouth resuscitation). If breathing is difficult, give oxygen. If heart has stopped begin CPR. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Avoid contact with contaminated skin. Observe victim for 24−48 h.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade®, Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH: *200 ppm*: CcrOv (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator) or SCBA (any self-contained breathing apparatus); *500 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where acetonitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3, Packing Group II.[19, 20]

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use foam spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep acetonitrile out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen cyanide and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective for fighting fires. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with nitrogen oxide removal from effluent gases by scrubbers or incinerators.[22]

References

US Environmental Protection Agency. (March 9, 1979). *Chemical Hazard Information Profile: Acetonitrile*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Acetonitrile: Health and Environmental Effects Profile No. 2*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (January/February 1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 44−46

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Acetonitrile*. Trenton, NJ

Acetonyl acetone A:0215

Molecular Formula: $C_6H_{10}O_2$

Common Formula: $CH_3COCH_2CH_2COCH_3$

Synonyms: Acetonylacetone; Diacetonyl; α,β-Diacetylethane; 1,2-Diacetylethane; 2,5-Diketohexane; 2,5-Dioxohexane acetonyl acetone; 2,5-Hexanedione

CAS Registry Number: 110-13-4

RTECS® Number: MO3150000

EC Number: 203-738-3

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory.

Canada: NDSL List; WHMIS Category B3; D2B.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S23; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Acetonyl acetone is a clear liquid, when pure; contact with air will turn it yellow to brown. Highly flammable. Molecular weight = 114.14; Specific gravity = 0.97; Boiling point = 186°C; Freezing/Melting point = −6°C; Vapor pressure = 0.4 mmHg at 20°C; Flash point = 78.9°C (cc); Autoignition temperature = 390°C. Explosive limits LEL = 1.5%, UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 1. Soluble in water; solubility ≥100 mg/mL at 25°C.

Potential Exposure: Neurotoxic. Solvent for cellulose acetate, roll-coating inks, lacquers, stains; intermediate for pharmaceuticals and photographic chemicals; electroplating.

Incompatibilities: Forms explosive mixture with air. Ketones react violently with strong oxidizers, many acids, bases, amines, amides, and inorganic hydroxides, alkali metals, hydrides, nitrides, and perchloric acid. Contact with all preceding materials that release heat and flammable gases, including hydrogen, the heat may be sufficient enough to ignite the hydrogen, causing fire or explosion. Incompatible with aldehydes, aliphatic amines, alkanolamines, cyanides, isocyanates,, peroxides. May attack plastics and some rubbers and coatings.

Permissible Exposure Limits in Air

ACGIH TLV®: 10 ppm/49 mg/m^3.

AIHA WEEL: 10 ppm.

No TEEL available.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = -0.27$.

Routes of Entry: Lungs, skin, eyes. May be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, mucous membrane, and respiratory tract. Absorbed through the skin. Skin contact may remove natural oils, causing redness and cracking. Inhalation may cause dizziness and high levels can cause narcosis and loss of consciousness. Ingestion causes gastrointestinal irritation with stomach pain, nausea, vomiting, and diarrhea. May affect central nervous system. Oral, rat: LD_{50} = (oral-rat) 2076 mg/kg.

Long Term Exposure: Chronic ingestion may cause brain damage; peripheral neuropathy; impairment of the central nervous system and peripheral nervous systems; testicular germinal cell damage. Prolonged skin contact may cause skin problems; dryness, dermatitis. It may cause testes and blood damage.

Points of Attack: Central nervous system (CNS), brain.

First Aid: Remove any contact lenses at once, then flush eyes, wash contaminated areas of body with soap and water. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: In an emergency use NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Based on its flash point, butyl glycidyl ether requires a “FLAMMABLE LIQUID” label. It falls into Hazard Class 3 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar noncombustible material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. Do not dump into a sewer. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Poisonous gases, including carbon dioxide and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, water spray, halon, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.[22]

Reference

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard. Occupational Exposure to Ketones*, NIOSH Publication No. 78-173. Washington, DC

Acetophenetidin A:0220

Molecular Formula: $C_{10}H_{13}NO_2$
Common Formula: $C_2H_5OC_6H_4NHCOCH_3$
Synonyms: Acetamide, *N*-(4-ethoxyphenyl)-; 1-Acetamido-4-ethoxybenzene; Acetofenetidna (Spanish); Aceto-*p*-phenalide; *p*-Acetophenetide; Aceto-*p*-phenetidide; Acetophenetidin; Aceto-4-phenetidine; Acetophenetidine; Acetophenetin; Acet-*p*-phenalide; *p*-Acetphenetidin; Acet-*p*-phenetidin; Acetphenetidin; Acetylphenetidin; *N*-Acetyl-*p*-phenetidine; Achrocidin; Anapac; APC; ASA compound; *p*-Ethoxyacetanilide; 4-Ethoxyacetanilide; *N*-(4-Ethoxyphenyl) acetamide; *N*,*p*-Ethoxyphenylacetamide; *p*-Phenacetin; Phenacetin; Phorazetim
CAS Registry Number: 62-44-2
RTECS® Number: AM4375000
UN/NA & ERG Number: UN2811/154
EC Number: 200-533-0
Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP 11th Report on Carcinogens, Known to be a Human Carcinogen; IARC: (phenacetin) Human Limited Evidence, Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 1.

Banned or Severely Restricted (many countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents.

US EPA Hazardous Waste Number (RCRA No.): U187, as phenacetin.

RCRA 40CFR261.33, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 16.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg).

California Proposition 65 Chemical: Cancer 10/1/89 (phenacetin and analgesic mixtures containing phenacetin).

European/International Regulations: Hazard Symbol: T; Risk phrases: R22; R45; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetophenetidin is a fine, white, crystalline powder or solid. Odorless with a slightly bitter taste. Molecular weight = 179.22; Boiling point = about 100°C (decomposes); Freezing/Melting point = 134−137°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Phenacetin is used as an analgesic and antipyretic drug. It is used alone or in combination with aspirin and caffeine for mild to moderate muscle pain relief. Phenacetin has also been used as a stabilizer for hydrogen peroxide in hair bleaching preparations. A laboratory reagent. In veterinary medicine, it is used as an analgesic and antipyretic.

Incompatibilities: Oxidizing agents, iodine and nitrating agents.[52]

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 60 mg/m^3

Russia[43] set a MAC of 0.5 mg/m^3 in working zones for phenacetin.

Determination in Water: EPA Method 8250A. Octanol−water coefficient: Log K_{ow} = <3.0.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure to high levels of this chemical can cause methemaglobinemia which lowers the ability of the blood to carry oxygen. This can result in a bluish color to skin and lips (cyanosis), headache, dizziness, collapse, and possible death.

Long Term Exposure: This chemical is a probable cancer-causing agent in humans. It has been shown to cause bladder, urinary tract, and nose cancer in animals. Mutation, reproductive, teratogenic data reported. There is limited evidence that this chemical may damage the developing fetus. High or repeated exposures can destroy red blood cells, causing low blood count; aplastic anemia; jaundice, kidney damage; and brownish color to urine. Can lead to a general allergic reaction with rash and itching.

Points of Attack: Bladder, kidneys, eyes, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: Blood test for methemoglobin level; Complete blood count and reticulocyte count; Blood and urine bilirubin; Blood Phenacetin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Wear chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any exposure level:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where Phenacetin is handled, used, or stored. Store in tightly-closed containers in a cool, well-ventilated area away from heat.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak after cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including nitrogen oxides, are produced in fire. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Permanganate oxidation, microwave plasma treatment, alkaline hydrolysis, or incineration.

References

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 26−27, (as phenacetin) (1980) and 6, No. 1, 107−110

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Phenacetin*. Trenton, NJ

Acetophenone A:0230

Molecular Formula: C_8H_8O

Common Formula: $CH_3COC_6H_5$

Synonyms: Acetofenona (Spanish); Acetylbenzene; Benzoyl methide hypnone; Dymex; Ethanone, 1-phenyl-; Hypnone®; Ketone methyl phenyl; Methyl phenyl ketone; 1-Phenylethanone; Phenyl methyl ketone

CAS Registry Number: 98-86-2

RTECS® Number: AM5250000

UN/NA & ERG Number: UN3082/171

EC Number: 202-708-7 [*Annex I Index No.:* 606-042-00-1]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *E. coli* polA without S9; *E. coli* polA with S9; Not classifiable as a human carcinogen.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.010; Nonwastewater (mg/kg), 9.7.

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste.

RCRA Land Ban Waste.

US EPA Hazardous Waste Number (RCRA No.): U0034.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36; Safety phrases: S2; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetophenone is a combustible, colorless, oily liquid with a sweet, floral odor. Molecular weight = 120.15[9]; Specific gravity (H_2O:1) = 1.028 at 20°C (liquid)[9]; Boiling point at 1 atm = 201.7°C[9]; Melting/Freezing point = 19.7°C[9]; Critical temperature = 428°C[9]; Critical pressure = 38 atm[9]; Surface Tension = 39.8 dynes/cm at 20°C (in contact with vapor); Liquid surface tension = 12 dynes/cm = 0.012 N/m at 30°C[9]; Liquid water interfacial tension = (estimate) 40 dynes/cm = 0.04 N/m at 27°C[9]; Relative vapor density (air = 1) = 4.15[9]; Ratio of specific heats of vapor (gas) = (estimate) 1.071[9]; Latent heat of vaporization = 150 Btu/lb = 83.6 cal/g[9]; 11,731.5 gcal/gmole; Heat of combustion = − 14,850 Btu/lb = − 8250 cal/g[9]; 991.60 kcal/g at 25°C (liquid); Vapor pressure = 0.99 mmHg at 20°C[9]; 0.133 kPa at15°C; Electrical conductivity = 3.12×10^5 pS/m[52]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 1; Flash point = 77°C (cc); 82°C (oc); Autoignition temperature = 570°C. Poor solubility in water; solubility = 0.73 g/100 mL at 20°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Primary Irritant. Acetophenone is used as a solvent and in perfume manufacture to impact a pleasant jasmine or orange-blossom odor. It is used as a catalyst in olefin polymerization and as a flavorant in tobacco. It is also used in the synthesis of pharmaceuticals.

Incompatibilities: Forms explosive mixture with air. See flash point, above. Strong oxidizers, strong bases, and strong reducing agents.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 10 ppm/49 mg/m^3 TWA.

AIHA WEEL: 10 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 200 mg/m^3

Hungary: TWA 15 mg/m^3; STEL 30 mg/m^3[skin] 1993; Russia: STEL 5 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 49 mg/m^3, 2003.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water for domestic purposes and 0.04 mg/L in water used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.58.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Skin contact can cause burning and rash. Exposure can result in headache, dizziness, nausea, and loss of coordination. A hypnotic, high levels of exposure may affect the nervous system. Toxic effects exacerbated by alcohol consumption.

Long Term Exposure: There is evidence that this chemical can cause genetic changes, mutations, and acne-like skin rash. Long-term exposure may cause central nervous system damage.

Points of Attack: Skin, eyes, central nervous system.

Medical Surveillance: Testing for hippuric acid levels in the urine is recommended.

First Aid: Remove any contact lenses at once, then flush eyes, wash contaminated areas of body with soap and water. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. ACGIH recommends Teflon™ as a protective material. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where acetophenone may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards but may be classified[52] as Environmentally hazardous substances, liquid, n.o.s. which falls in Hazard Class 9 and Packing Group III. This chemical requires a shipping label of "CLASS 9."

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetophenone out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, water spray, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably with a flammable solvent.

References

US Environmental Protection Agency acetophenone. (April 30, 1980). *Health and Environmental Effects Profile No. 3*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Acetophenone*. Trenton, NJ

Acetyl acetone

see 2,4-Pentanedione (CAS: 123-54-6)

Acetyl acetone peroxide A:0250

Molecular Formula: A C_{10}-ketone with no single definite structure, coexists with isomers. (Patnaik)

Synonyms: Lupersol 224; 2.4-Pentanedione, peroxide; Percure A; Peroxido de acetilacetona (Spanish); Trigonox 40

CAS Registry Number: 37187-22-7

RTECS® Number: SA2400000

UN/NA & ERG Number: UN3105 (organic peroxide type D, liquid)/145; UN3106 (organic peroxide type D, solid or paste)/145

EC Number: 253-384-9

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetyl acetone peroxide is an extremely flammable and dangerously explosive colorless to light yellow liquid with a sharp smell. An organic peroxide. May be shipped as a solution or a paste. Flash point = >90°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2. Soluble in water.

Potential Exposure: A catalyst to make resins, vinyl, polyolefins, and silicones; a curing agent for unsaturated thermoset resins.

Incompatibilities: An organic peroxide. May ignite combustibles, such as wood, cloth, oil, etc. Contact with oxidizers, heat, sparks, flame, shock, or contamination can cause explosions. Keep away from hot materials, cobalt napthenate, dimethyl aniline, and other accelerators, promoters, or reducing agents.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Acetyl acetone peroxide can be absorbed through the skin, thereby increasing exposure. Irritates eyes, skin, and respiratory tract. Can cause wheezing and coughing, dizziness, nausea, headache, and loss of consciousness. LD_{50} = (oral-rat) 3300 mg/kg.

Long Term Exposure: Unknown at this time.

Points of Attack: Eyes, skin, central nervous system.

First Aid: Remove any contact lenses at once, then flush eyes, wash contaminated areas of body with soap and water. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where acetyl acetone peroxide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: "ORGANIC PEROXIDE." FORBIDDEN from Transport by the US DOT, when active oxygen content >9%. This chemical requires a shipping label of "ORGANIC PEROXIDE TYPE D." It falls in Hazard Class 5.2, Packing Group II[19, 20].

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid or paste. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators

recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Acetyl Acetone Peroxide*. Trenton, NJ

Acetylaminofluorene A:0260

Molecular Formula: $C_{15}H_{13}NO$

Synonyms: 2-AAF; AAF; Acetamide, *N*-9H-fluoren-2-yl; Acetamide, *N*-fluoren-2-yl-; 2-Acetamidofluorene; Acetominofluorine; 2-2-Acetylamidofluorene; 2-Acetylamino-fluoren (German); *N*-Acetyl-2-aminofluorene; 2-Acetylaminofluorene; Azetylaminofluoren; 2-FAA; FAA; *N*-2-Fluoren-2-yl acetamide; 2-Fluorenylacetamide

CAS Registry Number: 53-96-3

RTECS® Number: AB9450000

UN/NA & ERG Number: UN3077/171

EC Number: 200-188-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen.

Gene-Tox Program, Negative: *In vitro* SCE—human lymphocytes; *In vitro* SCE—human; Negative: Sperm morphology—mouse; V79 cell culture—gene mutation; Negative: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Inconclusive: Cell transform.—RLV F344 rat embryo; Inconclusive: *In vivo* SCE—nonhuman; *D. melanogaster* sex-linked lethal; Inconclusive: *In vitro* UDS—human fibroblast; Positive: CHO gene mutation.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1014).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 140.

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste.

RCRA Land Ban Waste.

US EPA Hazardous Waste Number (RCRA No.): U005.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Banned or Severely Restricted (In Industrial Chemicals) (Belgium, Finland, Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 7/1/87.

Canadas WHMIS Ingredients Disclosure List Concentration Reporting Level: 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Acetylaminofluorene is a combustible, tan powder or crystalline solid. Molecular weight = 223.3; Freezing/Melting point = 194°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. 2-Acetylaminofluorene (AAF) was intended to be used as a pesticide, but it was never marketed because this chemical was found to be carcinogenic. AAF is used frequently by biochemists and technicians engaged in the study of liver enzymes and the carcinogenicity and mutagenicity of aromatic amines as a positive control. Therefore, these persons may be exposed to AAF.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. Not compatible with cyanides, acids, and acid anhydrides.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: potential occupational carcinogen; limit exposure to the lowest feasible concentration.

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 350 mg/m^3

Belgium carcinogen, 1993; Finland: carcinogen, 1993; Sweden; carcinogen, 999.

New York: 0.03 $\mu g/m^3$ for ambient air.[60]

Routes of Entry: Ingestion, inhalation, mucous membrane, skin absorption, skin and/or eye contact.

Harmful Effects and Symptoms

A carcinogen. Handle with extreme care.

Short Term Exposure: This chemical has limited use in industry, and contact is kept to a minimum to prevent cancer. Reduced function of liver, kidneys, bladder, pancreas (Potential occupational carcinogen).

Long Term Exposure: Incorporation of this compound in feed caused increased incidences of malignant tumors in a variety of organs in the rat. Long-term studies in which mice were given 2-acetylaminofluorene in their diet showed that this compound caused increased incidences of tumors and cancer of the liver, kidney, urinary bladder, lung, skin, and pancreas. There is limited evidence that this chemical is a teratogen in animals.

Points of Attack: Liver, bladder, kidney, pancreas, skin, lungs.

Medical Surveillance: Urine cytology for abnormal cells in the urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Prevent skin contact. Contact the manufacturer for recommendations. Because AAF is a carcinogen, on February 11, 1974, OSHA promulgated a standard for this chemical designating protective clothing, hygiene procedures for workers, and special engineering requirements for the manufacture or processing of AAF. Open vessel operations are prohibited. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Remove non-impervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode), or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where 2-acetylaminofluorene is handled, used, or stored. 2-Acetylaminofluorene must be stored to avoid contact with cyanides since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Usually shipped in small laboratory bottles as noted above. The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.

Spill Handling: If 2-Acetylaminofluorene is spilled or leaked, only specifically trained personnel should be involved in the cleanup. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover with lime or soda ash; collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Presumably high temperature incineration with scrubber for any produced nitrogen oxides can be used.

References

US DOL OSHA, Reduced Immunologic Competence, Code of Federal Regulations. 29CFR1910, air Contaminants. (July 1, 1996). US DHHS NIOSH and US DOL OSHA, urine (chemical/metabolite), *IOSH/OSHA Occupational Health Guidelines for Chemical Hazards*, DHHS (NIOSH) Publication No. 81-123

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: 2-Acetylaminofluorene*. Trenton, NJ

Acetyl benzoyl peroxide A:0270

Molecular Formula: $C_9H_8O_4$

Common Formula: $CH_3CO \cdot OO \cdot COC_6H_5$

Synonyms: Acetozone; Benzozone; Peroxide, acetyl benzoyl; Peroxido de acetil benzoilo (Spanish)

CAS Registry Number: 644-31-5

RTECS® Number: SD7860000

UN/NA & ERG Number: with>9% by mass active oxygen, FORBIDDEN

EC Number: 211-412-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetyl benzoyl peroxide is a white crystalline solid, forming needles. Molecular weight = 180.16; Freezing/Melting point = 36−39°C; Boiling point = 130°C; Flash point: 104°C. Decomposes in water; violent reaction; solubility = 639 mg/L at 25°C.

Potential Exposure: Used in disinfectants, to bleach flour; and in medications.

Incompatibilities: Acetyl benzoyl peroxide is an organic peroxide which can detonate if shocked, heated, or on contact with contaminants. A strong oxidizer. Avoid contact with moisture, water, steam, sources of ignition, combustible materials. Not compatible with strong bases, reducing materials, other oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set. Reacts violently with water.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.98$.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact can severely irritate and burn the eyes and skin. It may cause permanent damage. Breathing Acetyl benzoyl peroxide can irritate the nose, throat and lungs, causing a cough, difficulty breathing and chest tightness. Higher levels of exposure can cause pulmonary edema, a medical emergency, which can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause chronic irritation of the skin and eczema-like rash. Repeated lung exposure can cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, nose, throat, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Avoid skin contact with Acetyl Benzoyl Peroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear impact-resistant goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures to solid acetyl benzoyl peroxide, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposures and to the liquid form of Acetyl Benzoyl Peroxide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. This chemical is an organic peroxide which can detonate if shocked or heated. Before entering confined space where acetyl benzoyl peroxide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Acetyl benzoyl peroxide, solid, or with >40% in solution and falls in the FORBIDDEN category.[19] Solutions with <45% fall in Hazard Class 5.2 and Packing Group II. They must be labeled “ORGANIC PEROXIDE.”

Spill Handling: Restrict persons not wearing butyl rubber protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep this substance out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical or carbon dioxide extinguishers. Irritating fumes are produced in fire. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Acetyl Benzoyl Peroxide*. Trenton, NJ

Acetyl bromide A:0280

Molecular Formula: C_2H_3BrO

Common Formula: CH_3COBr

Synonyms: Acetic acid bromide; Acetic bromide; Acetilo de bromura (Spanish); Ethanoyl bromide

CAS Registry Number: 506-96-7

RTECS® Number: AO5955000

UN/NA & ERG Number: UN1716/156

EC Number: 208-061-7

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WMIS Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R34; Safety phrases: S25; S36/37/39; S45; S9 WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetyl bromide is a colorless, fuming liquid that turns yellow on contact with air. It has a sharp, unpleasant odor. Molecular weight = 122.97; Specific gravity (H_2O:1) = 1.58; Boiling point = 76.7°C; Freezing/Melting point = −96°C; Vapor pressure = 101 mmHg at 20°C; 13 kPa at 20°C; Relative vapor density (air = 1) = 4.2; Combustible but difficult to ignite; Flash point = 71°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Sinks in water; violent decomposition, forming toxic hydrogen bromide.

Potential Exposure: Acetyl bromide is used as an acetylating agent in the organic synthesis of other chemicals, pesticides, perfume, pharmaceuticals, and it is also used as a dye intermediate.

Incompatibilities: Contact with moisture, water, steam, alcohols causes a violent reaction releasing corrosive carbonyl bromide, hydrogen bromide, and bromine gases. Incompatible with organic solvents, ethers, oxidizers, and strong bases. Corrodes or attacks most metals and wood in the presence of moisture. Contact with combustibles may cause ignition.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.2 ppm
PAC-1: 0.6 ppm
PAC-2: 4 ppm
PAC-3: 20 ppm

Routes of Entry: Eye and/or skin contact, inhalation, and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Skin and eye contact can cause severe irritation and possible permanent damage including blindness. Inhalation and swallowing are very toxic. Exposure can irritate the nose, throat, air passages, and lungs with coughing and/or shortness of breath. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated respiratory exposure can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause chronic skin irritation.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, lung function tests are recommended. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Acetyl Bromide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and sunlight. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acetyl bromide requires a shipping label of "CORROSIVE MATERIAL." It falls in Hazard Class 8, Packing Group II.[19, 20]

Spill Handling: Prevent liquid from reaching water if possible. This material creates large amounts of toxic hydrogen bromide (HBr) vapor when spilled in water, and is considered by the North American Emergency Response Guide to be dangerous from 0.5 to 10 km (0.3−6.0 miles downwind). Enter area from upwind side. Evacuate area and issue warning of danger, including possible explosion. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids using dry lime or soda ash. *Do not use water or wet method.* Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.1/1.8

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 and seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Fire Extinguishing: This chemical is a combustible liquid, but does not ignite readily. Poisonous gases, including hydrogen bromide, carbonyl bromide, and bromine, are produced in fire. Reacts violently with water-based extinguishers, such as foam. *Do not use water or foam extinguishers.* Use dry chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire.

If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Slow addition to sodium bicarbonate solution.

References

Sax, I. N. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 29−30.

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Acetyl Bromide*. Trenton, NJ

Acetyl chloride A:0290

Molecular Formula: C_2H_3ClO

Common Formula: CH_3COCl

Synonyms: Acetic acid chloride; Acetic chloride; Cloruro de acetilo (Spanish); Ethanoyl chloride

CAS Registry Number: 75-36-5

RTECS® Number: AO6390000

UN/NA & ERG Number: UN1717/155

EC Number: 200-865-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Listed on the TSCA inventory.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants; RQ 40CFR117.3 (same as CERCLA).

US EPA Hazardous Waste Number (RCRA No.): U006.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

Banned or Severely Restricted (Singapore) (UN).[13]

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R14; R34; Safety phrases: S9; S16; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acetyl chloride is a highly flammable, colorless, fuming liquid with a pungent odor. The odor threshold is 1.0 ppm (as acetic acid or as HCl). Molecular weight = 78.5[9]; Specific gravity (H_2O:1) = 1.1[9]; Boiling point at 1 atm = 51°C[9]; Melting/Freezing point = − 112°C[9]; Critical temperature = (estimate) 246°C[9]; Critical pressure = (estimate) 845 psia = 57.5 atm[9]; Specific gravity = 1.1039 at 21°C (liquid); Liquid surface tension = 26 dynes/cm = 0.026 N/m at 20°C[9]; Relative vapor density (air = 1) = 2.7[9]; Electrical conductivity = $4 \times 10^{\ 7}$[du]; Ratio of specific heats of vapor (gas) = 1.1467[9]; Latent heat of vaporization = 160 Btu/lb = 88 cal/g[9]; Heat of combustion = − 6000 Btu/lb = − 3300 cal/g[9]; Heat of solution = (estimate) − 54 Btu/lb = − 30 cal/g[9]; Vapor pressure = 213 mmHg at 20°C[9]; 32 kPa at 20°C; Flash point = 4°C; Autoignition temperature = 390°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 3₩. Explosive limits LEL = 7.3%, UEL = 19.0%. Violent decomposition in water.

Potential Exposure: Compound description: Mutagen; Human Data. Acetyl chloride is used in organic synthesis as an acetylating agent, in testing for water and/or cholesterol in organic liquids, in the pharmaceutical industry, and in pesticide manufacture.

Incompatibilities: Avoid contact with moisture, steam, water, alcohols, dimethylsulfoxide, strong bases, phosphorus trichloride, oxidizers, and amines since violent reactions may occur. Keep away from heat, fire, and welding operations.

Permissible Exposure Limits in Air

AIHA WEEL: 1000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.0025 ppm

PAC-1: 0.0075 ppm

PAC-2: 0.05 ppm

PAC-3: 125 ppm

Permissible Concentration in Water: No criteria set. However, acetyl chloride reacts violently with water. Thus, its half-life in ambient water should be short and exposure from water should be nil. The degradation products should likewise pose no exposure problems if the pH of the water remains stable.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Acetyl chloride is an irritant and a corrosive. Cutaneous exposure results in skin burns, while vapor exposure causes extreme irritation of the eyes and mucous membranes. Inhalation of 2 ppm acetyl chloride has been found irritating to humans. Death or permanent injury may result after short exposures to small quantities of acetyl chloride. An aquatic toxicity rating has been estimated to range from 10 to 100 ppm.

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Skin and eye contact can cause severe irritation and possible permanent damage including blindness. Inhalation and swallowing are very toxic. Exposure can irritate the nose, throat, air passages, and lungs with coughing and/or shortness of breath. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated respiratory exposure can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause chronic skin irritation.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, lung function tests are recommended. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Acetyl Chloride, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and sunlight. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Should bear "FLAMMABLE LIQUID, CORROSIVE" label. It falls in Hazard Class 3 and 8, Packing Group II.[19, 20]

Spill Handling: Prevent liquid from reaching water if possible. This material creates large amounts of toxic hydrogen chloride (HCl) vapor when spilled in water and is considered by the North American Emergency Response Guide to be dangerous from 0.5 to 10 km (0.3−6.0 miles downwind). Enter area from upwind side. Evacuate area and issue warning of danger, including possible explosion. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids using dry lime or soda ash. *Do not use water or wet method.* Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/60
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.8/2.8

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Fire Extinguishing: This chemical is a combustible liquid but does not ignite readily. Poisonous gases, including hydrogen bromide, carbonyl bromide, and bromine, are produced in fire. *Do not use water or foam extinguishers*. Use dry chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. May be mixed slowly with sodium bicarbonate solution and then flushed to sewer with large volumes of water. May also be incinerated.

References

US Environmental Protection Agency. (April 30, 1980). *Health and Environmental Effects Profile No. 4*. Washington, DC: Office of Solid Waste (Acetyl chloride)

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 30−32 (1981) and 3, No. 3, 35−36

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Acetyl Chloride*. Trenton, NJ

Acetyl cyclohexane sulfonyl peroxide A:0300

Molecular Formula: $C_8H_{14}O_5S$

Synonyms: Acetil ciclohexilsulfoniloperoxide (Spanish); Acetyl cyclohexylsulfonyl peroxide; Lupersol 228Z; Peroxide, acetyl cyclohexylsulfonyl; Peroxido de acetilciclohexanosulfonil (Spanish)

CAS Registry Number: 3179-56-4

RTECS® Number: SD7864200 (>82%); SD7864000 (<82%); SD7864100 (<32% in solution)

UN/NA & ERG Number: UN3112 (Organic peroxide type B, solid, temperature controlled)/148

EC Number: 221-658-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetyl cyclohexane sulfonyl peroxide is a white solid which is often used in a liquid solution. It is an unstable organic peroxide. Molecular weight = 222.25; Flash point = 63°C. Insoluble in water.

Potential Exposure: Used in paint, rubber, and plastics manufacture.

Incompatibilities: Danger of explosion when dry. A very unstable organic peroxide that is heat, shock, and contamination sensitive. Store away from combustible materials; oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Eye and skin contact may cause irritation and burns. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can cause lung irritation with coughing and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure, lung function tests are recommended before beginning work and at regular times after that. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One manufacturer of acetyl cyclohexane sulfonyl peroxide recommends rubber as a protective material. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to *solid* Acetyl cyclohexane sulfonyl peroxide, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures* to *liquid* Acetyl cyclohexane sulfonyl peroxide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Danger of explosion when dry. Acetyl cyclohexane sulfonyl peroxide is commonly stored in a water slurry. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Acetyl cyclohexane sulfonyl peroxide must be stored to avoid contact with combustible materials, such as wood, paper, and oil, since violent reactions occur. Detached storage is recommended. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Danger of explosion when dry. Acetyl cyclohexane sulfonyl peroxide is commonly transported in a water slurry. Shipment of acetyl cyclohexane sulfonyl peroxide, with $>82\%$ wetted with $<12\%$ water is forbidden. Shipment of material $<82\%$ wetted with $>12\%$ water falls in Hazard Class 5.2 and Packing Group I; such materials must be labeled "ORGANIC PEROXIDE." Shipment of material $<32\%$ in solution falls in Hazard Class 5.2 and Packing Group II; such material must be labeled "ORGANIC PEROXIDE."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep spilled material wet. Because this chemical is a severe explosion hazard, contact the manufacturer regarding the safest method for cleanup and disposal. Keep acetyl cyclohexane sulfonyl peroxide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid or in solution. Poisonous gases, including sulfur oxides; are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Containers may explode in fire. *Evacuate area* if temperature control cannot be maintained. Cool containers with liquid nitrogen, dry ice, or ice. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Acetyl Cyclohexane sulfonyl Peroxide*. Trenton, NJ

Acetylene A:0310

Molecular Formula: C_2H_2
Common Formula: $HC{\equiv}CH$
Synonyms: Acetileno (Spanish); Acetylen; Acetylene, dissolved; Ethene; Ethine; Ethyne; Narcylen
CAS Registry Number: 74-86-2
RTECS® Number: AO9600000
UN/NA & ERG Number: UN1001/116

EC Number: 200-816-9 [*Annex I Index No.:* 601-015-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants, Accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): D001.

Highly Reactive Substance and Explosive (World Bank).[15]

European/International Regulations: Hazard Symbol: F + ; Risk phrases: R5; R6; R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonhazardous to water

Description: Acetylene is a highly flammable, colorless, compressed gas. It has a faint ethereal odor when pure; a garlic-like odor when contaminated. Molecular weight = 26.04[9]; Specific gravity (H_2O:1) = 0.613 at − 80°C (liquid)[9]; Boiling point at 1 atm = 84.0°C (sublimes)[9]; Melting/Freezing point = − 81°C (sublimes)[9]; Critical temperature = 35.2°C[9]; Critical pressure = 890.7 psia = 60.59 atm = 6.138 MN/m^2[A2]; Relative vapor density (air = 1) = 0.907[9]; Ratio of specific heats of vapor (gas) = 1.235[9]; Heat of combustion = − 20,747 Btu/lb = − 11,526 cal/g = − 482.57 × 10^5 J/kg[9]; Vapor pressure = 33.9 mmHg at 20°C[9]; Autoignition temperature: 305°C; Adiabatic flame temperature: 1597°C (estimate)[9]; Minimum ignition energy = 0.017 mJ[du]; Stoichiometric air-to-fuel ratio: 13.18 (estimate); Explosive limits: LEL = 2.5%, UEL = 82%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity (*gas*) 3; (*dissolved in acetone*) 2. Low solubility in water = 1.65 g/100 mL at 20°C.

Potential Exposure: Acetylene can be burned in air or oxygen and is used for brazing, welding, cutting, metallizing, hardening, flame scarfing, and local heating in metallurgy. The flame is also used in the glass industry. Chemically, acetylene is used in the manufacture of vinyl chloride, acrylinitrile, synthetic rubber, vinyl acetate, trichloroethylene, acrylate, butyrolactone, 1,4-butanediol, vinyl alkyl ethers, pyrrolidone, and other substances.

Incompatibilities: The substance may polymerize due to heating. The substance decomposes on heating and increasing pressure, causing a fire and explosion hazard. The substance is a strong reducing agent and reacts violently with oxidants and with fluorine or chlorine under influence of light, causing fire and explosion hazard. Reacts with copper, silver, and mercury or their salts, forming shock-sensitive compounds (acetylides). The content of lines carrying acetylene must not exceed 63% copper. Forms explosive mixture with air. Forms shock-sensitive mixture with copper and copper salts, mercury and mercury salts, and silver and silver salts. Reacts with brass, bromine, cesium hydride, chlorine, cobalt, cuprous acetylise; fluorine, iodine, mercuric nitrate; nitric acid, potassium, rubidium hydride; trifluoromethyl hypofluorite; and sodium hydride.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.06 mg/m^3 at 25°C & 1 atm

OSHA PEL: None established.

NIOSH REL: 2500 ppm/2662 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: Simple asphyxiant with no TLV value.

Arab Republic of Egypt: TWA 1 ppm (14 mg/m^3), 1993; Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 1000 ppm (1080 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant. Virginia has set a guideline or standard of 3.0 $\mu g/m^3$ for ambient air.[60]

Determination in Air: see NIOSH Acetylene Criteria Document.

Permissible Concentration in Water: No criteria set but EPA[32] suggests an ambient water limit of 73,000 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Rapid evaporation of the liquid may cause frostbite. Initial signs and symptoms of exposure to harmful concentrations of impure acetylene are rapid respiration, air hunger, followed by impaired mental alertness and muscular uncoordination. Other manifestations include cyanosis, weak and irregular pulse, nausea, vomiting, prostration, impairment of judgment and sensation, loss of consciousness, convulsions, and death. Low order sensitization of myocardium to epinephrine resulting in ventricular fibrillation may be possible. At high concentrations pure acetylene may act as a mild narcotic and asphyxiant. Most accounted cases of illness or death can be attributed to acetylene containing impurities of arsine, hydrogen sulfide, phosphine, carbon disulfide, or carbon monoxide.

Long Term Exposure: The substance may cause effects on the nervous system.

Points of Attack: Central nervous system; respiratory system.

Medical Surveillance: Watch for complications due to impurities, such as arsine, hydrogen sulfide, phosphine, carbon disulfide, or carbon monoxide.

First Aid: Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. If breathing is difficult, give oxygen. Remove and isolate contaminated clothing and shoes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. See also NIOSH criteria document cited below. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Acetylene poisoning can quite easily be prevented if (1) there is adequate ventilation and (2) impurities are removed when acetylene is used in poorly ventilated areas. General industrial hygiene practices for welding, brazing, and other metallurgical processes should also be observed.

Respirator Selection: See NIOSH criteria document for Acetylene, cited below. In an emergency use NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. After use for welding, turn valve off, regularly check tubing, etc., and test for leaks with soap and water. Acetylene in process may be stored in atmospheric gas holders. May be stored in conventional compressed gas cylinders. Content of lines carrying acetylene must not exceed 63% copper (Cu). Storage of liquid acetylene should be avoided. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Acetylene (liquefied) has a hazard class of "FORBIDDEN." Acetylene (dissolved) is in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Stop flow of gas. Gases in confined areas may explode when exposed to fire. Gases may travel long distances to ignition sources and flash back. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Do not extinguish the fire unless the flow of the gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use dry chemicals, carbon dioxide. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Acetylene.* NIOSH Document No. 76-195. Washington, DC

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 23−25

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Acetylene*. Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Acetylene*. Trenton, NJ

Acetylene tetrabromide A:0320

Molecular Formula: $C_2H_2Br_4$

Common Formula: $CHBr_2CHBr_2$

Synonyms: Ethane, 1,1,2,2-tetrabromo-; Muthmanns liquid; TBE; 1,1,2,2-Tetrabromaethan (German); Tetrabromoacetylene; *sym*-Tetrabromoethane; 1,1,2,2-Tetrabromoethane; 1,1,2,2-Tetrabromoethane, *sym*-; Tetrabromuro de acetileno (Spanish)

CAS Registry Number: 79-27-6

RTECS$^{®}$ Number: K18225000

UN/NA & ERG Number: UN2504/159

EC Number: 201-191-5 [*Annex I Index No.:* 602-016-00-9]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredient Disclosure List Concentration 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R26; R36; R52/53; Safety phrases: S1/2; S27; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetylene tetrabromide is a combustible, colorless to yellow liquid with a strong odor. Molecular weight = 345.7; Boiling point = 245.5°C (decomposes); Specific gravity (H_2O:1) = 2.96; Freezing/Melting point = − 1°C; Vapor pressure = 0.02 mmHg at 20°C; Relative vapor density (air = 1) = 11.9; Autoignition temperature = 335°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Very slightly soluble in water; solubility = 0.07%.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Primary Irritant. Acetylene tetrabromide is used as a solvent, a gauge fluid, and as a refractive index liquid in microscopy.

Incompatibilities: Chemically active metals (sodium, potassium, magnesium, zinc), strong caustics, hot iron. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

OSHA PEL: 1 ppm/14 mg/m^3 TWA.

NIOSH REL: After reviewing available published literature, NIOSH provided comments to OSHA on August 1, 1988, regarding the "Proposed Rule on Air Contaminants" (29 CFR 1910, Docket No. H-020). In these comments, NIOSH questioned whether the PELs proposed for this chemical were adequate to protect workers from recognized health hazards.

ACGIH TLV®[1]: 0.1 ppm/1.4 mg/m^3, inhalable fraction and vapors TWA.

NIOSH IDLH: 8 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 6 ppm

PAC-2: 8 ppm

PAC-3: 8 ppm

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 1 ppm (15 mg/m^3), 1993; Austria: MAK 1 ppm (14 mg/m^3), 1999; Belgium: TWA 1 ppm (14 mg/m^3), 1993; Denmark: TWA 1 ppm (14 mg/m^3), 1999; Finland: TWA 1 ppm (14 mg/m^3); STEL 3 ppm (42 mg/m^3), 1999; France: VME 1 ppm (15 mg/m^3), 1999; the Netherlands: MAC-TGG 7 mg/m^3 [skin] 2003; the Philippines: TWA 1 ppm (14 mg/m^3), 1993; Sweden: TWA 1 ppm (14 mg/m^3); STEL 2 ppm (30 mg/m^3), 1999; Turkey: TWA 1 ppm (14 mg/m^3), 1993; United Kingdom: 0.5 ppm (7.2 mg/m^3) [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm. Several states have set guidelines or standards for acetylene tetrabromide in ambient air[60] ranging from 0.15 mg/m^3 (North Dakota) to 0.25 mg/m^3 (Virginia) to 0.28 mg/m^3 (Connecticut) to 0.357 mg/m^3 (Nevada).

Determination in Air: Silica absorption followed by THF treatment and gas chromatographic analysis. See NIOSH Analytical Method, 1994: 1,1,2,2-Tetrabromoethane, #2003.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Can cause headaches, fatigue, dizziness, lightheadedness, and unconsciousness. High concentrations can cause death. Prolonged skin contact can cause burns.

Long Term Exposure: There is limited evidence that acetylene tetrabromide causes cancer, possibly stomach cancer. Repeated exposures can cause liver, kidney, and lung damage, and drying and cracking of the skin.

Points of Attack: Eyes, upper respiratory system, liver, kidneys, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests; expired air.[58]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of saltwater and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 8 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry in unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Acetylene tetrabromide begins to decompose at 245°C producing flammable and highly toxic vapors of bromine and carbonyl bromide. Avoid contact with incompatible materials cited above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Tetrabromoethane requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire, including bromine and carbonyl bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with combustible fuel and with scrubber to remove halo acids produced.

References

US Environmental Protection Agency. (June 14, 1983). *Chemical Hazard Information Profile Draft Report: Tetrabromoethane*. Washington, DC

US DHHS/NIOSH and US DOL/OSHA. (1981; 1995). *NIOSH/OSHA Occupational Health Guidelines For Chemical Hazards*, DHHS (NIOSH) Publication Nos. 81-123; 88-118, Supplements I–IV, Cincinnati, OH.

Linch, A. L. (1974). *Biological Monitoring for Industrial Chemical Exposure Control*. CRC Press.

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Acetylene Tetrabromide*. Trenton, NJ

Acetyl iodide A:0330

Molecular Formula: C_2H_3IO
Common Formula: CH_3COI
Synonyms: Yoduro de acetilo (Spanish)
CAS Registry Number: 507-02-8
RTECS® Number: AP4670000
UN/NA & ERG Number: UN1898/156

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Corrosive; Risk phrases: R14; R34; Safety phrases: S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetyl iodide is a corrosive, colorless liquid that turns brown on contact with air or moisture. It has a suffocating odor. Molecular weight = 169.96; Boiling point = 107.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0; (NJDHSS): Health 2, Flammability 1, Reactivity 1. Decomposes in water.

Potential Exposure: Used as an organic intermediate; to make other chemicals.

Incompatibilities: Moisture, water, steam, or alcohol. Corrosive to metals.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

No TEEL available.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Can cause severe skin and eye burns. Breathing this chemical can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency. This can cause death.

Long Term Exposure: Repeated exposure can cause lung irritation, bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure, lung function tests are recommended before beginning work and at regular times after that. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility. Continue observation for 24−48 h after breathing exposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture and alcohols. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Shipping label required is "CORROSIVE." It falls in Hazard Class 8, Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.1/1.8

Fire Extinguishing: Acetyl iodide may burn but does not readily ignite. Poisonous gases are produced in fire, including iodine vapors and iodides. Do not use water as this chemical reacts forming corrosive and toxic fumes. Use dry chemical, carbon dioxide or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Acetyl Iodide*. Trenton, NJ

Acetylsalicylic acid A:0340

Molecular Formula: $C_9H_8O_4$

Common Formula: $HOOCC_6H_4OCOCH_3$

Synonyms: Acenterine®; Acesa®; Acetaldehyde diethyl acetal; Acetal diethylique (French); Aceticyl; Acetol®;

Acetophen®; Acetosal®; Acetosalin®; Acetylin®; 2-(Acetyloxybenzoic) acid; Acetylsal®; Acisal®; Acylpyrin®; Asagran®; Aspirin; Aspro®; Asteric®; Benzoic acid, 2-(acetyloxy)-; Caprin; 1,1-Diaethoxy-aethan; Diaethylacetal (German); 1,1-Diethoxyethane; Diethyl acetal; Duramax®; Ecotrin®; Empirin®; Ethylidene diethyl ether; Neuronika®; Polopiryna®; Rhodine®; Salacetin®; Salicylic acid, acetate; Xaxa®

CAS Registry Number: 50-78-2; *(alt.)* 2349-94-2; *(alt.)* 11126-35-5; *(alt.)* 11126-37-7; *(alt.)* 26914-13-6; *(alt.)* 98201-60-6

RTECS® Number: VO0700000

UN/NA & ERG Number: UN2811/154

EC Number: 200-064-1

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Sperm morphology—mouse; Inconclusive: Mammalian micronucleus.

US EPA, FIFRA, 1998 Status of Pesticides: Active registration.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Developmental/Reproductive toxin (female) 7/1/90. Aspirin (*Note:* It is especially important not to use aspirin during the last 3 months of pregnancy, unless specifically directed to do so by a physician because it may cause problems in the unborn child or complications during delivery).

European/International Regulations: Hazard Symbol: T; Risk phrases: R25; Safety phrases: S24; S27; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acetylsalicylic acid is a white crystalline solid with a slightly bitter taste. It is odorless but hydrolyzes in moist air to give an acetic acid odor. Molecular weight = 180.15; Boiling point = decomposes at <140°C; Freezing/Melting point = 135°C[A1]; Density = 1.4 g/cm^3; Vapor pressure = 0 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0 Poor solubility in water = 0.3% at 15°C.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Used as an over-the-counter and proprietary pharmaceutical and veterinary drug. Those engaged in manufacture of aspirin or, more likely, in its consumption in widespread use as an analgesic, antipyretic, and anti-inflammatory agent.

Incompatibilities: Strong oxidizers, strong acids, strong bases, carbonates, moisture. Dust dispersed in air is explosive.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 ppm TWA.

ACGIH TLV®[1]: 5 ppm TWA.

Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Norway: TWA 5 gm/m^3, 1999; Russia: STEL 0.5 mg/m^3, 1993; Switzerland: MAK-W 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea,New Zealand, Singapore, Vietman: ACGIH TLV®: TWA 5 mg/m^3. Some states have set guidelines or standards for aspirin in ambient air[60] ranging from 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.21.

Routes of Entry: Primarily oral in medicinal use.

Harmful Effects and Symptoms

Short Term Exposure: Eye and skin contact can cause irritation. Burns to the eyes and scarring can occur. High exposures may cause headache, dizziness, depression, and irritability. This chemical can be absorbed through the skin, thereby increasing exposure. Adverse effects from the usual doses of aspirin are infrequent, most common are gastrointestinal disturbances. Prolonged administration of large doses results in occult bleeding and may result in anemia. LD$_{50}$ = (oral-rat) 200 mg/kg.

Long Term Exposure: Repeated exposures may cause headache, dizziness, depression, and irritability; allergy may develop causing hives. Animal tests show that this substance possibly causes toxic effects upon human reproduction; possible teratogen. This chemical can decrease the clotting ability of blood.

Points of Attack: *Cancer site:* Eyes, skin, respiratory system, blood, liver, kidneys.

Medical Surveillance: Tests of blood clotting ability. People taking anticoagulants may be at increased risk. Skin testing with dilute Acetylsalicylic acid may help diagnose allergy, if done by a qualified allergist. If allergy is confirmed, all future exposure to this chemical should be avoided since even small exposure can cause an allergic reaction. It is possible for severe allergic reaction to occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH; however where the potential exists for exposure, the following might be considered: P2 filter respirator for harmful particles meeting NIOSH classified N95. The use of N95 respirators is restricted to use in atmospheres free of oil aerosols. In Europe, similar respirators may contain the prefix "FF" (for filtering face-piece) and may be classified as FFP2.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture.

Shipping: This chemical requires a shipping label of "TOXIC SOLID, ORGANIC, n.o.s." It falls in Shipping Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Sweep spilled substance into containers; if appropriate, moisten first to prevent dusting. Carefully collect remainder, then remove to safe place (extra personal protection: P2 filter respirator for harmful particles). Use a vacuum or wet method to reduce dust during cleanup. *Do not dry sweep*. The spilled material may be dampened with 60−70% ethanol to avoid airborne dust and the material then scooped up for disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acetylsalicylic acid itself may burn but does not readily ignite. Dust of this chemical dispersed in air is explosive. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with large volumes of water.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 20−22 (as acetol)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Acetylsalicylic Acid*. Trenton, NJ

1-Acetyl-2-thiourea A:0350

Molecular Formula: $C_3H_6N_2OS$

Common Formula: $CH_3CONHCSNH_2$

Synonyms: Acetamide, *N*-(aminothioxomethyl)-; Acetyl thiourea

CAS Registry Number: 591-08-2

RTECS® Number: YR7700000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155; UN2811/154

EC Number: 209-699-9

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P002.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S23; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1-Acetyl-2-thiourea is a white crystalline solid; forming needles. Molecular weight = 118.16; Freezing/Melting point = 165−168°C; Flash point = 80°C. Slightly soluble in water.

Potential Exposure: Studied as possible rodenticide; used in organic synthesis.

Incompatibilities: Strong oxidizers, strong acids.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

An LD_{50} value (oral-rat) has been reported as 50 mg/kg and is the apparent basis for EPA classification as hazardous substance[4] and hazardous waste.[5] Acts as poison in humans by ingestion and intraperitoneal routes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where potential for exposure exists:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture.

Shipping: This chemical requires a shipping label of "TOXIC SOLID, ORGANIC, n.o.s." It falls in Shipping Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and sulfur oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Acifluorfen A:0360

Molecular Formula: $C_{14}H_7ClF_3NO_5$

Common Formula: $F_3C-C_6H_3(Cl)-O-C_6H_3(NO_2)(COOH)$

Synonyms: Acifluorfen; Acifluorfene; Benzoic acid, 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitro-; Blazer®; Carbofluorfen; 5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid; 5-(2-Chloro-α,α,α-trifluoro-*p*-tolyloxy)-2-nitrobenzoic acid; Tackle®

CAS Registry Number: 50594-66-6; 62476-59-9 (sodium salt, the parent chemical)

RTECS® Number: DG5643200

UN/NA & ERG Number: UN2588/151 (pesticide, solid, toxic, n.o.s.)

EC Number: 256-634-5 [*Annex I Index No.*: 604-041-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: Possible human; animal positive (EPA), *possibly carcinogenic to humans*, Group 2B, as sodium salt.

Clean Water Act: CFR 455, Table 1.

California Proposition 65 Chemical: Cancer 1/1/90 (62476-59-9).

SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0% (sodium salt).

European/International Regulations (*includes sodium*): Hazard Symbol: Xn, N; Risk phrases: R22; R38; R41; R50/53; Safety phrases: S2; S24; S39; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acifluorfen, a diphenyl ether, is a combustible, off-white, light tan to brown solid. Molecular weight = 361.65; Freezing/Melting point = 152–157°C[23]; 124–126°C (sodium salt). The sodium salt is soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this selective preemergence and postemergence herbicide used to control weeds and grass in soybean and peanut crops.

Incompatibilities: Strong oxidizers. Avoid contact with all sources of ignition.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: A no-adverse-effect level (NOAEL) has been determined to be 20 mg/kg. Body weight/day based on fetotoxicity. However, an NOAEL of 5.6 was determined based on increase in liver size of male rats; further an NOAEL of 1.25 mg/kg/day was determined in a 2-generation rat reproduction study. Based on this, a long-term health advisory of acifluorfen has been set at 0.44 mg/L for a 70-kg adult. A lifetime health advisory for that same adult is 0.009 mg/L. The EPA has also determined a reference dose (acceptable daily intake) of 0.013 mg/kg/day.

Determination in Water: Analysis of acifluorfen is by a gas chromatographic (GC) method applicable to the determination of certain chlorinated acid pesticides in water samples. In this method, approximately 1 L of sample is acidified. The compounds are extracted with ethyl ether using a separatory funnel. The derivatives are hydrolyzed with potassium hydroxide, and extraneous organic material is removed by a solvent wash. After acidification, the acids are extracted and converted to their methyl esters using diazomethane as the derivatizing agent. Excess reagent is removed, and the esters are determined by electron capture GC. The method detection limit has not been determined for this compound, but it is estimated that the detection limits for analytes included in this method are in the range of 0.5−2 μg/L. Fish Tox: 1499.99565000 ppb MATC (VERY LOW).

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

The acute oral LD_{50} for male rats is 2025 mg/kg; for female rats is 1370 mg/kg. Acifluorfen is a moderate dermal irritant.

Long Term Exposure: A known carcinogen. Similar chlorinated diphenyl ethers have caused liver damage in laboratory animals. Human Tox = 3.27103 ppb CHCL (Chronic Human Carcinogen Level) (HIGH).

Points of Attack: Skin and liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acifluorfen may be classified as a pesticide, solid, toxic, n.o.s. It would then fall in Hazard Class 6.1 and Packing Group III. This requires a “KEEP AWAY FROM FOOD” label.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Do not flush spilled material into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Reverse osmosis (RO) is a promising treatment method for pesticide-contaminated water. As a general rule, organic compounds with molecular weights greater than 100 are candidates for removal by RO, which yields 99% removal efficiency of chlorinated pesticides by a thin-film composite polyamide membrane operating at a maximum pressure of 1000 psi and at a maximum temperature of 45°C. More operational data are required, however, to specifically determine the effectiveness and feasibility of applying RO for the removal of acifluorfen from water. Also, membrane adsorption must be considered when evaluating RO performance in the treatment of acifluorfen-contaminated drinking water supplies. Soil Adsorption Index (K_{oc}) = 113 (Estimate).

Fire Extinguishing: This chemical is a combustible solid but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides, carbon monoxide, chlorides, and fluorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

US Environmental Protection Agency, Office of Drinking Water. (1987). *Health Advisory: Acifluorfen.* Washington, DC

Acridine A:0370

Molecular Formula: $C_{13}H_9N$

Synonyms: 10-Azaanthracene; 9-Azaanthracene; 2,3-Benzoquinoline; Benzo(b)quinoline; Dibenzo(b,e)pyridine; Dibenzopyridine

CAS Registry Number: 260-94-6

RTECS® Number: AR7175000

UN/NA & ERG Number: UN2713/153

EC Number: 205-971-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: Coal tar and similar materials which are known to be carcinogenic to humans may contain dibenzo (b,e)pyridine. (See also Coal Tar Pitch Volatiles).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: (*Coke oven emissions*) Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1% as coal tar pitch volatiles.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acridine is a crystalline solid made up of small, colorless or light yellow orthorhombic plates or needles. Molecular weight = 179.22; Density = 1.005 at 20°C; Boiling point = 346°C at 760 mmHg; Freezing/Melting point = 108−110.5°C (sublimes at 100°C); Vapor Pressure = 1 mmHg; Heat of combustion = −15,800 Btu/lb = −8790 cal/g = -368×10^5 J/kg.[C] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0.

Solubility in water = 38 mg/L; highly soluble in boiling water.

Potential Exposure: Acridine and its derivatives are widely used in the production of dyestuffs, such as acriflavine, benzoflavine, and chrysaniline; and in the synthesis of pharmaceuticals, such as aurinacrine, proflavine, and rivanol. A constituent of coal tar, coal tar creosote; found in wastes from gas and tar plants and coke oven emissions.

Incompatibilities: Strong acids, strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available. However, EPA[32] suggests an ambient air limit of 162 $\mu g/m^3$ based on health effects.

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene-soluble aerosol); Confirmed Human Carcinogen.

NIOSH IDLH: 80 mg/m^3 (as benzene-soluble aerosol).

DFG MAK: Category 1, human carcinogen.

Determination in Air: By fluorometry; NIOSH Analytical Method 5800, Polycyclic aromatic compounds.

Permissible Concentration in Water: No criteria set but EPA[32] suggests an ambient level goal of 800 μg/L based on health effects.

Determination in Water: Harmful to aquatic life in small quantities. Octanol−water coefficient: Log K_{ow} = about 3.5.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Acridine is a severe irritant to the conjunctiva of the eyes, the mucous membranes of the respiratory tract, and the skin. It is a powerful photosensitizer of the skin. Acridine causes sneezing on inhalation. Poisonous by ingestion and subcutaneous routes. Toxicity by ingestion = Grade 2; LD_{50} oral rat = 2000 mg/kg[C].

Long Term Exposure: Yellowish discoloration of sclera and conjunctiva may occur. Mutational properties have been ascribed to acridine, but its effect on humans is not known. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (Category 1) in animal studies.

Points of Attack: Eyes, skin, and respiratory tract.

Medical Surveillance: Evaluate the skin, eyes, and respiratory tract in the course of any placement or periodic examinations. Complete blood count, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles.[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. A protective layer of petroleum jelly, lanolin, or castor oil has been recommended in ILO literature. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as coal tar pitch volatiles): At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acridine requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Apply carbon or peat absorbents to dissolved material. Dredge up solid material for removal to disposal area. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use water spray or foam extinguishers, CO_2 and dry chemicals may not be effective. Poisonous gases are produced in fire, including nitrogen oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with nitrogen oxide removal from the effluent gas by scrubber, catalytic or thermal device.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 32−33 (1981) and 8, No. 5, 49−55 (1988)

Eller, P. M., & Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

Acrolein A:0380

Molecular Formula: C_3H_4O

Common Formula: CH_2CHCHO

Synonyms: Acquinite; Acrehyde; Acroleine (French); Acrylaldehyde; Acrylehyd (German); Acrylehyde; Acrylic aldehyde; Aldehyde acrylique (French); Allylaldehyde; Aqualin; Aqualine; Biocide; Ethylene aldehyde; 2-Propenal; Prop-2-en-1-al; Propenal; 2-Propen-1-one; Propylene aldehyde; Slimicide

CAS Registry Number: 107-02-8; *(alt.)* 25314-61-8; 100-73-2 (dimer)

RTECS® Number: AS1050000

UN/NA & ERG Number: UN1092 (stabilized)/131P; UN2607 (dimer, inhibited)/129P

EC Number: 203-453-4 [*Annex I Index No.:* 605-008-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1995.

EPA-1.

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 5000 lb (1275 kg).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A Priority Pollutants; 40CFR401.15 Toxic Pollutant.

US EPA Hazardous Waste Number (RCRA No.): P003.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.29; Nonwastewater, N/A.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested Methods (PQL μg/L): 8030 (5); 8240 (5).

CERCLA/SARA Section 302, Extremely Hazardous Substances: TPQ = 500 lb (228 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Mexico: Drinking Water 0.3 mg/L (ecological criteria); Listed as an organic toxic pollutant in wastewater.

European/International Regulations: Hazard Symbol: F + , T + , N; Risk phrases: R11; R24/25; R26; R34; R50; Safety phrases: S23; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Acrolein is a highly flammable, clear to yellowish liquid. It has a piercing, disagreeable odor and causes tears. Molecular weight = 56.06; Specific gravity = 0.843 at 20°C (liquid)[9]; Boiling point at 1 atm = 53°C[9]; Melting/Freezing point = − 88°C[9]; Critical temperature = (estimate) 254°C[9]; Critical pressure = (estimate) 737 psia = 50.0 atm[9]; Liquid surface tension = 24 dynes/cm = 0.024 N/m at 20°C[9]; Liquid water interfacial tension = (estimate) 35 dynes/cm = 0.035 N/m at 20°C; Relative vapor density (air = 1) = 1.94[9]; Ratio of specific heats of vapor (gas) = 1.1487[9]; Latent heat of vaporization = 216 Btu/lb = 120 cal/g[9]; Heat of combustion = − 12,500 Btu/lb = − 6950 cal/g[9]; Heat of polymerization = (estimate) − 50 Btu/lb = − 28 cal/g = -1.2×10^5 J/kg[9]; Vapor pressure = 210 mmHg at 20°C[9]; 290 hPa at 20°C; Flash point = − 26°C (cc); Autoignition temperature (unstable) = 220°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3; (Dimer): Health 1, Flammability 2, Reactivity 1. Explosive limits: LEL = 2.8%, UEL = 31.0%. Odor threshold = 0.174 ppm. Soluble in water; 20 g/100 mL at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as pharmaceutical; slimicide; and in production of cosmetics and food supplements; as an intermediate in the production of glycerine and in the production of methionine analogs (poultry feed protein supplements). It is also used in chemical synthesis (1,3,6-hexametriol and glutaraldehyde); as a liquid fuel; antimicrobial agent, in algae and aquatic weed control; and as a slimicide in paper manufacture; making plastics, drugs, and tear gas. Also, most allyl compounds may be metabolized to allyl alcohol which is metabolized to acrolein.

Incompatibilities: Forms explosive mixture with air. Elevated temperatures or sunlight may cause explosive polymerization. A strong reducing agent; reacts violently with oxidizers. Reacts with acids, alkalis, ammonia, amines, oxygen, peroxides. Shock-sensitive peroxides or acids may be formed over time. Attacks zinc and cadmium.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.33 mg/m^3[A1] at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.25 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.25 mg/m^3 TWA; 0.3 ppm/0.8 mg/m^3 STEL.

ACGIH TLV®[1]: 0.1 ppm/0.23 mg/m^3 Ceiling Concentration [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 2 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.03 ppm

PAC-1: **0.030** ppm

PAC-2: **0.1** ppm

PAC-3: **1.4** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 3B.

Arab Republic of Egypt: TWA 0.1 ppm (0.25 mg/m^3), 1993; Australia: TWA 0.1 ppm (0.25 mg/m^3); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.25 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.23 mg/m^3); STEL

0.3 ppm, 1993; Finland: STEL 0.1 ppm (0.25 mg/m^3) [skin] 1993; France: VLE 0.1 ppm (0.25 mg/m^3), 1999; Hungary: TWA 0.25 mg/m^3; STEL 0.5 mg/m^3, 1993; the Netherlands: MAC-TGG 0.05 mg/m^3, 2003; Japan; 0.1 ppm (0.23 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.25 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.25 mg/m^3), 1993; Poland: MAC (TWA) 0.2 mg/m^3, MAC (STEL) 0.5 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 0.2 mg/m^3, 1993; Sweden: NGV 0.1 ppm (0.2 mg/m^3), KTV 0.3 ppm (0.7 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.25 mg/m^3), KZG-W 0.2 ppm (0.5 mg/m^3), 1999; Turkey: TWA 0.1 ppm (0.25 mg/m^3), 1993; United Kingdom: TWA 0.23 mg/m^3; STEL 0.70 mg.m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: ceiling 0.1 ppm (skin). Several states have set guidelines or standards for acrolein in ambient air[60] ranging from 0.83 μg/m^3 (New York) to 1.25 μg/m^3 (South Carolina) to 2.5 μg/m^3 (Florida, North Dakota) to 4 μg/m^3 (Virginia) to 5 μg/m^3 (Connecticut) to 6.9 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2501, OSHA Analytical Method #52.

Permissible Concentration in Water: To protect freshwater aquatic life on an acute basis 68 μg/L and on a chronic basis 21 μg/L. *To protect saltwater aquatic life:* 55 μg/L on an acute toxicity basis. To protect human health—320 μg/L.[6] In addition, two states have set guidelines for acrolein in drinking water.[61] These are both 320 μg/L as set by Arizona and Kansas.

Determination in Water: Gas chromatography (EPA Method #603) or gas chromatography and mass spectrometry (EPA Method #624). Octanol−water coefficient: Log $K_{ow} = 0.88$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 44 mg/kg. This chemical can be absorbed through the skin, thereby increasing exposure. Eye and skin contact may cause intense tearing, irritation, blisters, and burns. Inhalation can irritate the lungs, causing irritation, coughing, wheezing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. If swallowed, produces acute abdominal pains. Extremely toxic; probable oral human lethal dose is 5−50 mg/kg, between 7 drops and one teaspoon for a 70-kg (150 lb) person. Inhalation of air containing 10 ppm of acrolein may be fatal in a few minutes. Death from cardiac failure accompanied by hyperemia and hemorrhage of the lungs and degeneration of the bronchial epithelium is possible. Acrolein causes acute respiratory and eye irritation, severe gastrointestinal distress with slowly developing pulmonary edema (lung fill up with fluid), and skin irritation.

Long Term Exposure: This chemical is a metabolite of cyclophosphamide, a well-recognized animal teratogen. Acrolein may cause mutations. Such chemicals have a cancer risk. Long-term exposure can cause drying and cracking of the skin. High or repeated lower exposure may cause permanent lung damage. Testing has not been completed to determine the carcinogenicity of acrolein. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Heart, lungs, eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic medical examinations should consider respiratory, skin, and eye disease. For those with frequent or potentially high exposure, lung function tests are recommended before beginning work and at regular times after that. Chest X-ray, expired air, pulmonary function tests.[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron->g/cm^2/min): butyl rubber gloves, suits, boots; Barricade®™ coated suits; Trychem 1000™ suits. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA/NIOSH *2 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF

(APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SAF: Pd,Pp:ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. *Do not* store uninhibited acrolein under any circumstances. Protect against physical damage. Outside or detached storage is preferable. Inside storage should be in a standard flammable liquids storage room or cabinet. Before entering confined space where acrolein may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and light. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Ship in unbreakable packaging. Do not transport with human food or animal feedstuffs. This chemical requires a shipping label of “POISON, FLAMMABLE LIQUID.” It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Take up very *small spills* for disposal by absorbing it in vermiculite, dry sand, or earth and disposing in a secured landfill or combustion chamber. Alternatively, cover with sodium bisulfite, add small amount of water and mix. Then, after 1 h, flush with large amounts of water and wash site with soap solution. Liquid should not be allowed to enter confined space, such as a sewer, because of potential for explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance ay need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 2.0/3.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0 + /11.0 +
Night 7.0 + /11.0 +

Fire Extinguishing: This chemical is a flammable liquid and explosion hazard. Under fire conditions, polymerization may occur, blocking relief valves leading to tank explosion. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration. Conditions are 816°C, 0.5 s minimum for primary combustion; 1093°C, 1.0 s for secondary combustion.

References

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: Acrolein.* Trenton, NJ

Acrylamide A:0390

Molecular Formula: C_3H_5NO

Common Formula: $CH_2CHCONH_2$

Synonyms: Acrilamida (Spanish); Acrylamide monomer; Acrylic acid amide (50%); Acrylic amide; Acrylic amide 50%; Ethylenecarboxamide; Ethylene monoclinic tablets carboxamide; 2-Propenamide; Propenamide; Vinyl amide

CAS Registry Number: 79-06-1

RTECS® Number: AS3325000

UN/NA & ERG Number: UN2074/153P

EC Number: 201-173-7 [*Annex I Index No.:* 616-003-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1994; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: Cytogenetics—male germ cell; Negative: *In vivo* cytogenetics—nonhuman bone marrow; Inconclusive: *In vivo* SCE—nonhuman.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA)[48] (Minnesota).[61]

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U007.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 19; Nonwastewater, 23.

Safe Drinking Water Act, MCL, treatment technique; MCLG = zero; Regulated Chemical (47FR9352).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R46; R20/21; R25; R36/38; R43; R48/23/24/25; R62; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Acrylamide in monomeric form is odorless, flake-like crystals. May be dissolved in a flammable liquid. Molecular weight = 71.08; Specific gravity (H_2O:1) = 1.05 at 25°C (liquid); 1.122 at 30°C; Boiling point = (decomposes) 175−300°C at 1 atm; Melting/Freezing point = 85°C; Vapor pressure = 0.0068 mmHg at 20°C; Relative vapor density (air = 1) = 1.0 at 20; Vapor density = 2.46; Autoignition temperature = 240°C; Flash point = 138°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2. Soluble in water; solubility = 2155 g/L at 30°C; 2045 g/L at 25°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Used in the manufacture of plastics, resins, rubber, synthetic textiles; as a dye, pigment. A major application for monomeric acrylamide is in the production of polymers as polyacrylamides. Polyacrylamides are used for soil stabilization, gel chromatography, electrophoresis, papermaking strengtheners, clarifications, and treatment of potable water and foods.

Incompatibilities: Acrylamide may decompose with heat and polymerize at temperatures above 84°C, or exposure to light, releasing ammonia gas. Reacts violently with strong oxidizers. Reacts with reducing agents, peroxides, acids, bases, and vinyl polymerization initiators. Fine particles of dust form explosive mixture with air.

Permissible Exposure Limits in Air

OSHA PEL: 0.3 mg/m^3 TWA [skin].

NIOSH REL: 0.03 mg/m^3 TWA [skin] Potential occupational carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.03 mg/m^3 TWA inhalable fraction and vapors [skin]; confirmed animal carcinogen with unknown relevance to humans (2003).

NIOSH IDLH: (potential occupational carcinogen) 60 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.03 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 60 mg/m^3

DFG MAK: [skin]; danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Group 2 (2004).

Australia: TWA 0.3 mg/m^3, [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 0.3 mg/m^3, [skin], Carcinogen 1993; Denmark: TWA 0.03 mg/m^3, [skin], 1999; Finland: TWA 0.3 mg/m^3; STEL 0.9 mg/m^3, 1993; France: VME 0.1 ppm (0.3 mg/m^3), [skin], continuous; carcinogen, 1999; Hungary: STEL 0.3 mg/m^3, [skin], carcinogen, 1993; Japan: 0.3 mg/m^3, [skin], 2A carcinogen, 1999; Norway: TWA 0.3 mg/m^3, 1999; the Philippines: TWA 0.3 mg/m^3, [skin], 1993; Poland: TWA 0.1 mg/m^3, 1999; Russia: STEL 0.2 mg/m^3, [skin], 1993; Sweden: NGV 0.03 mg/m^3, KTV 0.1 mg/m^3, [skin], 1999; Switzerland; MAK-W 0.03 mg/m^3, [skin], carcinogen, 1999; United Kingdom: TWA 0.3 mg/m^3, [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for acrylamide ambient concentrations in air[60]: 0.3 μg/m^3 (South Carolina) to 1.0 μg/m^3 (New York) to 3.0 μg/m^3 (South Dakota) to 5.0 μg/m^3 (Virginia) to 6.0 μg/m^3 (Connecticut) to 7.0 μg/m^3 (Nevada).

Determination in Air: Filter/Si gel; Methanol; Gas chromatography/Nitrogen/phosphorus detection; OSHA Analytical Method 21: The sampling train consists of a 13-mm glass fiber filter in a Swinnex cassette (available from the laboratory), followed by a standard silica gel tube. The filter and gaskets, within the cassette used to hold the filter, are extracted in the field in exactly 1 mL of methanol. This extraction is very important so a volumetric pipette calibrated to 1 mL must be used. The silica gel tube is extracted with methanol at the laboratory. Analysis is performed by gas chromatography (GC) using a nitrogen/phosphorous detector; or OSHA Analytical Method PV 2004: Samples are collected by drawing known volumes of air through OSHA versatile sampler (OVS-7) tubes, each containing a glass fiber filter and two sections of XAD-7 adsorbent. Samples are desorbed with a solution of 5% methanol 95% water and analyzed by high-performance liquid chromatography using an ultraviolet detector.

Permissible Concentration in Water: Health advisories have been developed by EPA[48] on a long-term (7 year) basis as 0.02 mg/L for a 10-kg child and 0.07 mg/L for a 70-kg adult. A guideline for acrylamide in drinking water of 0.10 μg/L has been developed by the state of Minnesota.[61]

Determination in Water: There is no standardized method for the determination of acrylamide in drinking water. An analytical procedure for the determination of acrylamide has been reported in the literature. This procedure consists of bromination, extraction of the brominated product from water with ethyl acetate, and quantification using high-performance liquid chromatography (HPLC) with an ultraviolet detector. The concentration of the ethyl acetate to dryness and dissolution in a small volume of distilled water prior to HPLC analysis allows the detection of acrylamide at concentrations of 0.2 μg/L.[48] Octanol−water coefficient: Log $K_{\mathrm{ow}} = -0.65$.

Routes of Entry: Eyes, skin, central and peripheral nervous systems, reproductive system. Acrylamide can be absorbed through unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Symptoms of exposure include complaints of drowsiness, fatigue, tingling of fingers. A stumbling, propulsive type of walking with sense of unsteadiness has been reported. Motor and sensory impairment, numbness, tremor, abnormal feelings in the lower limbs accompanied by weakness, and speech disturbances were also reported. Classified as very toxic; probably oral lethal human dose is between 50 and 500 mg/kg or between one teaspoon and 1 oz for a 150-lb person. Polymerized acrylamide may not be toxic, but the monomer can cause peripheral nerve damage. Toxic effects exacerbated by alcohol consumption.

Long Term Exposure: There is evidence that acrylamide causes cancer in animals. It may cause skin and lung cancer in humans. There is limited evidence that this chemical damages the male testes. It can cause damage to the central nervous system; causing numbness and weakness of the hands and feet. Acrylamide is a cumulative neurotoxin and repeated exposure to small amounts may cause serious injury to the nervous system. The neurological effects may be delayed. Polymer inhibitors or stabilizers added to the monomer may also produce toxicity. The symptoms of acrylamide toxicity are consistent with midbrain lesions and blocked transport along both motor and sensory axons.

Points of Attack: Central nervous system, peripheral nervous system, skin, and eyes.

Medical Surveillance: Since skin contact with the substance may result in localized or systemic effects, NIOSH recommends that medical surveillance be made available to all employees working in an area where acrylamide is stored, produced, processed, or otherwise used, except as an unintentional contaminant in other materials at a concentration of less than 1% by weight. For those with frequent or potentially high exposure, nerve condition tests should be considered. The use of alcoholic beverages may enhance the harmful effects. Nerve conduction studies.[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron->g/cm^2/min): butyl rubber gloves, suits, boots; Tychem 1000™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): nitrile rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves. Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. Wear protective gloves and clothing to prevent repeated or prolonged skin contact. Wear dust-proof eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store only if stabilized, under inert gas. Before entering confined space where acrylamide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Use water spray to reduce vapors. Remove all ignition sources. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. If you need to seek emergency information, call CHEMTREC at (800) 424-9300, or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: A combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Dike fire control water for later disposal; do not scatter the material.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Acrylamide residue and sorbent material may be packaged in epoxy-lined drums and taken to an EPA-approved disposal site. Incineration with provisions for scrubbing of nitrogen oxides from flue gases. Deep well injection.

References

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US Environmental Protection Agency. (July 1980). *Assessment of Testing Needs: Acrylamide*, Report No. EPA-560/11-80-016. Washington, DC: Office of Toxic Substances

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LaDou, J. (1990). *Nerve Conduction Studies, Occupational Medicine*. Appleton and Lange, Norwalk, CT.

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Acrylamide*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Acrylamide*. Trenton, NJ

Acrylic acid A:0400

Molecular Formula: $C_3H_4O_2$

Common Formula: $CH_2CHCOOH$

Synonyms: Acido acrilico (Spanish); Acroleic acid; Acrylic acid, glacial; Acrylic acid, inhibited; Aqueous acrylic acid (technical grade is 94%); Ethylenecarboxylic acid; Glacial acrylic acid; Propene acid; 2-Propenoic acid; Propenoic acid; Vinylformic acid

CAS Registry Number: 79-10-7

RTECS® Number: AS4375000

UN/NA & ERG Number: UN2218 (stabilized)/132P

EC Number: 201-177-9 [*Annex I Index No.:* 607-061-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal No Adequate Data; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U008, D002.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R10; R20/21/22; R35; R50; Safety phrases: S1/2; 26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Acrylic acid is a colorless, flammable, and corrosive liquid or solid (below 13°C) with an irritating rancid odor. Sinks and mixes with water; irritating vapor is produced. Molecular weight = 72.07; Specific gravity = 1.05; Vapor pressure = 3 mmHg at 20°C; Freezing/Melting point = 12−14°C; Boiling point = 141°C; Relative vapor density (air = 1): 2.48; Flash point = 50°C (oc) [glacial]; 54°C (oc); Autoignition temperature = 438°C[17]; 360°C. Explosive limits: LEL = 2.4%, UEL = 8.02%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2. Odor threshold = 0.092 ppm. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Acrylic acid is chiefly used in manufacture of plastics, acrylates, polyacrylic acids, polymer, and resins; as a monomer in the manufacture of acrylic resins and plastic products, leather treatment, and paper coatings. Also, it is used as a tackifier and flocculant.

Incompatibilities: Forms explosive mixture with air. Light, heat, and peroxides can cause polymerization. Violent reaction with strong oxidizers. Incompatible with sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides, epichlorohydrin, toluene diamine, oleum, pyridine, methyl pyridine, *n*-methyl pyrrolidone, 2-methyl-6-ethyl aniline, aniline, ethylene diamine, ethyleneimine, and 2-aminoethanol. Severely corrodes carbon steel and iron; attacks other metals. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion: 1 ppm = 2.95 mg/m^3.

OSHA PEL: None.

NIOSH REL: 2 ppm/6 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/5.9 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 1.5 ppm

PAC-1: **1.5** ppm

PAC-2: **46** ppm

PAC-3: **180** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 10 ppm/30 mg/m^3; Peak Limitation Category I (1); Pregnancy Risk Group C.

Australia: TWA 10 ppm (30 mg/m^3), 1993; Belgium: TWA 10 ppm (29 mg/m^3), 1993; Denmark: TWA 2 ppm (5.9 mg/m^3), [skin], 1999; France: VME 10 ppm (30 mg/m^3), 1999; Norway: TWA 10 ppm (30 mg/m^3), 1999; Russia: STEL 5 mg/m^3, 1993; The Netherlands: MAC-TGG 5.9 mg/m^3, 2003; Switzerland: MAK-W 0.03 mg/m^3, [skin], carcinogen, 1999; United Kingdom: TWA 10 ppm (30 mg/m^3), STEL 20 ppm (60 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The former Russia-UNEP/IRPTC joint project has set a limit in workplace air of 5 mg/m^3.[43] Several states have set guidelines or standards for acrylic acid in ambient air[60]: 0.003 mg/m^3 (North Dakota) to 0.1 mg/m^3 (New York) to 0.45 mg/m^3 (Virginia) to 0.6 mg/m^3 (Connecticut) to 0.714 mg/m^3 (Nevada).

Determination in Air: XAD®[2]; Methanol/Water; High-pressure liquid chromatography/Ultraviolet detection; OSHA Analytical Method #28.

Permissible Concentration in Water: No US criteria set, but former USSR-UNEP/IRPTC joint project has set 0.5 mg/L as a limit in drinking water.[43]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.36$ (estimated).

Routes of Entry: Inhalation, skin and eye contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact can cause burns and permanent damage. Inhaling this chemical can cause respiratory tract irritation.

Long Term Exposure: Acrylic acid may cause skin allergy and lung and kidney damage.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider lung function tests in preplacement and regular physical examinations. Consider kidney function tests if symptoms develop or overexposure is suspected. Skin testing with dilute acrylic acid may be used by a qualified allergist to diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): butyl rubber gloves, suits, boots; Saranex™, Responder™ suits, Trellchem HPS™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Teflon™ gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. In an emergency use NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Do not allow to solidify. Can be stored only in glass, stainless steel, aluminum, or polyethylene-lined containers. Before entering confined space where acrylic acid may be present, check to make sure that an explosive concentration does not exist. Acrylic acid is a dangerous explosion hazard unless it is stored with an inhibitor. Store in tightly closed containers in a cool, well-ventilated area away from heat and sunlight. Do not freeze or refrigerate acrylic acid. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acrylic acid, inhibited, requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." It falls in DOT/UN Hazard Classes 8 and 3, and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover spill with soda ash or sodium bicarbonate. Mix and add water. Neutralize and flush into sewer. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Keep acrylic acid out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up

spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. In advanced or massive fires, firefighting should be done from a safe distance or from a protected location. If a leak or spill has not ignited, use water spray to disperse the vapors. Water spray may be used to flush spills away from exposures and to dilute spills to nonflammable mixtures. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration. 100−500 ppm potassium permanganate will degrade acrylic acid to a hydroxy acid which can be disposed of at a sewage treatment.

References

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New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Acrylic Acid*. Trenton, NJ

Acrylonitrile A:0410

Molecular Formula: $C_3H_3N_4$

Common Formula: CH_2CHCN_4; $CH_2{=}CH{-}CN$

Synonyms: Acrilonitrilo (Spanish); Acrinet®; Acrylnitril (German); Acrylon®; Acrylonitrile monomer; AN; Carbacryl; Cyanoethylene; Cyanure de vinyle (French); ENT 54; Fumigrain; Miller's fumigrain; Nitrile acrylique (French); 2-Propenenitrile; Propenenitrile; TL 314; VCN; Ventox; Vinyl cyanide; Vinyl cyanide, propenenitrile

CAS Registry Number: 107-13-1; *(alt.)* 29754-21-0; *(alt.)* 63908-52-1

RTECS® Number: AT5250000

UN/NA & ERG Number: UN1093 (stabilized)/131P

EC Number: 203-466-5 [*Annex I Index No.:* 608-003-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC[12]: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; EPA-B1 Limited evidence of carcinogenicity based on epidemiologic studies.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1045).

Banned or Severely Restricted (Germany) (U.N.).[13]

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Section 112[r], Accidental Release Prevention/Flammable Substances (Section 68.130), TQ = 20,000 lb (9150 kg).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

US EPA Hazardous Waste Number (RCRA No.): U009.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.24; Nonwastewater, 84.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8030 (5); 8240 (5).

Safe Drinking Water Act, 55FR1470 Priority List.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.5 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Mexico, Wastewater, organic pollutants.

European/International Regulations: Hazard Symbol: F+, T, N; Risk phrases: R45; R11; R23/24/25; R37/R38; R41; R43; R51/53; Carc. Cat. 2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Acrylonitrile is a highly flammable, clear, colorless or light yellowish liquid. It has an irritating, faint garlic- or onion-like odor. Its odor threshold is 17 ppm; odor can only be detected above the PEL. Molecular weight: 53.05; Specific gravity (H_2O:1) = 0.806 at 20°C;

Boiling point: 77.4°C[C] at 1 atm; Melting/Freezing point: − 83.6°C[C]; Critical temperature: 263°C[C]; Critical pressure: 660 psia = 45 atm = 4.6 MN/m^2[C]; Specific gravity: 0.8075 at 20°C[C]; Relative vapor density (air = 1): 1.83[C]; Ratio of specific heats of vapor (gas): 1.151[C]; Latent heat of vaporization: 265 Btu/lb = 147 cal/g = 6.16 × 10^5 J/kg[C]; Heat of combustion: − 14,300 Btu/lb = − 7930 cal/g = − 332 × 10^5 J/kg[C]; Ionization potential = 10.9 eV; Vapor pressure: 83 mmHg at 20°C[C]; Saturation concentration in air = 257 g/m^3 at 20; Flash point = 0°C[17]; − 5°C[52]; Autoignition temperature = 480°C; Explosive limits: LEL = 3%, UEL = 17%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 2. Floats on water and is moderately soluble; solubility = 7.3 g/mL at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Acrylonitrile is used in the manufacture of synthetic fibers, polymers, acrylostyrene plastics, acrylonitrile-butadiene-styrene plastics, nitrile rubbers, chemicals, and adhesives. It is also used as a pesticide. In the past, this chemical was used as a room fumigant and pediculicide (an agent used to destroy lice).

Incompatibilities: Forms explosive mixture with air. Reacts violently with strong acids, strong alkalis, bromine, and tetrahydrocarbazole. Copper, copper alloys, ammonia, and amines may cause breakdown to poisonous products. Unless inhibited (usually with methylhydroquinone) acrylonitrile may polymerize spontaneously. It may also polymerize on contact with oxygen, heat, strong light, peroxides, and concentrated or heated alkalis. Reacts with oxidizers, acids, bromine, amines. Attacks copper and copper alloys. Attacks aluminum in high concentrations. Heat and flame may cause release of poisonous cyanide gas and nitrogen oxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.21 mg/m^3[C] at 25°C & 1 atm. Odor threshold is 17 ppm; odor can only be detected above the PEL.

OSHA PEL: [1910.1045] 2 ppm TWA [skin]; 10 ppm [15 min] Ceiling Concentration.

NIOSH REL: 1 ppm TWA; 10 ppm [15 min] Ceiling Concentration; [skin] potential occupational carcinogen.

ACGIH TLV®[1]: 2 ppm/4.3 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 85 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **10** ppm

PAC-2: **35** ppm

PAC-3: **75** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin]; Carcinogen Category: 2; Danger of skin sensitization (2006); TRK: 3 mL/m3/7 mg/m^3; Sampling time: not fixed; 420 μg[erythrocytes cyanoethylvaline]/L blood.

Arab Republic of Egypt: TWA 2 ppm, [skin], 1993; Australia: TWA 2 ppm (4.5 mg/m^3), [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 2 ppm (4.3 mg/m^3), [skin], Carcinogen 1993; Denmark: TWA 2 ppm (4 mg/m^3), [skin], 1999; Finland: TWA 2 ppm (4.5 mg/m^3); STEL 4 ppm, [skin], carcinogen, 1993; France: VME 2 ppm (4.5 mg/m^3), VLE 15 ppm (32.4 mg/m^3), carcinogen, 1999; Hungary: STEL 0.5 mg/m^3, [skin], carcinogen, 1993; India: TWA 2 ppm (4.5 mg/m^3), [skin], carcinogen, 1993; Japan; 2 ppm (4.3 mg/m^3), [skin], 2A carcinogen, 1999; Norway: TWA 2 ppm (4 mg/m^3), 1999; the Philippines: TWA 20 ppm (45 mg/m^3), [skin], 1993; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Russia: TWA 2 ppm; STEL 0.5 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (4.5 mg/m^3), KTV 6 ppm, [skin], carcinogen, 1999; Switzerland: MAK-W 2 ppm (4.5 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 20 ppm (45 mg/m^3), [skin], 1993; United Kingdom: TWA 2 ppm (4.4 mg/m^3), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for acrylonitrile in ambient air[60]: 0.0147 μg/m^3 (Indiana) to 0.145 μg/m^3 (North Carolina) to 0.15 μg/m^3 (Massachusetts) to 11.3 μg/m^3 (Pennsylvania) to 15.0 μg/m^3 (New York) to 22.0 μg/m^3 (Connecticut and South Dakota) to 22.5 μg/m^3 (South Carolina) to 45.0 μg/m^3 (Florida and Virginia).

Determination in Air: Charcoal adsorption followed by acetone extraction and gas chromatographic analysis. Use NIOSH Analytical Method 1604[18] or OSHA Analytical Method 37 where samples are collected on charcoal, desorbed with acetone, and analyzed by gas chromatography using a nitrogen/phosphorus detector.

Permissible Concentration in Water: The substance is toxic to aquatic organisms. Acrylonitrile usually breaks down in about 1 or 2 weeks, but this can vary depending on conditions. For example, high concentrations (such as might occur following a spill) tend to be broken down more slowly. In one case, measurable amounts of acrylonitrile were found in nearby wells 1 year after a spill (ATSDR public Health Statement, December 1990). See RCRA and Clean Water Act under Regulatory Authority and Advisory Bodies. To protect freshwater aquatic life (on an acute basis), 7550 μg/L and on a chronic basis, 2600 μg/L over 30 days. *To protect saltwater aquatic life:* insufficient data to yield a value. *To protect human health:* preferably zero. Water concentration should be below 0.58 μg/L to keep lifetime cancer risk below 10^{-5}. Russia[43] set a MAC of 2.0 mg/L for water bodies used for domestic purposes. The Mexico drinking water ecological criteria is 0.0006 mg/L, reduce human exposure to a minimum. Several states have set guidelines for acrylonitrile in drinking water[61] ranging from 0.67 μg/L (Minnesota) to 3.8 μg/L (Kansas) to 10 μg/L (Arizona) to 35 μg/L (Connecticut).

Determination in Water: Charcoal tube; Acetone/CS2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1604. Also, by gas chromatography (EPA Method #603) or gas chromatography plus mass spectrometry (EPA Method #624). Octanol−water coefficient: Log $K_{ow} = -0.91$.

Routes of Entry: Inhalation and percutaneous absorption. It may be absorbed from contaminated rubber or leather. Routes include ingestion and eye and skin contact. Acrylonitrile vapor is absorbed readily from the lungs; and inhalation is an important route of exposure. This chemical's odor generally provides inadequate warning of hazardous concentrations and olfactory fatigue develops rapidly.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Splashes in the eye may result in corneal damage. Skin contact can cause severe irritation and blistering. Breathing acrylonitrile can irritate the lungs, causing coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can result in death. Skin contact contributes significantly in overall exposure and can lead to systemic toxicity. Acrylonitrile reaction causes redness, blisters, and some systemic signs. Symptoms derive from tissue anoxia in order of onset: limb weakness, dyspnea (difficult breathing); burning sensation in throat; dizziness, impaired judgment; cyanosis (turning blue); nausea, collapse, irregular breathing; convulsions and death. In later stages, collapse, irregular breathing or convulsions, and cardiac arrest may occur without warning. Some patients appear hysterical or may even be violent. Acrylonitrile is classified as very toxic. Probable oral lethal dose for humans is 50−500 mg/kg (between 1 teaspoon and 1 oz) for a 70-kg (150 lb) person. Toxic concentrations have been reported at 16 ppm/20 min. Acute toxicity is similar to that due to cyanide poisoning and the level of cyanide ion in blood is related to the level of poisoning. Inhalation or ingestion can result in fatal systemic poisoning, collapse and death due to tissue anoxia (lack of oxygen), and cardiac arrest (heart failure). At higher concentrations there may be damage to red blood cells and the liver. Jaundice may develop 24 h following exposure and persist for several days. Because of continued metabolic release of cyanide, symptoms of severe poisoning may recur and the patient may relapse.

Long Term Exposure: This chemical is a probable carcinogen in humans. There is some evidence that it causes lung and large intestine cancer in humans and has been shown to cause brain and stomach cancer in animals. Exposure may cause the thyroid gland to enlarge and interfere with normal thyroid function. There is limited evidence that acrylonitrile may damage the developing fetus and the male reproductive system. Repeated exposure can irritate the nose, causing discharge, nose bleeds, and sores inside the nose. Acrylonitrile may affect the liver function.

Points of Attack: Eyes, skin, cardiovascular system, liver, kidneys, central nervous system. *Cancer site:* brain, lung, and bowel.

Medical Surveillance: For those with frequent or high exposure, consider urine thiocyanate levels, blood cyanide levels, liver function tests; fecal occult blood screening, pulmonary function tests. Consider the skin, respiratory tract, heart, central nervous system; renal and liver function in placement and periodic examinations. A history of fainting spells or convulsive disorders might present and added risk to persons working with toxic nitriles. Fecal occult blood screening for workers 40 years of age or older and chest X-ray *Code of Federal Regulations. 29 CFR Part 1910* Occupational Safety and Health Standards. Part 1910.1045, Page 319.[2] Pulmonary function tests, Blood cyanide, Blood plasma, Blood serum, Expired air, Urine (chemical/metabolite).[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron->g/cm^2/min): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade®™ coated suits; Responder™ suits; Trychem 1000™ suits. Wear protective gloves and clothing to prevent repeated or prolonged skin contact. Leather should not be used in protective clothing since it is readily penetrated by acrylonitrile; contaminated leather shoes and gloves should be destroyed. Rubber clothing should be frequently washed and inspected because it will soften and swell. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Contact lenses should not be worn when working with this substance. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers. See also NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SAF:Pd,Pp:ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. See Incompatibilities for materials and physical conditions not permitted in storage room or cabinet. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in tightly closed containers in a cool, well-ventilated area. Do not store uninhibited acrylonitrile under any conditions. Store drums on end with bungs up, no more than two high. Outside tanks should be above ground and surrounded with dikes of sufficient capacity to hold entire tank contents. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Acrylonitrile, inhibited, requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 3 and Packing Group I.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acrylonitrile out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acrylonitrile is a dangerously reactive and flammable liquid. Poisonous gases are produced in fire, including hydrogen cyanide. A few "whiffs" of vapor could cause death. Vapor or liquid could be fatal on penetrating the firefighter's normal full protective clothing. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. May react with itself without warning, blocking relief valves, and leading to container explosion. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Vapors may travel long distances to ignition sources and flash back. Storage containers and parts of containers may rocket great distances, in many directions. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay away from ends of tanks. Do not get water inside container. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with provision for nitrogen oxides removal from effluent gases by scrubbers or afterburners. A chemical disposal method has also been suggested involving treatment with alcoholic NaOH; the alcohol is evaporated and calcium hypochlorite added; after 24 h the product is flushed to the sewer with large volumes of water. Recovery of acrylonitrile from acrylonitrile process effluents is an alternative to disposal.

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Acryloyl chloride A:0420

Molecular Formula: C_3H_3ClO
Common Formula: $CH_2{=}CHCOCl$
Synonyms: Acrylic acid chloride; Cloruro de acriloilo (Spanish); 2-Propenoyl chloride
CAS Registry Number: 814-68-6
RTECS® Number: AT7350000 I
UN/NA & ERG Number: UN3130 (Water-reactive liquid, toxic, n.o.s.)/139; UN3383 [Poisonous by inhalation liquid, flammable, n.o.s. (Inhalation Hazard Zone A)]/131
EC Number: 212-399-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

Clean Air Act: 42USC7412; Title I, Part A, §112(r), Regulated Chemicals for Accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 5000 lb (2270 kg).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).[7]

WGK (German Aquatic Hazard Class): No value assigned.

Description: Acryloyl Chloride is a highly flammable and toxic (inhalation), light yellow liquid. A lacrimator. Molecular weight = 90.51; Boiling point = 75°C; Specific gravity: 1.114 at 20°C. Flash point = 14°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts violently with water.

Potential Exposure: May be used as a monomer in preparation of specialty polymers or as a chemical intermediate.

Incompatibilities: Reacts violently with water, forming acrylic acid. Keep away from strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.05 ppm
PAC-1: 0.15 ppm
PAC-2: 0.243 ppm
PAC-3: 10 ppm

Routes of Entry: Inhalation and percutaneous absorption. Can be absorbed through the eyes.

Harmful Effects and Symptoms

Short Term Exposure: A highly toxic and corrosive lacrimator. Inhalation, skin absorption, or ingestion can be fatal. Highly destructive to the mucous membranes and upper respiratory system, skin, and eyes. May cause blindness. Skin contact can cause burns.

Harmful Effects and Symptoms

LC_{50} (inh., mouse, 2 h) = 92 mg/m^3; this may be the basis for inclusion in the EPA "Extremely Hazardous Substances" list.[7] Inhalation may cause burning feeling, coughing, shortness of breath, headache, dizziness, nausea, and vomiting; spasm, inflammation; chemical pneumonitis. Exposure can cause pulmonary edema, a medical emergency that can result in death.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acryloyl chloride requires a shipping label of WATER-REACTIVE LIQUID, TOXIC, N.O.S. 4.2 (Packing Group II) “POISON INHALATION HAZARD, FLAMMABLE LIQUID; PIH: ZONE A.” It falls in DOT/UN Hazard Class 6.1 and Packing Group I.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Acryloyl chloride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 2.9/4.7
Night 5.5/8.9

Fire Extinguishing: Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Violent reaction with water. Poisonous gases are produced in fire, including carbon monoxide. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Acryloyl Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Actinomycin D A:0430

Molecular Formula: $C_{62}H_{86}N_{12}O_{16}$

Synonyms: Actinomicina D (Spanish); Actinomycindioic D acid, dilactone; Actinomycin I; AD; Cosmegen; Dactinomycin; Dactinomicina (Spanish); Dilactone actinomycindioic D acid; HBF 386; Lyovac cosmegen; Meractinomycin; Oncostatin K

CAS Registry Number: 50-76-0

RTECS® Number: AU1575000

UN/NA & ERG Number: UN2811/154

EC Number: 200-063-6

Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Studies (ipr); clear evidence rat; no evidence mouse; IARC: Animal Inadequate Data; Human No Available Data, Group 3, 1987.
California Proposition 65 Chemical: Cancer 10/1/89; Developmental/Reproductive toxin 1/1/89.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Actinomycin D is a bright-red crystalline solid; Freezing/Melting point = 241.5−243°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Soluble in water.
Potential Exposure: An antibiotic product from *Streptomyces*, used as anticancer drug.
Incompatibilities: Strong oxidizers, strong acids, and strong bases.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Intravenous, skin, eyes.
Harmful Effects and Symptoms
Short Term Exposure: Highly Toxic. Irritates eyes and skin. A poison if ingested. LD_{50} = (oral-rat) 7.2 mg/kg.
Long Term Exposure: Has been shown to cause peritoneal and local sarcomas in animals. May damage the developing fetus.
Medical Surveillance: Complete blood count (CBC), EKG.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers may be able to provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or other cool, dry place.
Shipping: Classified as medicines, toxic solid, n.o.s. This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Shipping Class 6.1 and Packing Group III.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen with 60−70% ethanol to avoid airborne dust, then transfer to a suitable sealed container in the most convenient and safe manner. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
References
Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 23−24
New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Actinomycin D*. Trenton, NJ

Adamsite (Agent DM, WMD) A:0435

Molecular Formula: $C_{12}HgAsClN$; $C_6H_4 \cdot NH \cdot C_6H_4 \cdot AsCl$
Common Formula: $HN{-}(C_6H_4)_2{-}AsCl$
Synonyms: Dibenzo-1-chloro-1,4-arsenine; DM (US Army code); Diphenylamine chloroarsine; Diphenylamine chloroarsine (DOT); phenarsazine chloride

CAS Registry Number: 578-94-9
RTECS® Number: SG0680000
UN/NA & ERG Number: UN1698/154
EC Number: 209-433-1
Regulatory Authority
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Adamsite, or Agent DM, is a light green to yellow crystalline solid at room temperature; can be dark green depending on purity and age; canary yellow when concentrated; colorless when diluted with air. Odorless but irritating; similar to pepper. Molecular weight = 277.59; Density (solid) = 1.65 at 20°C; Boiling point = 410°C; Freezing/Melting point = 193−195°C; Vapor pressure = very low; 2×10^{-13} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water. Not readily soluble in any of the liquid chemical warfare agents.

Potential Exposure: Adamsite (military designation DM), a chloroarsenical, was first produced during World War I. Adamsite (DM) is used as a riot control or harassing agent, tear gas, and (vomiting agent) gas. It was designed as a battlefield agent and can be dissolved in acetone and dispersed as an aerosol. Adverse health effects due to exposure to adamsite (DM) are generally self-limited and do not require specific therapy. Most adverse health effects resolve within 30 min. Exposure to large concentrations of adamsite (DM), or exposure to adamsite (DM) within an enclosed space or under adverse weather conditions, may result in more severe adverse health effects, serious illness, or death. Adamsite (DM) is more disagreeable than tear gas, but less dangerous than sarin. It is considered to be too extreme for use against civilian populations, and was banned for this use in the 1930s by western nations. Produced worldwide, DM was superseded by the CN series of tear agents. It produces irritation to the upper respiratory tract and the eyes. Although DM has been replaced by CS, it might be mixed with a nerve agent. This may cause a vomiting victim to remove respiratory protection and be exposed to the more lethal agent.

Persistence of Chemical Agent: Short, because compounds are disseminated as an aerosol. *Soil*: persistent; *Surface of materials* (wood, metal, masonry, rubber, paint): persistent. *Water*: persistent; when material is covered with water, an insoluble film forms which prevents further hydrolysis.

Incompatibilities: Slowly hydrolyzes in water. *Stability:* stable in pure form; after 3 months, caused extensive corrosion of aluminum, anodized aluminum, and stainless steel; will corrode iron, bronze, and brass when moist. *Corrosive properties:* titanium—71°C, 6 months, appeared good. Stainless steel—43°C, 30 days, slight discoloration. Common steel—43°C, 30 days, covered with rust. Aluminum anodized—43°C, 30 days, minor corrosion and pitting. Aluminum—43°C, 30 days, severe corrosion. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC) DM
TEEL-0: 0.016 mg/m^3
PAC-1: **0.016** mg/m^3
PAC-2: **2.6** mg/m^3
PAC-3: **6.4** mg/m^3
NOAEL (no-observed-adverse-effect-level, inhalation) = 4 mg-min/m^3.

Determination in Air: No method is available to detect Adamsite in environmental samples.

Determination in Water: No method is available to detect Adamsite in environmental samples. People should not drink water containing DM. Warn pollution control authorities and advise shutting water intakes. Octanol−water coefficient: Log K_{ow} = 4.05.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms
Adamsite (Agent DM) is a vomiting compound. It is normally a solid, but upon heating, DM first vaporizes and then condenses to form aerosols. It is toxic through inhalation, ingestion, and skin contact. Adamsite is dispersed as an aerosol, irritating to the eyes and respiratory tract but not necessarily to the skin. Under field conditions, vomiting agents can cause great discomfort to the victims; when released indoors, they can cause serious illness or death. Symptoms include irritation of eyes and mucous membranes, coughing, sneezing, severe headache, acute pain and tightness in the chest, nausea, and vomiting. DM has been noted to cause necrosis of corneal epithelium in humans. The human body will detoxify the effects of mild exposures within 30 min of evacuation. Severe exposures may take several hours to detoxify and minor sensory disturbances may persist for up to 1 day. The majority of exposures occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory tract irritation. Nonspecific gastrointestinal symptoms (e.g., vomiting or diarrhea) might also occur. The effects of adamsite poisoning take minutes to begin and might last for hours. If a rapid onset of manifestations of one of the following respiratory effects occurs, the clinical description for adamsite poisoning has been met: nose or throat irritation, cough, or dyspnea.

Short Term Exposure: The majority of exposures occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory tract irritation. Nonspecific gastrointestinal symptoms (e.g., vomiting or diarrhea) might also occur. The effects of adamsite poisoning take minutes to begin and might last for hours (1). If a rapid onset of manifestations of one of the following respiratory effects occurs, the clinical description for adamsite poisoning has been met: nose or throat irritation, cough, or dyspnea.[CDC]

Long Term Exposure: No assessment has been made of possible long-term effects of short-term exposures to Adamsite. However, see medical surveillance below.

Medical Surveillance: Pulmonary function tests and radiographic imaging, especially those who have persistent symptoms of dyspnea, cough, or chest discomfort.

First Aid: *Inhalation: Never* perform mouth-to-mouth resuscitation, or you will get sick. Remove victim to fresh air;

wear a mask/respirator in spite of coughing, sneezing, salivation, and nausea; lift the mask from the face briefly, if necessary, to permit vomiting or to drain saliva from the face-piece; seek medical attention immediately. *Eye contact:* Don a respiratory protective mask; seek medical attention immediately. *Skin contact:* Rinse the nose and throat with saline water or bicarbonate of soda solution; wash exposed skin and scalp with soap and water and allow to dry on the skin; dust the skin with borated talcum. *Ingestion:* seek medical attention immediately; carry on duties as vigorously as possible; this will help to lessen and shorten the symptoms.

Decontamination: Decontaminate as soon as possible. This is extremely important. Victims will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves. If you do not have the equipment and training do not enter the hot or the warm zone to rescue and decontaminate victims. If the victim cannot move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Contaminated clothes and personal belongings should be placed in a sealed double bag. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 min. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods:
Protective Gloves: Wear Norton chemical protective glove set, wear chemical goggles; wear a mask/respirator in open areas. Wear additional protective clothing, such as gloves and lab coat with an M9, M17, or M40 mask readily available in closed or confined spaces.

Respirator Selection: When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Diphenylamine chloroarsine requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Issue poison warning. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial Isolation and Protective Action Distances (**when used as a weapon**)

Small Spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters)	100/30
Then: Protect persons downwind (miles/kilometers)	
Day	0.1/0.2
Night	0.2/0.3

Large Spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters)	200/60
Then: Protect persons downwind (miles/kilometers)	
Day	0.2/0.3
Night	0.9/1.5

Fire Extinguishing: In case of fire, *do not put out the fire*. DM vapor and liquid are so bad that the fire is safer than the unburned DM. If there is some reason that you have to put out the fire—for example, there are things you cannot let burn nearby—use water or ordinary foam. It is always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of DM canisters adjacent to a fire, cool the canisters with large amounts of water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. Poisonous gases are produced in fire, including arsenic and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Approximately 9 tons of Adamsite was discovered on the territory of Poland after World War II. This agent was stored in steel barrels and special preventive measures were undertaken in order to protect it against spreading. The Polish government decided to destroy the abandoned Adamsite and different suitable technologies were considered. The first laboratory experiments have started in 1996 and elimination of the Adamsite on semi-technical scale will begin by June 1998. In this paper methods of neutralization of Adamsite, based on its hydrolysis with hydrochloric acid, reduction with phosphorous acid, and fusion with sulfur, are discussed. These methods were found to be useful at the laboratory scale. Advantages and disadvantages of considered methods of destruction of organic arsenical agents have been discussed. The most promising method seems to be the reduction of Adamsite with phosphorous acid. The products of this reaction are metallic arsenic, diphenylamine (DPA), and hydrogen chloride. These products can be separated and reused or neutralized.

References

Army Field Manual (DA FM) 3-9 (PCN 320 008457 00). (December 12, 1990). Navy Publication No. P-467; Air Force Manual No. 355-7; *Potential Military Chemical/ Biological Agents and Compounds.* Washington, DC: Headquarters Department of the Army, Department of the Navy, Department of the Air Force

Department of the Army. 1969. *Technical Manual (DA TM) 3-250, Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*

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Adipic acid A:0440

Molecular Formula: $C_6H_{10}O_4$

Common Formula: $HOOC(CH_2)_4COOH$

Synonyms: Acido adipico (Spanish); Acifloctin; Acinetten; Adilac-tetten; Adipinic acid; 1,4-Butanedicarboxylic acid; Dicarboxylic acid C_6; 1,6-Hexanedioic acid; Hexanedioic acid

CAS Registry Number: 124-04-9

RTECS® Number: AU8400000

EC Number: 204-673-3

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Cell transform.-SA7/SHE; TRP reversion.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), SARA 313 [4].

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Adipic acid is a combustible, white, crystalline solid. Odorless. Molecular weight = 146.14; Boiling point = (decomposes) 337°C at 760 mmHg; Specific gravity (H_2O:1) = 1.37 at 20°C (solid); Freezing/Melting point = 152°C[C]; Vapor pressure = 7.7×10^{-4}; 10 Pa at 18.5°C; Relative vapor density (air = 1) = 5.04; Flash point = 196°C (cc). Explosive limits: (*dust*): 10–15 mg/L[C]; Autoignition temperature = 421°C; Heat of combustion = -8242 Btu/lb = -4579 cal/g = -191.6×10^5 J/kg[C]; Heat of Vaporization = 19,570.2 g cal/g mol[C]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in hot water; solubility = 1.5%.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Workers in manufacture of nylon, plasticizers, urethanes, adhesives, and food additives.

Incompatibilities: Oxidizers, reducing agents, and strong bases. Dust forms an explosive mixture with air. Friction from stirring, pouring, or pneumatic transfer can form electrostatic charge on dry material.

Permissible Exposure Limits in Air

ACGIH TLV® 5 mg/m^3 TWA, averaged over an 8-h work shift.

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 125 mg/m^3
Russia: STEL 4 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003.

Permissible Concentration in Water: Regulated as a hazardous substance by the Clean Water Act.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <0.9, 0.08$.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause burns to nose, throat, and respiratory tract. May cause eye irritation and burns. There may be an asthmatic reaction.

Long Term Exposure: Repeated prolonged exposure may cause asthma. The symptoms of asthma may not be apparent for hours following exposure and may be aggravated by physical effort. Anyone with symptoms of asthma due to this chemical should avoid all further contact with it.

Medical Surveillance: Consult a qualified allergist if asthma is suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: There are no UN/DOT labeling requirements for adipic acid. Adipic acid falls in DOT Hazard Class ORM-E and UN Hazard Class 9.2 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Moisten spilled material to prevent dust buildup. This is a weak acid: use lime or sodium bicarbonate to neutralize, and absorb with peat, vermiculite, or carbon. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including acidic vapors and valeric acid. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 28−29 (1981) and 3, No. 3, 46−49 (1983)

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Adipic Acid*. Trenton, NJ

New York State Department of Health (1986). *Chemical Fact Sheet: Adipic Acid*. Albany, NY: Bureau of Toxic Substance Assessment.

Adiponitrile A:0450

Molecular Formula: $C_6H_8N_2$
Common Formula: $NC(CH_2)_4CN$
Synonyms: Adipic acid dinitrile; Adipic acid nitrile; Adipodinitrile; Adiponitrilo (Spanish); 1,4-Dicyanobutane; Hexanedinitrile; Hexanedioic acid, dinitrile; Tetramethylene cyanide
CAS Registry Number: 111-69-3
RTECS® Number: AV2625000
UN/NA & ERG Number: UN2205/153
EC Number: 203-896-3
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).[7]
CERCLA/SARA 40CFR304, Appendix A, Reportable Quantity (EHS, RQ): 1 lb (0.454 kg), SARA 313: (as cyanide compounds) Form R *de minimis* Concentration Reporting Level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures or solutions.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Adiponitrile is a combustible, water-white to yellow, oily liquid. A solid below 1.1°C. Practically odorless. Molecular weight = 108.10[C]; Boiling point = 295°C[C]; Freezing/Melting point = 2.3°C; Specific gravity = 0.97 at 25°C (liquid)[C]; Latent heat of vaporization = (estimate) 240 Btu/lb = 134 cal/g = 5.59×10^5 J/kg[C]; Heat of combustion = −14,230 Btu/lb = −7910 cal/g = -331×10^5 J/kg[C]; Flash point = 93°C, technical grade (oc); 163°C (pure); Vapor pressure = 2.3×10^{-3} mmHg at 20°C; 0.3 Pa at 20°C; Explosive limits: LEL = 1%, UEL = 5.0%; Autoignition temperature = 550°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Floats on water; slightly soluble.
Potential Exposure: Compound Description: Reproductive Effector. Used in the manufacture of corrosion inhibitors, rubber accelerators, and Nylon 66; and in organic synthesis.
Incompatibilities: Forms explosive mixture with air. Violent reaction with oxidizers. Also incompatible with strong acids, strong bases, and reducing agents.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 4 ppm/18 mg/m^3 TWA.
ACGIH TLV®[1]: 2 ppm/8.8 mg/m^3 TWA [skin].
Protective Action Criteria (PAC)
TEEL-0: 2 ppm
PAC-1: 3.85 ppm
PAC-2: 3.85 ppm
PAC-3: 150 ppm
Russia: STEL 10 mg/m^3, 993; the Netherlands: MAC-TGG 8.8 mg/m^3, 2003.
A guideline or standard in ambient air has been set in Connecticut[60] at 360 μg/m^3.
Determination in Air: Charcoal tube; Toluene; Gas chromatography/Flame ionization detection; See NIOSH Criteria Document 212 *Nitriles*.
Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.32$.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates eyes, skin, and respiratory tract. Skin and eye contact can cause burns. This chemical can be absorbed through the skin, thereby increasing exposure. Inhalation can cause coughing and shortness of breath. Exposure can cause fatal cyanide poisoning with symptoms of flushing of the face, chest tightness, nausea and vomiting, weakness, lightheadedness, confusion, headache, trouble breathing, and convulsions. Higher exposure can lead to convulsions, irregular heartbeat, coma, and death. Ingestion of a few milliliters may cause weakness, mental confusion, vomiting, rapid respiration, fast heartbeat, and convulsions.
Long Term Exposure: Adiponitrile produces disturbances of respiration and circulation, irritation of the stomach and intestine, and loss of weight. Repeated exposure may cause personality changes, depression, anxiety, irritability, thyroid gland damage and enlargement, and nervous system damage. Adiponitrile may damage the developing fetus. Adiponitrile may have effects on the blood and adrenal gland, resulting in anemia and tissue lesions.
See also NIOSH Criteria Document 212 *Nitriles*.
Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system.
Medical Surveillance: Consider urine thiocyanate test for preemployment and regular medical testing. If symptoms develop or overexposure is suspected, have blood cyanide levels, nervous system, and thyroid function tested.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote

kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Prevent skin contact **4 h** (At least 4 but $<$8 h of resistance to breakthrough $>$0.1 micron$>$g/cm^2/min): Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document *212 Nitriles.*

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Up to 40 ppm*: Sa (APF = 10) (any supplied-air respirator). *100 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *200 ppm*: SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 ppm*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other *positive-pressure mode*). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Outside or detached storage is preferred. Before entering confined space where adiponitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. *Small spills:* absorb liquids in vermiculite, dry sand, earth, peat, activated carbon, or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep adiponitrile out of a confined space, such as a sewer, because of the potential for an explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including deadly hydrogen cyanide, nitrogen oxides, hydrogen, and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add excess alcoholic KOH. Then evaporate alcohol and add calcium hypochlorite. After 24 h, flush to sewer with water.[24] Can also be incinerated with afterburner and scrubber to remove nitrogen oxides.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Adiponitrile*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 22−24

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Adiponitrile*. Trenton, NJ

Adriamycin A:0460

Molecular Formula: $C_{27}H_{29}O_{11}N$

Synonyms: ADM; Adriablastine; Adriamycin-HCl; Adriamycin semiquinone; Adriblastina; Doxorubicin; DX; 14′-Hydroxydaunomycin; 14-Hydroxydaunomycin; 14-Hydroxydaunorubicine

CAS Registry Number: 23214-92-8

RTECS® Number: AV9800000

UN/NA & ERG Number: UN2811 (as medicines, toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2A, 1987. NTP: Reasonably anticipated to be a human carcinogen.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Adriamycin is an orange to red cake-like or needle-like crystalline solid. Molecular weight = 543.6; Freezing/Melting point = 205°C. Slightly soluble in water.

Potential Exposure: An antibiotic product from *Streptomyces*, used as anticancer drug.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Intravenous, skin, eyes.

Harmful Effects and Symptoms

Short Term Exposure: Highly toxic. Irritates eyes and skin. A poison if ingested. This chemical can be absorbed through the skin, thereby increasing exposure.

Long Term Exposure: Has been shown to cause breast cancer in animals. There is limited evidence that adriamycin is a teratogen in animals. Causes baldness, stomatitis, and bone marrow aphasia in humans. Fatal human cardiac disturbances have been reported.

Points of Attack: Cardiovascular system.

Medical Surveillance: Complete blood count (CBC), EKG, examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: A regulated, marked area should be established where Adriamycin is handled, used, or stored. All operations should be enclosed and locally ventilated through HEPA filters. Wear protective work clothing. Wash thoroughly immediately after exposure to Adriamycin and at the end of the work shift. Medical personnel preparing solutions of Adriamycin should only do so under a biological safety hood with a vertical laminar flow. Workers whose clothing has been contaminated by Adriamycin should change into clean clothing promptly. Do not take contaminated work clothes home. Family members could be exposed. Contaminated work clothes should be laundered by individuals who have been informed of the hazards of exposure to Adriamycin. Do not eat, smoke, or drink where Adriamycin is handled, processed, or stored, since the chemical can be swallowed. Wash hands carefully before eating or smoking. When vacuuming, a high-efficiency particulate absolute (HEPA) filter should be used, not a standard shop vacuum.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where Adriamycin is handled, used, or stored.

Shipping: Medicines, toxic solid, n.o.s. require shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup

is complete. Remove all ignition sources. Collect powdered material using a HEPA filter vacuum cleaner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and hydrogen chloride. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 24–25

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Adriamycin*. Trenton, NJ

Aflatoxins A:0470

Molecular Formula: $C_{16\text{-}17}H_{10\text{-}14}O_{6\text{-}7}$; $C_{17}H_{12}O_6$ (B; B1; B2); $C_{17}H_{12}O_7$ (G1; M1); $C_{17}H_{14}O_7$ (G2; M2); $C_{16}H_{10}O_6$ (P1)

Synonyms: AFL; Aflatoxicol; Aflatoxin B1 dichloride; Cyclopenta[c]furo(3′,2′:4,5)furo(2,3-H)(1)benzopyran-1,11-dione, 2,3,6a,8,9,9a-hexahydro-8,9-dichloro-4-methoxy-, [6aS-(6a-A-8-B,9-A-9aa-)]-; 2,3-Dichloroaflatoxin B1; Dihydroaflatoxin B1; Dihydroaflatoxin G1; 4-Dihydroxyaflatoxin B1

CAS Registry Number: 1402-68-2 (aflatoxin); 1162-65-8 (B); 1162-65-8 (B1); 7220-81-7 (B2); 1165-39-5 (G1); 58209-98-6 (B1 dichloride); 7241-98-7 (G2); 6795-23-9 (M1); 6885-57-0 (M2); 32215-02-4 (P1); 29611-03-8 (Ro)

RTECS® Number: AW5950000 (aflatoxin); GY1925000 (B); GY1925000 (B1); GY1722000 (B2); LV1700000 (G1); LV1700000 (G2); GY1880000 (M1); GY1720000 (M2); GY1775000 (P1)

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP 11th Report on Carcinogens, Known to be a Human Carcinogen; IARC: naturally occurring aflatoxins, *carcinogenic to humans*, Group 1; Aflatoxin M_1, *possibly carcinogenic to humans*, Group 2B, 1997; Human Sufficient Evidence, naturally occurring mixtures of aflatoxins and aflatoxin B_1; Animals Sufficient Evidence, naturally occurring mixtures of aflatoxins and aflatoxins B_1, G_1, and M_1; Human Inadequate Evidence, aflatoxin M1; Animal Limited Evidence aflatoxin B_2; Animal Inadequate Evidence aflatoxin G_2; NTP: Known to be a human carcinogen.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.[5]

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: The aflatoxins are a group of molds produced by the fungus *Aspergillus flavus*. They are natural contaminants of fruits, vegetables, and grains. They are also described as a series of condensed-ring heterocyclic compounds. They form colorless to pale yellow crystals. Slightly soluble in water. Molecular weight = 312.3 (B1), 383.2 (B1 dichloride), 314.3 (B2), 328.3 (G1), 330.3 (G2), 328.3 (M1), 314.3 (Ro); Freezing/Melting point = 268–269°C (B1), 247–250°C (G1), 237–240°C (G2), 290°C (M1), 225°C (Ro).

Potential Exposure: Aflatoxins are a group of toxic metabolites produced by certain types of fungi. Aflatoxins are not commercially manufactured; they are naturally occurring contaminants that are formed by fungi on food during conditions of high temperatures and high humidity. Most human exposure to aflatoxins occurs through ingestion of contaminated food. The estimated amount of aflatoxins that Americans consume daily is estimated to be 0.15–0.50 μg. Grains, peanuts, tree nuts, and cottonseed meal are among the more common foods on which these fungi grow. Meat, eggs, milk, and other edible products from animals that consume aflatoxin-contaminated feed may also contain aflatoxins. Aflatoxins can also be breathed in.

Permissible Exposure Limits in Air

No standards or TEEL available.

DFG MAK: [skin]; Carcinogen Category 2B [CAS: 6795-23-9 (M1)].

Routes of Entry: Ingestion and inhalation. An unavoidable contaminant in foods: the FDA limits the levels of aflatoxin contamination that are permitted in food. The complete elimination of aflatoxin contamination of food is probably not technically feasible. The FDA has lowered the maximum amount allowed in food products as methods of detection and methods of control have improved. Upper limits of 20 ppb (total B1, B2, G1, and G2) in foods and feeds and 0.5 ppm (M1) in milk are now in effect.

Harmful Effects and Symptoms

Aflatoxins are carcinogenic in mice, rats, fish, ducks, marmosets, tree shrews, and monkeys by several routes of administration (including oral), producing mainly cancers of the liver, colon, and kidney. Epidemiological studies have shown a positive correlation between the average dietary concentrations of aflatoxins in populations and the incidence of primary liver cancer. These studies were undertaken to test this specific hypothesis; however, no studies have been carried out which could link an increased risk of liver cancer to actual aflatoxin intake in individuals.

Short Term Exposure: No acute health effects are known at this time.

Long Term Exposure: Aflatoxins are carcinogens in humans. They may cause liver cancer. They have also been shown to be teratogens in animals. Aflatoxins may cause liver and kidney damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: A Class I, Type B, biological safety hood should be used when handling, mixing, or preparing aflatoxins. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Latex gloves are recommended as a protective material, *unless using aflatoxins in chloroform.* Contact lenses should not be worn when working with this chemical. Wear indirect vent, impact and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where aflatoxins are handled, used, or stored. Store in a refrigerator and protect from exposure to air and light.

Shipping: Falling in the DOT category of Toxic solid, organic, n.o.s. Aflatoxins require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% of acetone to avoid airborne dust, then transfer to a suitable sealed container for disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but will not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Use of oxidizing agents such as hydrogen peroxide or 5% sodium hypochlorite bleach. Acids and bases may also be used.[22]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 31−33 (1981) and 7, No. 2, 36−43 (1987)

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Aflatoxins*. Trenton, NJ

Alachlor A:0480

Molecular Formula: $C_{14}H_{20}ClNO_2$

Synonyms: Acetamide, 2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)-; Acetanilide, 2-chloro-2′,6′-diethyl-*N*-methoxymethyl)-; Al3-51506; Alachlore; Alanex; Alanox®; Alatox480®; α-Chloro-2′,6′-diethyl-*N*-(methoxymethyl) acetanilide; 2-Chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl) acetamide; EPA pesticide chemical code 090501; Glyphosate isopropylamine salt; Lassagrin; Lasso®; Lasso® Micro-tech; Lazo®; Metachlor; Methachlor; *N*-(Methoxymethyl)2,6-diethylchloroacetamide; Pillarzo®

CAS Registry Number: 15972-60-8

RTECS® Number: AE1225000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155; UN3077

EC Number: 240-110-8 [*Annex I Index No.:* 616-015-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: (EPA) Probable human; likely for high doses; not likely for low doses.[47]

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (EPA-FIFRA) (See "References" below).

Safe Drinking Water Act, MCL, 0.002 mg/L; MGLC, zero; Regulated chemical (47 FR 9352).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Water Pollution Standard Proposed (Various States).[61]

California Proposition 65 Chemical: Cancer 1/1/89.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R43; R50/53; Safety phrases: S2; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3-severe hazard to waters.

Description: Alachlor, an acetanilide pesticide, is a cream-colored solid. Molecular weight = 269.79; Density = 1.1 g/cm^3; Freezing/Melting point = 39.5−41.5°C; Flash point = 137°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. A chloracetanilide herbicide. In manufacture, formulation, and application of this preemergence herbicide, personnel may be exposed. Its major use (99%) is as a preemergence herbicide for field crops (corn, soybeans, peanuts, etc.).

Incompatibilities: Strong oxidizers. Corrosive to iron and steel.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 1 mg/m^3 TWA inhalable fraction and vapor; confirmed animal carcinogen with unknown relevance to humans.

Permissible Concentration in Water: No adverse-effect-level in drinking water has been calculated by NSA/NRC[46] as 0.7 mg/L. Allowable daily intake (ADI) has been calculated at 0.1 mg/kg/day. More recently, the EPA[47] has reviewed alachlor and determined a 10-day health advisory value of 0.1 mg/L for a 10-kg child. An acceptable daily intake was calculated as 0.01 mg/kg/day in the study. A maximum level in drinking water of 0.002 mg/L has been proposed by EPA.[62] Several states[61] have set guidelines for alachlor in drinking water ranging from 0.15 μg/L (Arizona) to 0.2 μg/L (Illinois) to 2.0 μg/L (Massachusetts) to 10.0 μg/L (Minnesota) to 15 μg/L (Kansas) to 200 μg/L (Maine).

Determination in Water: May be accomplished by liquid extraction gas chromatographic procedure.[47] Octanol−water coefficient: Log K_{ow} = 3.48.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

No effects found in human studies.[47] Exhibits relatively low acute oral toxicity; the LD_{50} value for rats is 0.93 g/kg. The technical product has only slight skin and eye irritation potential after an acute exposure.[47] However, alachlor feeding studies have demonstrated oncogenic effects including lung tumors in mice, and stomach, thyroid, and nasal turbinate tumors in rats.

Short Term Exposure: Toxic by skin contact, ingestion, and inhalation. Eye contact may cause severe irritation or injury. Skin contact may irritate and burn skin.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. May cause liver damage. A suspected endocrine disruptor and carcinogen; developmental toxin. Human mutation data reported.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Do not reuse container; see disposal methods, below.

Shipping: Do not transport with human food or animal feedstuffs. This chemical requires a shipping label of

"POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Take up with diatomite, clay, expanded mineral, foamed glass, or synthetic treated absorbent material and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. For *large spills* seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: This chemical is not flammable, but may support combustion. Stay upwind of fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is hydrolyzed under strongly acid or alkaline conditions, to chloroacetic acid, methanol, formaldehyde, and 2,6-diethylanilne. Incineration is recommended as a disposal procedure. Techniques for alachlor removal from potable water have been reviewed by EPA[47] but the data revealed no superior method. Improper disposal of pesticides is a violation of federal law. Dispose in accordance with 40CFR165; follow recommendations for the disposal of pesticides and pesticide containers.

References

US Environmental Protection Agency. (December 31, 1987). *Alachlor: Notice of Intent to Cancel Registrations; Conclusion of Special Review*, Federal Register 52, No. 251, pp. 49480−49504

Waxman, M. F., & Kammel, D. W. (1991). *A Guidebook for the Safe Use of Hazardous Agricultural Farm Chemicals and Pesticides*, North Central Regional Publication 402. Madison, WI

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Aldicarb A:0490

Molecular Formula: $C_7H_{14}N_2O_2S$

Common Formula: $CH_3SC(CH_3)_2CH{=}NOCONHCH_3$

Synonyms: A13-27093; Aldecarb; Aldecarbe (French); Ambush®; Carbamic acid, methyl-,*O*-([2-methyl-2-(methylthio)propylidene]amino) derivative; Carbanolate; Caswell No. 011A; EPA pesticide chemical code 098301; 2-Methyl-2-(methylthio)propanaldehyde, *O*-(methylcarbamoyl) oxime; 2-Methyl-2-(methylthio)propanal, *O*-[(methylamino) carbonyl] oxime; 2-Methyl-2-methylthio-propionaldehyd-*O*-(*n*-methyl-carbamoyl)-oxim (German); Permethrin; Propanal, 2-methyl-2-(methythio)-, *O*-[(methylamino)carbonyl] oxime; Propionaldehyde, 2-methyl-2-(methylthio)-, *O*-(methylcarbamoyl) oxime; Sulfone aldoxycarb; Temic®; Temik®; Temik 10 G®; Temik G10®; Tedmik® 150G; UC 21149® (Union Carbide); Union Carbide 21149; Union Carbide UC-21149

CAS Registry Number: 116-06-3

RTECS® Number: UE2275000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151

EC Number: 204-123-2 [*Annex I Index No.:* 006-017-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Data; Human No Available Data, *not classifiable as carcinogenic to humans*, Group 3, 1991; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

Classified by the EPA as Restricted Use Pesticide (RUP).

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (Austria, Belgium, Germany, Israel, Norway, Philippines) (UN).[13]

Very Toxic Substance (World Bank).[15]

US EPA Hazardous waste number (RCRA No.): P070.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Safe Drinking Water Act, MCL, 0.003 mg/L; MCLG 0.001 mg/L; Regulated chemical (47 FR 9352). CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): CERCLA 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA)[47] (Several States).[61]

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R24; R26/28; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Aldicarb is a noncombustible, white crystalline solid with a slight sulfurous odor. Molecular weight = 190.28; Boiling point = (decomposes); Freezing/Melting point = 98−100°C; Specific gravity (H_2O:1) = 1.18; Vapor pressure = 3.5×10^{-5} mmHg at 20°C. Relative vapor density (air = 1) = 6.59. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water; solubility = 0.6% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. A systemic, restricted use (RUP), carbamate pesticide. It is available for purchase and use by certified pesticide applicators or by those under their direct supervision. Personnel involved in manufacture, formulation, or application of this insecticide to crops are at risk.

Incompatibilities: Strong alkalis.

Permissible Exposure Limits in Air

AIHA WEEL: 0.0001 ppm, (skin), 8 h TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.0001 mg/m^3

PAC-1: 0.0003 mg/m^3

PAC-2: 0.3 mg/m^3

PAC-3: 100 mg/m^3

Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, 1999. Guidelines or standards have been set for aldicarb in ambient air[60] ranging from 2.0 μg/m^3 (New York) to 6.0 μg/m^3 (South Carolina).

Permissible Concentration in Water: EPA/Safe Drinking Water Act levels: MCL, 0.003 mg/L; MCLG 0.001 mg/L. Canada Drinking Water Quality = 0.009 mg/L MAC.

Determination in Water: Aldicarb may be determined in water by gas−liquid chromatography with flame photometric detection after oxidation to the sulfone (aldoxycarb) by peracetic acid or 3-chloro-perbenzoic acid. Colorimetric methods have also been used based on hydrolysis to hydroxylamine which is oxidized to nitrous acid, the latter used to diazotize sulfanilic acid which is then coupled to give a dye.[23] Fish Tox = 3.75027000 MATC (HIGH). Octanol−water coefficient: Log $K_{ow} = 1.35$. EC_{50} = 0.41 mg/L (48 h, *Daphnia magna*).

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Aldicarb is a carbamate pesticide. This material is super toxic; the probable oral lethal dose for humans is less than 5 mg/kg, or a taste (less than 7 drops) for a 150-lb person; it is extremely toxic by both oral and dermal routes. Symptoms include headache, blurred vision, nausea, vomiting, diarrhea, and abdominal pain. In severe cases, unconsciousness and convulsions may occur.

Short Term Exposure: This chemical is one of the most highly toxic pesticides. It can be harmful or fatal if swallowed, inhaled, or absorbed through the skin. Exposure can cause rapid severe poisoning with headache, sweating, nausea and vomiting, diarrhea, loss of coordination, and possible death. Aldicarb may affect the nervous system causing convulsions and respiratory failure. It is a cholinesterase inhibitor. Exposure may result in death. The effects may be delayed; medical observation is recommended.

Long Term Exposure: Human mutation data reported. May affect the immune system. Aldicarb is a questionable carcinogen with no firm human evidence. Human tox = 7.00 ppb (MCL) (HIGH).[77]

Points of Attack: Skin, lungs.

Medical Surveillance: Plasma and red blood cell cholinesterase levels (test for enzyme poisoned by this chemical). For this substance, these tests are accurate only if done within about 2 h of exposure.

First Aid: Move victim to fresh air; call emergency medical care. Speed in removing material from eyes and skin is of extreme importance. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. All users of Temik® 150G must have attended a training program and be issued with a Bayer CropScience Certificate of Temik® Accreditation prior to purchase and use of this product.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where Aldicarb is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as Sodium Hydroxide and Sodium Bicarbonate).

Shipping: Aldicarb is a solid toxic carbamate and should be labeled "POISONOUS/TOXIC MATERIALS." It falls into DOT/UN Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with diatomite, clay, expanded mineral, vermiculite, sand, or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 30.

Fire Extinguishing: May burn but does not ignite readily. Poisonous gases, including oxides of carbon, nitrogen, and sulfur; aldicarb nitrile, aldicarb oxime, and methylamine, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with effluent gas scrubbing is recommended.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 37−41

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Aldicarb*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Aldicarb*. Trenton, NJ

Aldol A:0500

Molecular Formula: $C_4H_8O_2$

Synonyms: Acetaldol; Aldehido, β-hidroxibutirico (Spanish); 3-Butanolal; Butyraldehyde, 3-hydroxy-; 3-Hydroxybutanal; β-Hydroxybutyraldehyde; 3-Hydroxybutyraldehyde; Oxybutanal; Oxybutyric aldehyde

CAS Registry Number: 107-89-1

RTECS® Number: ES1500000

UN/NA & ERG Number: UN2839/153

EC Number: 203-530-2

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Aldol is a flammable, colorless to pale yellow, syrupy liquid. Molecular weight = 88.1; Specific gravity (H_2O:1) = 1.1; Boiling point = 80°C at 20 mmHg,[17] (decomposes above 83°C); Freezing/Melting point = 0°C; Vapor pressure = $<7.6 \times 10^{-3}$ mmHg at 20°C[52]; Vapor density (air = 1) = 2.98; Flash point = 66°C; Autoignition temperature = 250°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2. Good solubility in water.

Potential Exposure: Aldol is used as a solvent and to manufacture rubber accelerators, perfumes; in fungicides; and in engraving, cadmium plating.

Incompatibilities: Contact with oxidizers may cause fire and explosions. Contact with metals may cause the formation of flammable and explosive hydrogen gas. Heat above 83°C causes the formation of crotonaldehyde vapor (which may cause explosion) and water.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin, eyes, and respiratory tract. This chemical can be absorbed through the skin, thereby increasing exposure. Exposure to vapor may cause sore throat, coughing, dizziness, lightheadedness, and unconsciousness. Ingestion causes abdominal pain.

Long Term Exposure: Prolonged or repeated skin contact may cause redness, irritation, and dryness.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where Aldol may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Aldol is a liquid toxic pesticide and should be labeled "POISONOUS/TOXIC MATERIALS." It falls into DOT/UN Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Aldol*. Trenton, NJ

Aldrin A:0510

Molecular Formula: $C_{12}H_8Cl_6$

Synonyms: Aldocit®; Aldrec®; Aldrex®; Aldrex-30®; Aldrex-40®; Aldrina® (Spanish); Aldrin y dieldrin (Spanish); Aldrine (French); Aldrite®; Aldron®; Aldrosol®; Algran®; Altox®; 1,4,5,8-Dimethanonaphthalene,1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-(1a,4a,4b,5a,8a,8b)-; 1,4:5,8-Dimethanon aphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endoexo-; Drinox®; ENT15949; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endoexo-5,8-dimethanonaphthalene; 1,2,3,4,10-10-Hexachloro-1,4,4a,5, 8,8a-hexahydro-1,4,5,8-endoexo-dimethanonaphthalene; Hexachlorohexahydro-endoexo-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-exo-1,4-endo-5,8-dimethanonaphthalene; HHDN; Octalene; Octalene®; Seedrin; Seedrin®; Toxadrin®

CAS Registry Number: 309-00-2; *(alt.)* 34487-55-3

RTECS® Number: IO2100000

UN/NA & ERG Number: UN2761(Organochlorine pesticides, solid toxic)/151; UN2762 (Organochlorine pesticides liquid, flammable, toxic, flash point <23°C)/131

EC Number: 206-215-8 [*Annex I Index No.:* 602-048-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; (feed); equivocal evidence: rat; IARC: Animal Limited Evidence; Human Inadequate Evidence Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Set (EPA) (Mexico).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A Priority Pollutants; 57FR41331 Priority Chemicals; 40CFR401.15 Toxic Pollutant.

US EPA Hazardous Waste Number (RCRA No.): P004.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8080 (0.05); 8270 (10).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg); SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/88.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R40; R48/24/25; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Aldrin is a colorless, crystalline solid. The technical grade is a tan to dark brown solid. It has a mild, chemical odor. Molecular weight = 364.93; Boiling point = 145°C (decomposes); Freezing/Melting point = 104°C (pure); 49−60°C (technical grade); Specific gravity = 1.6 at 20°C (solid); Vapor pressure = 6.6×10^{-6} mmHg. Although noncombustible, aldrin may be dissolved in a flammable liquid. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.003%.[2]

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Formerly used as an insecticide in the US

Pesticide manufacturers, formulators, and applicators. Some people in the United States may be exposed to aldrin (and dieldrin) in air, water, and food because of its persistence in the environment. See "Dieldrin" for more details.

Incompatibilities: Avoid concentrated mineral acids, acid catalysts, acid oxidizing agents, phenol, or active metals.

Permissible Exposure Limits in Air Odor threshold = 0.3 mg/m^3.

OSHA PEL: 0.25 mg/m^3 TWA [skin].

NIOSH REL: 0.25 mg/m^3 TWA [skin], potential occupational carcinogen; Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.05 mg/m^3 TWA inhalable fraction and vapors [skin]; confirmed animal carcinogen with unknown relevance to humans (2006).

NIOSH IDLH: 25 mg/m^3, inhalable fraction [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK: 0.25 mg/m^3 measured as inhalable fraction [skin]; Peak limitation Category II(8).

Australia: TWA 0.25 mg/m^3, [skin], 1993; Austria: MAK 0.25 mg/m^3, [skin], 1999; Belgium: TWA 0.25 mg/m^3, [skin], 1993; Denmark: 0.25 mg/m^3, [skin], 1999; Finland: TWA 0.25 mg/m^3; STEL 0.75 mg/m^3, [skin], 1999; France: VME 0.25 mg/m^3, [skin], carcinogen, 1999; the Netherlands: MAC-TGG 0.25 mg/m^3, [skin], 2003; Norway: TWA 0.25 mg/m^3, 1999; the Philippines: TWA 0.25 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3; STEL 1.5 mg/m^3, 1999; Russia: STEL 0.01 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.25 mg/m^3, [skin], 1999; Thailand: TWA 0.25 mg/m^3, 1993; Turkey: TWA 0.25 mg/m^3, [skin], 1993; United Kingdom: TWA 0.25 mg/m^3; STEL 0.75 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for aldrin in ambient air[60]: 0.035 μg/m^3 (Pennsylvania) to 0.595 μg/m^3 (Kansas) to 1.5 μg/m^3 (Connecticut) to 2.5 μg/m^3 (North Dakota) to 4.0 μg/m^3 (Virginia) to 6.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5502.[18] A filter plus bubbler containing isooctane followed by workup with isooctane and analysis by gas chromatography.

Permissible Concentration in Water: To protect freshwater aquatic life: not to exceed 3.0 μg/L at any time. To protect saltwater aquatic life: not to exceed 1.3 μg/L at any time. To protect human health: preferably zero. A limit of 0.00074 μg/L is believed to keep lifetime cancer risk below 10^{-5}.[6] Russia[43] set a MAC of 0.01 mg/L in water used for domestic purposes. Mexico limit in drinking water 0.00003 mg/L. Several states have set guidelines and standards for Aldrin in drinking water.[61] Illinois has set a standard of 0.1 μg/L. Guidelines in other states range from 0.013 μg/L (Kansas) to 0.03 μg/L (Minnesota) to 0.05 μg/L (California). Aldrin is highly toxic to aquatic organisms and every care must be taken to avoid release to the environment. In the food chain important to humans, bioaccumulation takes place, specifically in aquatic organisms. It is strongly advised not to let the chemical enter into the environment because of its persistence.

Determination in Water: Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 7.4. Fish toxicity (threshold)[77]: 0.18049 ppb MACT. (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye and skin contact can cause irritation and burns. Can be fatal if swallowed or absorbed through the skin. Aldrin tends to produce convulsions before other less serious signs of illness have appeared. Victims have reported headache, nausea, vomiting, dizziness, and mild chronic jerking. Some victims have convulsions without warning. Poisoning by Aldrin usually involves convulsions due to its effects on the central nervous system. Probable oral lethal dose for humans is between 7 drops and 1 oz for a 150-lb adult human.

Long Term Exposure: May cause tumors, cancer, mutations, reproductive effects. Reproductive effects and liver effects have also been reported. It is classified as an extremely toxic chemical. Conflicting reports of carcinogenicity of this compound remain an area of controversy. Similar chemically and toxicologically to dieldrin. Cancer site in animals: lungs, liver, thyroid, and adrenal glands.[2] Human Tox = 0.02058 ppb CHCL (Chronic Human Carcinogen Level) (EXTRA HIGH).

Points of Attack: Central nervous system, liver, kidneys, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. NIOSH recommends the following tests: blood plasma, complete blood count, liver function tests, urinalysis (routine), reticulocyte count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, preferably outdoors.

Shipping: Aldrin requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. For large spill seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: Solid is not combustible, but Aldrin is often dissolved in a flammable liquid. Poisonous gases, including hydrogen chloride and chlorine, are produced in fire. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Aldrin is very stable thermally with no decomposition noted at 250°C. Aldrin (along with the structurally related compounds dieldrin and isodrin) is remarkably stable to alkali (in contrast to chlordane and heptachlor) and refluxing with aqueous or alcoholic caustic has no effect. Incineration methods for aldrin disposal involving 816°C, 0.5 s minimum for primary combustion, 1760°C, 1.0 s for secondary combustion, with adequate scrubbing and ash disposal facilities have been recommended. The combustion of aldrin in polyethylene on a small scale gave more than 99% decomposition. Aldrin can be degraded by active metals, such as sodium in alcohol (a reaction which forms the basis of the analytical method for total chlorine), but this method is not suitable for the layman. A disposal method suggested for materials contaminated with aldrin, dieldrin, or endrin consists of boring 8−12 feet underground in an isolated area away from water suppliers, with a layer of clay, a layer of lye, and a second layer of clay beneath the wastes. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

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New York State Department of Health. (January 1986). *Chemical Fact Sheet: Aldrin*. Albany, NY: Bureau of Toxic Substance Assessment

US Public Health Service. (November 1987). *Toxicological Profile for Aldrin/Dieldrin*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

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Baselt, R. C. (1988). *Biological Monitoring Methods for Industrial Chemicals*. (2nd ed.Year Book Medical Publishers, Inc., Chicago, IL.

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Allethrin A:0520

Molecular Formula: $C_{19}H_{26}O_3$ (I); $C_{10}H_{26}O_5$ (II)

Synonyms: (+)-Allelrethonyl; D-Allethrin; D-*trans* Allethrin; Allethrin I; Alleviate; Allyl cinerin; Allyl homolog of cinerin I; DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one-DL-chrysanthemum monocarboxylate; 3-Allyl-4-keto-2-methylcyclopentenyl chrysanthemummonocarboxylate 3; 3-Allyl-2-methyl-4-oxo-2-cyclopenten-1-yl chrysanthemate; DL-3-Allyl-2-methyl-4-oxocyclopent-2-enyl DL-*cis*,*trans*-chrysanthemate; Allylrethronyl DL-*cis*,*trans*-chrysanthemate; Bioallethrin; Bioaltrina; (+)-*cis*,*trans*-Chrysanthemate; Cinerin I allyl homolog; Depallethrin; ENT 17,510; Exthrin; FDA 1446; FMC 249; Necarboxylic acid; NIA 249; OMS 468; Pallethrine; Pynamin; Pynamin-forte; Pyresin; Pyresyn; Synthetic pyrethrins

CAS Registry Number: 584-79-2 (I); 497-92-7 (II)

RTECS® Number: GZ1925000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: 584-79-2 (I) 209-542-4 [*Annex I Index No.:* 006-025-00-3]; 497-92-7 (II) not listed.

Regulatory Authority and Advisory Bodies

AB 1803-Well Monitoring Chemical (CAL) as pyrethrins.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum.

Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins.

EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg) as pyrethrins.

European/International Regulations [584-79-2 (I)]: Hazard Symbol: Xn, N; Risk phrases: R20/22; R50/53; Safety phrases: S2; S36; S46; S60; S61; [497-92-7 (II)] Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Allethrin is a clear, yellow to amber, oily liquid which is also available as a wettable powder or granules. Boiling point = 140−160°C; Flash point = approximately 120−123°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0−1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Allethrin is used to control insects in homes and animal shelters, and to treat lice in humans.

Incompatibilities: Strong alkalis and oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 4.75−4.80.

Routes of Entry: Skin, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact causes irritation and burns. Inhalation can cause respiratory tract irritation with coughing and wheezing. High exposure may cause dizziness, shaking, irritability, seizures, and unconsciousness. Allethrins may affect the nervous system.

Long Term Exposure: May cause skin allergy. If the allergy develops, very low future exposure can cause itching and skin rash. Allethrin may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Allethrin can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may cause liver and kidney damage. There is no evidence that allethrin affects reproduction.[2]

Points of Attack: Skin, lungs, liver, and kidneys.

Medical Surveillance: Liver and kidney function tests. Lung function test. (These could be normal if the person is not having an attack at the time of the test). Evaluation by a qualified allergist may help to diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *5000 mg/m^3:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Allethrin is a liquid toxic pesticide and should be labeled “POISONOUS/TOXIC MATERIALS.” It falls into DOT/UN Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Irritating gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

Reference

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Allethrin.* Trenton, NJ

Allyl acetate A:0530

Molecular Formula: $C_5H_8O_2$

Synonyms: Acetic acid, allyl acetate; Acetic acid, 2-propenyl ester; 3-Acetoxypropene; 2-Propenyl methanoate

CAS Registry Number: 591-87-7

RTECS® Number: AF1750000

UN/NA & ERG Number: UN2333/131

EC Number: 209-734-8

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Allyl acetate is a flammable, colorless liquid with an acrid odor. Molecular weight = 100.12; Boiling point = 103−104°C; Flash point = 22°C; Autoignition temperature = 374°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.-

Potential Exposure: Allyl acetate is used to control insects in homes and animal shelters, and to treat lice in humans.

Also, generally speaking, most allyl compounds may be metabolized to allyl alcohol which is metabolized to acrolein.

Incompatibilities: Contact with oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: 10 ppm
PAC-3: 50 ppm

Routes of Entry: Skin, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Prolonged or repeated contact can cause rash, redness, and itching. Skin and eye contact causes irritation, severe burns, and permanent damage. Inhalation can cause respiratory tract irritation with coughing and wheezing. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death.

Long Term Exposure: Allyl acetate can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may cause liver and kidney damage.

Points of Attack: Skin, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl acetate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Allyl acetate requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls into DOT/UN Hazard Class 3, Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl acetate is a highly flammable liquid. Irritating gases, including carbon dioxide and carbon monoxide, are produced in fire. Use propylene foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Allyl Acetate*. Trenton, NJ

Allyl alcohol A:0540

Molecular Formula: C_3H_6O

Common Formula: CH_2CHCH_2OH

Synonyms: AA; Alcool allylique (French); Alilico alcohol (Spanish); Allyl al; Allyl alcohol; Allylalkohol (German); Allylic alcohol; 3-Hydroxypropene; Orvinylcarbinol; 1-Propen-3-ol; 2-Propen-1-ol; 2-Propenol; Propenol; Propen-1-ol-3; 2-Propenyl alcohol; Propenyl alcohol; Shell Unkrautted A; Vinyl carbinol; Vinyl carbinol,2-propenol

CAS Registry Number: 107-18-6

UN/NA & ERG Number: UN1098/131

EC Number: 203-470-7 [*Annex I Index No.:* 603-015-00-6]

RTECS® Number: BA5075000

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 15,000 lb (5825 kg).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

US EPA Hazardous Waste Number (RCRA No.): P005.

RCRA Land Ban Waste Restrictions.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.5 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R10; R23/24/25; R36/37/38; R50; Safety phrases: S1/2; S36/37/39; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Allyl alcohol is a flammable, colorless liquid. It has a pungent, mustard-like odor. Molecular weight = 58.09. Boiling point = 97°C. Melting/Freezing point = − 129°C; Critical temperature = 271.9°C; Critical pressure = 840 psia = 57 atm = 5.8 MN/m^2; Specific gravity (H_2O:1) = 0.852 at 20°C (liquid); Relative vapor density (air = 1) = 2.0; Ratio of specific heats of vapor (gas) = 1.12; Latent heat of vaporization = 295 Btu/lb = 164 cal/g = 6.87×10^5 J/kg; Saturation concentration in air = 57 g/m^3 at 20°C; Heat of combustion = − 13,720 Btu/lb = − 7620 cal/g = -319.0×10^5 J/kg; Heat of polymerization = 100°C; Vapor pressure = 24 hPa at 20°C; 18 mmHg at 20°C; Electrical conductivity = 6.5×10^5 pS/m; Flash point = 21°C (cc); 32°C (oc); Autoignition temperature = 378°C. Explosive limits: LEL = 2.5%, UEL = 18.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1. Highly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. Allyl alcohol is used without formulation for weed control and applied as a drench to tobacco beds; in the production of allyl esters. These compounds are used as monomers and prepolymers in the manufacture of resins and plastics. Allyl alcohol is also used in the preparation of pharmaceuticals; in organic syntheses of glycerol and acrolein; and as a fungicide and herbicide.

Incompatibilities: Forms explosive mixture with air. Reacts explosively with carbon tetrachloride, strong bases. Also incompatible with strong acids. Contact with oxidizers may cause fire and explosions. Polymerization may be caused by heat above 99°C, peroxides, or oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.38 mg/m^3 Odor threshold = 1.4−2.1 ppm. The odor at 25°C at 1 atm and irritant properties of allyl alcohol is above the TLV and nearly the same as the PEL.

OSHA PEL: 2 ppm/5 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/5 mg/m^3 TWA; 4 ppm/10 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.5 ppm/1.19 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

NIOSH IDLH value = 20 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **5.1** ppm
PAC-2: **13** ppm
PAC-3: **40** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin]; Carcinogen Category 3B.

Arab Republic of Egypt: TWA 2 ppm (5 mg/m^3), [skin], 1993; Australia: TWA 2 ppm (5 mg/m^3); STEL 4 ppm, [skin], 1993; Austria: MAK 2 ppm (5 mg/m^3), [skin], 1999; Belgium: TWA 2 ppm (4.8 mg/m^3); STEL 4 ppm (9.5 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (5 mg/m^3), [skin], 1999; Finland: TWA 2 ppm (5 mg/m^3); STEL 4 ppm (10 mg/m^3), [skin], 1993; France: VME 2 ppm (5 mg/m^3), VLE 4 ppm (10 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 5 mg/m^3, [skin], 2003; Japan: 1 ppm (2.4 mg/m^3), [skin], 1999; Norway: TWA 2 ppm (5 mg/m^3), 1999; the Philippines: TWA 2 ppm (5 mg/m^3), [skin], 1993; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 10 mg/m^3, [skin], 1999; Russia: TWA 1 ppm, 1993; Sweden: NGV 2 ppm (5 mg/m^3), KTV 6 ppm (14 mg/m^3), [skin], 1999; Switzerland: MAK-W 2 ppm (5 mg/m^3), KZG-W 4 ppm (10 mg/m^3), [skin], 1999; Turkey: TWA 2 ppm (5 mg/m^3), [skin], 1993; United Kingdom: TWA 2 ppm (4.8 mg/m^3); STEL 4 ppm (9.7 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Guidelines or standards for allyl alcohol in ambient air have been set[60] by various states: 5 mg/m^3/STEL 10 mg/m^3 (California), 5 mg/m^3 (North Dakota); 8 mg/m^3 (Virginia); 10 mg/m^3 (Connecticut); 11.9 mg/m^3 (Nevada).

Determination in Air: Adsorption on charcoal, workup with CS_2 and gas chromatographic analysis. Use NIOSH Analytical Method #1402.[18]

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 0.17–0.2$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Allyl alcohol vapor can cause serious irritation and burns of eyes, nose, and throat. Eye irritation may be accompanied by sensitivity to light, pain, blurred vision leading to permanent damage. The pain may not begin until 6 h after exposure. Contact with the liquid may cause first and second degree burns of skin and blister formation. Areas of contact will become swollen and painful and local muscle spasms may occur. Allyl alcohol causes burns on contact; and may cause pulmonary edema, a medical emergency, if inhaled. It is poisonous in small quantities. The probable oral lethal dose is 50–500 mg/kg, or between 1 teaspoonful and 1 oz for a 150-lb person.

Long Term Exposure: Allyl alcohol may cause mutations; such chemicals may have a cancer or reproductive risk. This chemical may cause liver and kidney damage. Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic examinations should include lung function tests, liver and kidney function tests. Following acute exposure, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots; Barricade®™ coated suits; Responder™ suits; Trychem 1000™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Viton™ gloves, suits. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* Sa:Cf* (APF = 25) * (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Store to avoid contact with strong oxidizers, such as halogens. Avoid smoking, sparks or open flames in storage areas.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." The DOT/UN Hazard Class is 6.1 and 3 (subsidiary), and the Packing Group is I.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep allyl alcohol out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day 0.4/0.6

Night 0.7/1.2

Fire Extinguishing: This chemical is a flammable liquid. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after dilution with a flammable solvent.

References

US Environmental Protection Agency. (April 30, 1980). *Allyl Alcohol: Health and Environmental Effects Profile No. 9*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 29−31

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Allyl Alcohol*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Allyl Alcohol*. Trenton, NJ

Allylamine A:0550

Molecular Formula: C_3H_7N

Common Formula: $CH_2{=}CHCH_2NH_2$

Synonyms: Alilamina (Spanish); 3-Aminopropene; 3-Aminopropylene; Monoallylamine; 2-Propen-1-amine; 2-Propenamine

CAS Registry Number: 107-11-9

RTECS® Number: BA5425000

UN/NA & ERG Number: UN2334/131

EC Number: 203-463-9 [*Annex I Index No.:* 612-046-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 10,000 lb (4540 kg).

Clean Air Act: 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 10,000 lb (4540 kg).

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg).[7]

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): EHS lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F + , T, N; Risk phrases: R11; R23/24/25; R51/53; Safety phrases: S1/2; S9; S16; S24/25; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Allylamine is a highly flammable, colorless liquid with a strong ammonia odor. Molecular weight = 57.11; Freezing/Melting point = − 88°C; Boiling point = 53−58°C; Specific gravity (H_2O:1) = 0.760 at 20°C; Flash point = − 29°C; Autoignition temperature = 374°C; Vapor pressure = 195 mmHg at 20°C. Explosive limits: LEL = 2.2%, UEL = 22.0%. Odor threshold = 2.5 ppm. Vapors are highly disagreeable; it is unlikely that any person would voluntarily stay in dangerous concentration. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1. Highly soluble in water.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Used in manufacture of pharmaceuticals (e.g., mercurial diuretics) and in organic synthesis. Used to improve dyeability of acrylic fibers.

Incompatibilities: Forms explosive mixture with air. Oxidizing materials and acids may cause a violent reaction. Attacks copper and corrodes active metals (i.e., aluminum, zinc, etc.).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.23 mg/m^3 at 25°C & 1 atm.

Protective Action Criteria (PAC)*

TEEL-0: 0.125 ppm

PAC-1: **0.42** ppm

PAC-2: **3.3** ppm

PAC-3: **18** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Denmark: TWA 2 ppm (4.7 mg/m^3), [skin], 1999; Norway: TWA 2 ppm (5 mg/m^3), 1999; Russia: STEL 0.05 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (5 mg/m^3), KTV 6 ppm (14 mg/m^3), [skin], 1999.

Routes of Entry: Inhalation, ingestion and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to eyes, skin, and respiratory tract which is highly toxic if inhaled or ingested and moderately toxic if absorbed on skin. Ingestion or inhalation may cause death or permanent injury after very short exposure to small quantities. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Swallowing liquid may cause pneumonia. Vapors are extremely unpleasant and may ensure voluntary avoidance of dangerous concentrations. Symptoms include irritation of nose, eyes, and mouth with tearing, runny nose, and sneezing. Can cause excitement, convulsions, and death. Skin absorption may cause irreversible and reversible changes. Toxic air concentration in humans is 5 ppm over 5 min.

Long Term Exposure: Mutation data reported.

Points of Attack: Skin, pulmonary, system, cardiovascular system.

Medical Surveillance: Lung function tests. Following acute exposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers recommend butyl rubber as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN

149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allylamine may be present, check to make sure that an explosive concentration does not exist. Outside or detached storage preferred. Keep containers closed and away from oxidizers, acids, or combustible materials. If stored indoors, use standard flammable liquids storage room or cabinet. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." The Hazard Class is 6.1 and 3 (subsidiary), and the Packing Group is I.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Keep allylamine out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 1.9/3.1

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High temperature incineration; encapsulation by resin or silicate fixation.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 28−30

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Allylamine*. Washington, DC: Chemical Emergency Preparedness Program

Allyl bromide A:0560

Molecular Formula: C_3H_5Br

Common Formula: $BrCH_2CH{=}CH_2$

Synonyms: Bromallylene; 1-Bromo-2-propene; 3-Bromopropeno (Spanish); 3-Bromopropylene; Bromuro de alilo (Spanish); 1-Propene, 3-bromo-

CAS Registry Number: 106-95-6
RTECS® Number: UC7090000
UN/NA & ERG Number: UN1099/131
EC Number: 203-446-6

Regulatory Authority and Advisory Bodies

Air and Water Pollutant Standard Set: see Bromine.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Description: Allyl bromide is a highly flammable, colorless to light yellow liquid with an unpleasant, pungent odor. Molecular weight = 120.98; Boiling point = 71.3°C; Freezing/Melting point = − 119°C; Specific gravity (H_2O:1) = 1.4161 at 20°C; Vapor pressure = about 111−112 mmHg at 20°C; Liquid surface tension = 0.0269 N/m at 20°C; Relative vapor density (air = 1) = 4.2; Latent heat of vaporization = (estimate) 2.5×10^5 J/kg; Heat of combustion = (estimate) -150×10^5 J/kg; Flash point = − 1°C; Autoignition temperature = 295°C. Explosive limits: LEL = 4.4%, UEL = 7.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: Used as an insecticide; in the manufacture of resins, fragrances, and other chemicals.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause fire and explosions. Heat or light exposure may cause decomposition and corrosive vapors.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.1 ppm TWA [skin] Not classifiable as a human carcinogen.

NIOSH IDLH: 3 ppm *bromine.*

Temporary Emergency Exposure Limits (DOE)
TEEL-0: 4 ppm
PAC-1: 12 ppm
PAC-2: 75 ppm
PAC-3: 400 ppm

DFG MAK: Suspended 2004.

European OEL: 0.1 ppm/0.7 mg/m^3 TWA (2004).

Routes of Entry: Skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous. This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, skin, and respiratory tract. Can cause burns and permanent damage. Inhalation can cause respiratory tract irritation with coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death.

Long Term Exposure: Allyl bromide can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may cause liver and kidney damage, skin disorders; mutations.

Points of Attack: Skin, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray should be considered. Kidney and liver function tests. Consult a dermatologist if skin disorders result from exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For bromine, OSHA/NIOSH: *2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern. *3 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprTS (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed. Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl bromide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Allyl bromide should be labeled "FLAMMABLE LIQUID, POISON." It falls into DOT/UN Hazard Class 3 and 6.1 (subsidiary), and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Keep allyl bromide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl bromide is a highly flammable liquid. Irritating gases, including carbon monoxide and hydrogen bromide gas, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Allyl Bromide*. Trenton, NJ

Allyl chloride A:0570

Molecular Formula: C_3H_5Cl

Common Formula: CH_2CHCH_2Cl

Synonyms: Allylchlorid (German); Allyl chloride; Allyle (chlorure d') (French); Chlorallylene; 3-Chloroprene; 1-Chloro propene-2; 1-Chloro-2-propene; 3-Chloro-1-propene; 3-Chloropropene; 3-Chloropropene-1; α-Chloropropylene; 3-Chloropropylene; 3-Chlorpropen (German); Cloruro de alilo (Spanish)

CAS Registry Number: 107-05-1

RTECS$^{®}$ Number: UC7350000

UN/NA & ERG Number: UN1100/131

EC Number: 203-457-6 [*Annex I Index No.:* 602-029-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Bioassay (gavage); equivocal evidence: mouse; no evidence: rat.

EPA-C.

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—homozygosis.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA Hazardous Constituents 40 CFR261, Appendix 8, waste number not listed.

RCRA Land Ban Waste Restrictions.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8010 (5); 8240 (5).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): CERCLA 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Delisted as a cancer causing agent 10/29/99.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; R20/21/22; R36/37/38; R48/20; R68; R50; Safety phrases: S2; S16; S25; S26; S36/37; S46; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Allyl chloride is a highly reactive and flammable, colorless, brown or purple liquid, with an unpleasant, pungent odor. Odor threshold = 0.48−5.9 ppm. Molecular weight = 76.53; Boiling point = 44−45°C; Freezing/Melting point = −135°C; Specific gravity (H_2O:1) = 0.9 at 20°C; Relative vapor density (air = 1) = 4.15; Ratio of specific heats of vapor (gas) = 1.0804; Latent heat of vaporization = (estimate) 2.3×10^5 J/kg; Heat of combustion = (estimate) -180×10^5 J/kg; Vapor pressure = 295 mmHg at 20°C; 393 hPa at 20°C; Flash point = −32°C; Autoignition point = 485°C. Explosive limits: LEL = 2.9%, UEL = 11.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Slightly soluble in water; solubility = 0.4%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Allyl chloride is used as a chemical intermediate and in making allyl compounds, epichlorohydrin, and glycerol.

Incompatibilities: Contact with water forms hydrochloric acid. Keep away from strong oxidizers, acids, aluminum, amines, peroxides, chlorides of iron and aluminum; magnesium, zinc.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.13 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/3 mg/m^3 TWA.

NIOSH REL: 1 ppm/3 mg/m^3 TWA; 2 ppm/6 mg/m^3 STEL.

ACGIH TLV®[1]: 1 ppm/3 mg/m^3 TWA; 2 ppm/6 mg/m^3 STEL [skin]; Confirmed Carcinogen with unknown relevance to humans.

NIOSH IDLH value = 250 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **2.8** ppm

PAC-2: **54** ppm

PAC-3: **140** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 3B (2004).

Australia: TWA 1 ppm (3 mg/m^3); STEL 2 ppm, 1993; Austria: MAK 1 ppm (3 mg/m^3), suspected carcinogen, 1999; Belgium: TWA 1 ppm (3 mg/m^3); STEL 2 ppm, 1993; Denmark: TWA 1 ppm (3 mg/m^3), 1999; Finland: TWA 1 ppm (3 mg/m^3); STEL 3 ppm (9 mg/m^3), 1999; France: VME 1 ppm (3 mg/m^3), 1999; the Netherlands: MAC-TGG 3 mg/m^3, 2003; India: TWA 1 ppm (3 mg/m^3); STEL 2 ppm (6 mg/m^3), 1993; Norway: TWA 1 ppm (3 mg/m^3), 1999; Russia: STEL 0.3 mg/m^3, [skin], 1993; Sweden: TWA 1 ppm (3 mg/m^3); STEL 3 ppm (9 mg/m^3), [skin], 1999; Switzerland: MAK-W 1 ppm (3 mg/m^3), KZG-W 2 ppm (6 mg/m^3), 1999; Turkey: TWA 1 ppm (3 mg/m^3), 1993; United Kingdom: LTEL 1 ppm (3 mg/m^3); STEL 2 ppm (6 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2 ppm.

Determination in Air: Charcoal tube; Benzene; Gas chromatography/Flame ionization detection; Use NIOSH Analytical Methods (IV) #1000.

Permissible Concentration in Water: Russia[43] set a MAC of 0.3 mg/L in water bodies used for domestic purposes. Minnesota[61] has set a guideline for allyl chloride in drinking water of 2.94 mg/L.

Routes of Entry: Employees may be exposed by dermal or eye contact, inhalation, or ingestion. This chemical can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Corrosive to eyes, skin, and respiratory tract; can cause burns and permanent damage. In addition to burns, skin contact can cause deep aching and "bone pain." Effects on the skin may not be apparent for some hours following contact. Inhalation can cause respiratory tract irritation with coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death.

Long Term Exposure: May cause liver and kidney damage, lung irritation and bronchitis, drying and cracking skin. Allyl chloride has caused mutations. There is limited evidence that this chemical causes cancer of the stomach. The potential for damage to the respiratory tract, liver, and kidneys from inhalation was recognized through experimental evidence during the early commercial development of the industry involving this compound and is reflected in the precautions taken during its manufacture and use. Industrial experience in the United States has pointed to such problems as orbital pain and deep-seated aches after eye or skin contact. Both of these phenomena are believed to be transient when they occur and have been minimized through improved work practices.

Points of Attack: Respiratory system, lungs, skin, eyes, liver, and kidneys.

Medical Surveillance: Preplacement and periodic physical examinations have been detailed by NIOSH. They give special attention to the respiratory system, liver, kidneys, skin, and eyes. Urine, blood, and pulmonary function testing are required by NIOSH.[45] If symptoms of overexposure develop, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Tychem 1000™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves· All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls shall be used to maintain allyl chloride vapor concentrations below the permissible exposure limits. Compliance with the permissible exposure limits may be achieved by the use of respirators only in the following situations: (1) During the time necessary to install or test the required engineering controls. (2) For nonroutine operations, such as maintenance or repair activities, in which concentrations in excess of the permissible exposure limits may occur. (3) During emergencies when air concentrations of allyl chloride may exceed the permissible limits. When a respirator is permitted, it shall be selected as follows: *Up to 25 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl chloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a dark, cool, well-ventilated and fireproof area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Allyl chloride requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 3 and 6.1 (subsidiary), and the Packing Group is I.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Do not wash into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Allyl chloride is a highly flammable liquid. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Use dry chemical, carbon dioxide, polymer, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration at a temperature of 982°C for 2 s minimum.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Allyl Chloride*, NIOSH Document No. 76-204. Washington, DC

US Environmental Protection Agency. (July 1979). *Chemical Hazard Information Profile: Allyl Chloride*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 32−34 (1981) and 8, No. 1, 20−28 (1988)

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Allyl Chloride*. Trenton, NJ

Allyl ethyl ether A:0580

Molecular Formula: $C_6H_{10}O$
Common Formula: $CH_2H_5OCH_2CH{=}CH_2$
Synonyms: 1-Propene, 3-ethoxy-; Eter, aliletil (Spanish)
CAS Registry Number: 557-31-3
RTECS® Number: KM9120000
UN/NA & ERG Number: UN2335/131
EC Number: 209-169-7
Regulatory Authority and Advisory Bodies
DOT Appendix B, §172.101.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
Description: Allyl ethyl ether is a highly flammable liquid. Molecular weight = 86.12; Boiling point = 66°C; Specific gravity (H_2O:1) = 0.79; Vapor pressure = 136 mmHg at 20°C; Flash point = −21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 4. Insoluble in water.
Potential Exposure: Used for making other chemicals.
Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause fire and explosions. Incompatible with strong acids. May form explosive peroxides during storage.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Through the skin, inhalation, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, skin, and respiratory tract. Exposure can cause headache, dizziness, nausea, and vomiting. May affect the central nervous system.
Long Term Exposure: May cause central nervous system damage. Removes the skin's natural oils, leading to dryness, irritation, redness, possible cracking.
Points of Attack: Skin, lungs.
Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray and nervous system tests should be considered.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary

edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl ethyl ether may be present, check to make sure that an explosive concentration does not exist. Check for peroxides and inhibit if necessary. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Allyl ethyl ether should be labeled “FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS.” It falls into DOT/UN Hazard Class 3 and Hazard Class 6.1 (subsidiary) and is in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Keep allyl chloride out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl ethyl ether is a highly flammable and reactive liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Allyl Ethyl Ether*. Trenton, NJ

Allyl glycidyl ether A:0590

Molecular Formula: $C_6H_{10}O_2$

Synonyms: AGE; Alil glicidikico eter (Spanish); Allyl-2,3-epoxypropyl ether; Allylglycidaether (German); 1-Allyloxy-2,3-epoxy-propan (German); 1-(Allyloxy)-2,3-epoxypropane; 1,2-Epoxy-3-allyloxypropane; Oxirane, [(2-propenyloxy)methyl]; [(2-Propenyloxy) methyl]oxirane

CAS Registry Number: 106-92-3

RTECS$^{®}$ Number: RR0875000

UN/NA & ERG Number: UN2219/129

EC Number: 203-442-4 [*Annex I Index No.:* 603-038-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies (inhalation); some evidence: mouse; equivocal evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/22; R37/38; R40; R41; R43; R52/53; R62; R68; Safety phrases: S2; S24/25; S26; S36/37/39; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Allyl glycidyl ether is a colorless liquid with a strong, sweet odor. Molecular weight = 114.16; Boiling point = 154°C; Freezing/Melting point = − 100°C; Density (H_2O:1) = 0.97; Vapor density (air = 1) = 3.9; Vapor pressure = 3.69 mmHg at 20°C; Flash point = 57°C. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Used as a solvent and emulsifier; making epoxy resins, chlorinated compounds; and rubber.

Incompatibilities: Forms explosive mixture with air. Contact with acids or bases may cause explosive polymerization. Contact with oxidizers or amines may cause fire and explosions.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.67 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/45 mg/m^3 Ceiling Concentration.

NIOSH REL: 5 ppm/22 mg/m^3 TWA; 10 ppm/44 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 1 ppm/4.7 mg/m^3 TWA; not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: [skin] Carcinogen Category 2; danger of skin sensitization (2004).

NIOSH IDLH value = 50 ppm.

Australia: TWA 5 ppm (22 mg/m^3); STEL 10 ppm, [skin], 1993; Austria: carcinogen, 1999; Belgium: TWA 5 ppm (23 mg/m^3); STEL 10 ppm (47 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (22 mg/m^3), [skin], 1999; Finland: STEL 5 ppm (22 mg/m^3), [skin], 1999; France: VME 5 ppm (22 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 10 ppm (45 mg/m^3), 1993; Switzerland: MAK-W 0.05 ppm (0.1 mg/m^3), 1999; Thailand: TWA 10 ppm (45 mg/m^3), 1993; Turkey: TWA 10 ppm (45 mg/m^3), 1993; United Kingdom: TWA 5 ppm (24 mg/m^3); STEL 10 ppm (47 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for AGE in ambient air[60]: 22 mg/m^3; STEL 44 22 mg/m^3 (California), 22 mg/m^3 (Connecticut), 44 mg/m^3 (North Dakota), 40 mg/m^3 (Virginia), 52.4 mg/m^3 (Nevada).

Determination in Air: Adsorption in a Tenax-tilled tube, workup with ethyl ether, analysis by gas chromatography. Use NIOSH Analytical Method #2545.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact contributes significantly to overall exposure. Inhalation of vapors may irritate the eyes, skin, and respiratory tract, causing shortness of breath and coughing. Higher exposure may cause dizziness, lightheadedness, unconsciousness, pulmonary edema; a medical emergency that can cause death. Skin or eye contact with the liquid may cause irritation, burns, and skin rash. The DFG warns of the danger of skin sensitization. Use of alcoholic beverages enhances the harmful effect.

Long Term Exposure: This chemical may be a human carcinogen. It may cause mutations and damage male reproductive glands. Repeated exposures may cause permanent lung damage.

Points of Attack: Eyes, skin, respiratory system, blood, reproductive system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests, lung function tests, examination of the eyes for corneal opacities. A qualified allergist may be consulted concerning potential skin allergy. Following acute overexposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers recommend natural rubber, butyl rubber, nitrile, polyvinyl alcohol, polyvinyl chloride, Neoprene™/natural rubber material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." Falls in DOT/UN Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers. Wash away residue with plenty of water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Glycidyl Ethers*, Report No. PB 276-678. Rockville, MD, pp. 116−123

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Allyl Glycidyl Ether*. Trenton, NJ

Allyl iodide A:0600

Molecular Formula: C_3H_5I
Common Formula: $CH_2{=}CHCH_2I$
Synonyms: 3-Iodo-1-propene; 3-Iodopropene; 3-Iodopropylene; 1-Propene, 3-iodo-
CAS Registry Number: 556-56-9
RTECS® Number: UD0450000
UN/NA & ERG Number: UN1723/132
EC Number: 209-130-4 [*Annex I Index No.:* 602-054-00-6]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R34; Safety phrases: S1/2; S7; S16; S26; S45.

Description: Allyl iodide is a highly flammable, corrosive, yellowish liquid that darkens on contact with air. It has an unpleasant, pungent odor. Molecular weight = 167.98; Boiling point = 103°C; Freezing/Melting point = −99°C; Flash point = 18°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Insoluble in water.

Potential Exposure: Allyl iodide may be used as an organic intermediate and in polymer manufacture.

Incompatibilities: Oxidizing materials. Do not expose to heat, light, or air.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

No TEEL available.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

A powerful irritant. Acts as a poison by inhalation and ingestion.

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Eye and skin contact can cause burns and permanent damage. Inhalation can cause coughing and/or shortness of breath; may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long Term Exposure: May cause mutations, liver, kidney damage; and lung damage with the development of bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, nose, throat, and lungs.

Medical Surveillance: Preemployment and annual lung function tests are recommended. If symptoms develop or if overexposure is suspected, liver and kidney function tests may be useful. Consider chest X-rays after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl iodide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat, light, or air. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." The DOT/UN Hazard Class 3, the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep allyl iodide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen iodide, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Allyl Iodide*. Trenton, NJ

Allyl isothiocyanate A:0610

Molecular Formula: C_4H_5NS

Common Formula: $CH_2{=}CHCH_2NCS$

Synonyms: AITC; Allyl isorhodanide; Allyl isosulfocyanate; Allyl mustard oil; Allylsenfoel (German); Allyl sevenolum; Allyl thiocarbonimide; Artificial mustard oil; Carbospol; Isothiocyanate d'allyle (French); 3-Isothiocyanato-1-propene; Isotiocianato de alilo (Spanish); Mustard oil; Oil of mustard, artificial; Oleum sinapis volatile; 2-Propenyl isothiocyanate; Redskin; Senf oel (German); Synthetic mustard oil; Volatile oil of mustard

CAS Registry Number: 57-06-7; *(alt.)* 50888-64-7; *(alt.)* 50978-48-8; *(alt.)* 58391-87-0; *(alt.)* 107231-30-1

RTECS® Number: NX8225000

UN/NA & ERG Number: UN1545 (stabilized)/155

EC Number: 200-309-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: rat; (gavage); no evidence: mouse; IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Allyl isothiocyanate is a highly flammable, colorless to pale yellow, oily liquid with a pungent, irritating odor and acrid taste. Molecular weight = 99.16; Boiling point = 151°C; Flash point = 46°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Used in fumigants, veterinary drugs, ointments and counter irritants, mustard plasters, and as a flavoring agent.

Incompatibilities: Alcohols, strong bases, strong acids, and amines.

Permissible Exposure Limits in Air

AIHA WEEL: 1 ppm STEL (15 min) [skin] Potential for dermal sensitization.

Protective Action Criteria (PAC)

TEEL-0: 0.35 ppm

PAC-1: 1 ppm

PAC-2: 12.5 ppm

PAC-3: 12.5 ppm

DFG MAK: [skin] May cause skin sensitization.

Russia: TWA 0.3 mg/m^3; STEL 0.6 mg/m^3, 1993.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye and skin contact can cause skin irritation. Prolonged contact can cause burns and blisters. This chemical can be absorbed through the skin, thereby increasing exposure.

Long Term Exposure: There is limited evidence that this chemical causes cancer in animals. It may cause bladder cancer in male rats. May damage the developing fetus. Exposure can cause an allergy-type reaction to develop with symptoms of asthma, watery eyes, sneezing, runny nose, coughing, sneezing, chest tightness. Skin allergy may develop, small exposures can cause symptoms to appear.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: Preemployment and regular lung function tests are recommended (these may be normal if the persons are not having an attack at the time of the test). If symptoms develop or if overexposure is suspected, evaluation by a qualified allergist may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISON, FLAMMABLE LIQUID." It falls in DOT/UN Hazard Class 6.1 and 3 (subsidiary), and Packing Group II.[19, 20] This chemical must be inhibited.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with vermiculite, dry sand, soil, or similar adsorbent, and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl isothiocyanate is a highly flammable liquid. Poisonous gases, including nitrogen oxides, sulfur oxides, and hydrogen cyanide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 28−29

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Allyl Isothiocyanate*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Allyl propyl disulfide A:0620

Molecular Formula: $C_6H_{12}S_2$

Common Formula: $CH_2{=}CHCH_2SSC_3H_7$

Synonyms: Disulfide, 2-propenyl propyl; Disulfuro de alil propilo (Spanish); 4,5-Dithia-1-octene; Onion oil; 2-Propenyl propyl disulfide; Propyl allyl disulfide

CAS Registry Number: 2179-59-1

RTECS® Number: JO0350000

EC Number: 218-550-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Allyl propyl disulfide is a combustible, pale yellow liquid with a strong, irritating, onion-like odor. Molecular weight = 148.29; Boiling point = 67−69°C; Flash point: 54°C; Freezing/melting point = −15°C; Vapor pressure = 1.35 mmHg at 25°C. Insoluble in water.

Potential Exposure: The primary ingredient in onion oil. Workers in onion processing (slicing and dehydration) operations.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.07 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 2 ppm/12 mg/m^3.

NIOSH REL: 2 ppm/12 mg/m^3 TWA; 3 ppm/18 mg/m^3 STEL.

ACGIH TLV®[1]: 0.5 ppm/3 mg/m^3, potential for dermal sensitization (2001).

DFG MAK: 2 ppm/12 mg/m^3 TWA; Peak Limitation Category I(1).

Australia: TWA 2 ppm (12 mg/m^3); STEL 3 ppm (18 mg/m^3), 1993; Austria: MAK 2 ppm (12 mg/m^3), 1999; Belgium: TWA 2 ppm (12 mg/m^3); STEL 3 ppm (18 mg/m^3), 1993; Denmark: TWA 2 ppm (12 mg/m^3), 1999; Finland: TWA 2 ppm (12 mg/m^3); STEL 4 ppm (24 mg/m^3), 1993; Norway: TWA 2 ppm (12 mg/m^3), 1999; the Netherlands: MAC-TGG 12 mg/m^3, 2003; Turkey: TWA 2 ppm (12 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 ppm. Several states have set guidelines or standards for allyl propyl disulfide in ambient air[60]: 2 ppm (PEL); 3 ppm STEL (California), 0.12−0.18 mg/m^3 (North Dakota), 0.20 mg/m^3 (Virginia), 0.24 mg/m^3 (Connecticut), 0.286 mg/m^3 (Nevada).

Determination in Air: Sample collection by charcoal tube, analysis by gas−liquid chromatography.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Irritation of eyes, nose, and throat. Acts as a poison by inhalation and ingestion.[44]

Short Term Exposure: Contact with the eyes produces tears. The vapor can irritate the eyes and respiratory tract, producing runny nose and tears.

Long Term Exposure: May cause skin sensitization and dermatitis. May affect the liver, kidneys, thyroid gland, stomach, and bladder.

Points of Attack: Eyes, nose, and throat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- and gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: No specific labeling or shipping precaution specified by DON/UN.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Cover with vermiculite, dry sand, earth, or similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 32−33

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Allyl Propyl Disulfide*. Trenton, NJ

Allyl trichlorosilane A:0630

Molecular Formula: $C_3H_5Cl_3Si$

Common Formula: $CH_2{=}CHCH_2SiCl_3$

Synonyms: Aliltriclorosilano (Spanish); Allylsilicone trichloride; Allyltrichlorosilane; Allyl trichorosilane, stabilized; Silane, allyltrichloro-; Silane, trichloroallyl-; Silane, trichloro-2-propenyl-; Trichloroallylsilane; Trichloro-2-propenylsilane

CAS Registry Number: 107-37-9

RTECS® Number: VV1530000

UN/NA & ERG Number: UN1724/155

EC Number: 203-485-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade) (stabilized).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Allyl trichlorosilane is a volatile, corrosive, flammable, colorless liquid with an irritating odor. Molecular weight = 175.5; Boiling point = 117°C; Specific gravity: 1.215 at 20°C (liquid); Liquid surface tension = (estimate) 20 dynes/cm; Relative vapor density (air = 1) = 6.05; Ratio of specific heats of vapor (gas) = 1.0863; Latent heat of vaporization = 2.3×10^5 J/kg; Heat of combustion = (estimate) = -120×10^5 J/kg; Flash point = 35°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩ (water reactive).

Potential Exposure: Used to make silicones and glass fiber finishes.

Incompatibilities: Water reaction is violent and forms toxic and corrosive hydrogen chloride gas. Contact with oxidizers may cause fire and explosions. Avoid all sources of ignition.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.6** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Permissible Concentration in Water: No criteria set. Reacts vigorously with water.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Allyl trichlorosilane is corrosive and contact can cause severe eye and skin burns. Exposure can irritate the eyes, nose, and respiratory tract. Higher levels can irritate the lungs, causing coughing and shortness of breath; still higher exposures can cause pulmonary edema, a medical emergency that can cause death.

Long Term Exposure: Corrosives may cause long-term lung problems, although it is not known at this time that this chemical causes lung damage.

Points of Attack: Eyes, skin, respiratory tract.

Medical Surveillance: Lung function tests. Following acute overexposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA for *Hydrogen Chloride*: *50 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where allyl trichlorosilane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from contact with water and sources of ignition. Use and store allyl trichlorosilane under nitrogen. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Allyltrichlorosilane, stabilized, requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." It falls in DOT/UN Hazard Class 8, Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use foam spray to reduce vapors. Cover with dry lime, dry sand, soda ash, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep allyl trichlorosilane out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters)	100/30
Then: Protect persons downwind (miles/kilometers)	
Day	0.1/0.2
Night	0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters)	200/60
Then: Protect persons downwind (miles/kilometers)	
Day	0.4/0.6
Night	1.2/1.9

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a highly flammable liquid. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Do Not Use Water. Use dry chemical, CO_2, or foam extinguishers. Use low or medium expansion AFFF foam or dry chemical if available in sufficient amounts (FEMA). Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Allyl Trichlorosilane*. Trenton, NJ

Aluminum alkyl halides A:0640

Molecular Formula: $C_4H_{10}AlBr$ (Diethylaluminum bromide); $C_4H_{10}AlCl$ (Diethylaluminum chloride); $C_2H_5AlI_2$ (Ethylaluminum diiodide); $C_2H_5AlCl_2$ (Ethylaluminum dichloride); $C_6H_{15}Al_2Cl_3$ (Ethylaluminum sesquichloride); $C_3H_9Al_2Cl_3$ (Methylaluminum sesquichloride); $C_3H_9AlBr_3$ methylaluminum sesquibromide

Catalyst for polymerization of olefins and hydrogenation of aromatics, chemical intermediate.

Synonyms: *diethylaluminum chloride:* Chlorodiethylaluminum; Diethylaluminum monochloride; Diethylchloroaluminum. *ethylaluminum dichloride:* Aluminum, dichloroethyl-; Dichloroethylaluminum; Dichloromonoethylaluminum; Ethyldichloroaluminum. *ethylaluminum sesquichloride:* Riethyldialuminum trichloride; Sesquicloruro de etilalumino (Spanish); Sesquiethylaluminum chloride; Trichlorotriethyl-dialuminium; Trichlorotriethyldialuminum; Triethylaluminum sesquichloride; Triethyltrichlorodialuminum trichlorotrimethyldi-; Methyl aluminium sesquichloride; Trichlorotrimethyldialuminum. *methylaluminum sesquichloride:* Sesquicloruro de metilalumino (Spanish). *methylaluminum sesquibromide:* Sesquibromuro de metilalumino (Spanish)

CAS Registry Number: 96-10-6 (diethylaluminum chloride); 760-19-0 (diethylaluminum bromide); (ethylaluminum dichloride); 2938-73-0 (ethylalumium diiodide); 12075-68-2 (ethylaluminum sesquichloride)

methylaluminum sesquichloride: 563-43-9; 12542-85-7

RTECS® Number: BD0558000 (diethylaluminum chloride); BD0705000 (ethylaluminum dichloride); BD1950000 (ethylaluminum sesquichloride); BD1970000 (methylaluminum sesquichloride)

UN/NA & ERG Number: UN3052/135

EC Number: 212-075-9 (CAS: 760-19-0); 202-477-2 (CAS: 96-10-6); 209-248-6 (CAS: 563-43-9); 235-137-7 (CAS: 12075-68-2); 235-698-8 (CAS: 12542-85-7)

Regulatory Authority and Advisory Bodies

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List 1% as aluminum alkyl compounds.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*96-10-6; 760-19-0*).

Description: The aluminum alkyl halides are flammable, reactive, and may be spontaneously combustible in air. They are colorless to yellow liquids.

ethyl aluminum sesquichloride: Molecular weight = 247.49; Boiling point = 114.5−116.5°C; Flash point = −20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 3₩; violent reaction with water.

methylaluminum sesquichloride: Boiling point = 120−140°C; Flash point = −17°C.

methylaluminum sesquibromide: Freezing/melting point = −3.8°C; Boiling point = (about) 165°C.

ethylaluminum dichloride: Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3.

Potential Exposure: These materials are used as components of olefin polymerization catalysts. The reader is referred to the entry on "Aluminum alkyls" for additional information on this entry. The aluminum alkyl halides parallel very closely the aluminum alkyls.

Incompatibilities: These chemicals react violently with nitromethane. Ethylaluminum sesquichloride reacts explosively with carbon tetrachloride at room temperature. This chemical reacts violently with water, forming corrosive hydrogen chloride and flammable ethane gas. Diethylaluminum chloride may form an explosive product with chlorine azide.

Permissible Exposure Limits in Air

As aluminum alkyls

OSHA PEL: None.

NIOSH REL: 2 mg/m³ TWA.

563-43-9

Protective Action Criteria (PAC)

TEEL-0: 9.41 ppm

PAC-1: 10 ppm

PAC-2: 10 ppm

PAC-3: 10 ppm

Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Lung function tests.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials.

Shipping: These chemicals require a shipping label of "SPONTANEOUSLY COMBUSTIBLE MATERIAL." They fall in DOT/UN Hazard Class 4.2, Packing Group I.[19, 20]

Spill Handling: Ethyl aluminum sesquichloride is flammable, reactive, and a dangerous fire and explosion hazard. Ethyl aluminum sesquichloride is spontaneously combustible in air and reacts violently with water. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate area of spill or leak. These chemicals ignite spontaneously in air. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Do not use water or wet method*. It may be necessary to contain and dispose of this chemical as a hazardous waste. Ventilate area of spill or leak. Keep ethyl aluminum sesquichloride out of confined spaces, such as sewers, because of the possibility of an explosion. *Do not* wash into sewer. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Aluminum alkyl halides

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.8/1.3

References

New Jersey Department of Health and Senior Services. (August 2009). *Hazardous Substances Fact Sheet: Ethyl Aluminum Sesquichloride*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Diethyl Aluminum Chloride*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Ethyl Aluminum Dichloride*. Trenton, NJ

Aluminum alkyls A:0650

Molecular Formula: C_3H_9Al (trimethyl-); $C_6H_{15}Al$ (triethyl-); $C_9H_{21}Al$ (tripropyl-); $C_{12}H_{27}Al$ (triisobutyl)

Synonyms: Trialkylaluminum (general)

tributyl-isomer: Aluminum, Tributyl-; TNBA; Tributylalane; tri-*n*-Butyl aluminum

triethyl-isomer: Aluminum, triethyl-; TEA; Triethylalane

triisobutyl-isomer: Aluminum, triisobutyl-; Aluminum, tris (2-methylpropyl); Triisobutylalane; Tris(2-methylpropyl) aluminum

trimethyl-isomer: Trimethylalane

tripropyl-isomer: Aluminum, tripropyl-; Tripropylalane

CAS Registry Number: 75-24-1 (trimethyl-); 97-93-8 (triethyl-); 102-67-0 (tripropyl-); 1116-70-7 (tributyl-); *(alt.)* 100-99-2; 130565-62-7 (triisobutyl-)

RTECS® Number: BD2204000 (trimethyl-); BD2050000 (triethyl-); BD2208000 (tripropyl-); BD1820000 (tributyl-); BD2203500 (triisobutyl-)

UN/NA & ERG Number: UN3051/135

EC Number: 200-853-0 (CAS: 75-24-1); 202-619-3 (CAS: 97-93-8); 203-045-6 (CAS: 102-67-0); 214-240-0 (CAS: 1116-70-7); 202-906-3 (CAS: 100-99-2)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: The aluminum alkyls are highly flammable and reactive, colorless to yellow liquids at room temperature. The lighter trialkylaluminums ignite spontaneously in air. They are normally supplied and used in a 20% solution with a hydrocarbon solvent, such as hexane, heptane, benzene, toluene. Properties may depend on solvent. Reacts violently with water. Molecular weight = 198.33 (triisobutyl-); Boiling point = 86°C (triisobutyl-); 185°C (triethyl-); Freezing/Melting point = 4−6°C (triisobutyl); −46°C (triethyl); Flash point = ignites spontaneously in air. Hazard

Identification (triethyl-, triisobutyl-): Health 3, Flammability 4, Reactivity 3₩ (water reactive; violent).

Potential Exposure: Alkyl aluminum compounds are used as components of olefin polymerization catalysts. They are also used in the synthesis of higher primary alcohols and in pyrophoric fuels, as a catalyst in making ethylene gas, and in plating aluminum.

Incompatibilities: The lighter trialkylaluminums ignite spontaneously in air. These compounds are strong reducing agents. Violent reaction with oxidizers, water. Incompatible with water, oxygen (air), acids, alcohols, phenols, amines, carbon dioxide, sulfur oxides, halogenated compounds, and many other substances.

Permissible Exposure Limits in Air

As aluminum alkyls

OSHA PEL: None.

NIOSH REL: 2 mg/m^3 TWA.

Protective Action Criteria (PAC)

75-24-1

TEEL-0: 5.34 mg/m^3

PAC-1: 16 mg/m^3

PAC-2: 26.7 mg/m^3

PAC-3: 125 mg/m^3

97-93-8

TEEL-0: 8.46 mg/m^3

PAC-1: 8.46 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set. These compounds react violently with water.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Can cause severe eye and skin irritation and burns. Inhaling vapors or fumes can irritate the respiratory tract, causing coughing, wheezing, and/or shortness of breath. They can cause "metal fume fever" with symptoms of headache, nausea, vomiting, chills, cough, and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure. See also NIOSH #8310, Metals in Urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Exposure to large quantities, as in plant transfers, require full body aluminized proximity suit. Gloves, used in plant transfers or operations should be aluminized leather, preformed Neoprene™, aluminized vinyl, or other fire-resistant, nonreactive material. Preformed rubber gloves may be used in the laboratory. All gloves used when handling aluminum alkyls should be loose-fitting for instant removal if necessary. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL: 2 mg/m^3* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Protect against physical damage. Outside or detached storage is preferable. Before entering confined space where aluminum alkyls may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. All transfer lines must be free of water, oxygen, and other substances that react with aluminum alkyls. All vessels must be dry and oxygen free. Transfer lines should be blanked when not in use. Vessels should be top unloading when feasible with remote manual pressure relief. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Shipped in containers containing a blanket of nitrogen gas. Aluminum alkyls require a shipping label of "SPONTANEOUSLY COMBUSTIBLE MATERIAL." The Hazard Class is 4.2 and the Packing Group is I.[19, 20] Also, this material is dangerous when wet.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. These chemicals ignite spontaneously in air. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Stop flow of liquid, if possible, before extinguishing fire. These chemicals may ignite spontaneously in air and are flammable liquids. Poisonous and flammable gases, including aluminum oxides and ethylene, are produced in fire. *Do not use water, foam*, or a *halogenated* extinguishing agent. Use dry chemical, graphite powder, soda ash, or lime extinguishers. On solvent-based material use carbon dioxide or dry chemical. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, carefully use water spray to cool fire-exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Careful incineration.

References

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Triethyl Aluminum*, Trenton, NJ. There are very similar fact sheets from the same source on: Trimethyl Aluminum (May 2000), Tripropyl Aluminum (May 2000), Tributyl Aluminum (November 2000), Triisobutyl Aluminum (April 2000)

Aluminum & Aluminum oxide A:0660

Molecular Formula: Al

Synonyms: *aluminum:* A 00; A 95; A 99; A 995; A 999; AA 1099; AA 1199; AD 1; AD1M; ADO; AE; Alaun (German); Allbri aluminum paste and powder; Alumina fibre; Aluminio (Spanish); Aluminium; Aluminium flake; Aluminum 27; Aluminum dehydrated; Aluminum, metallic powder; Aluminum powder; AO A1; AR2; AV00; AV000; C.I. 77000; Emanay atomized aluminum powder; JISC 3108; JISC 3110; L16; Metana; Metana aluminum paste; Noral aluminum; Noral extra fine lining grade; Noral non-leafing grade; PAP-1

aluminum oxide: A-1 (sorbent); A-2; Alcan AA-100; Alcan C-70; Alcan C-71; Alcan C-72; Alcan C-73; Alcoa F1; Alexite; Almite; Alon; Alon C; Aloxite; Alufrit; α-Alumina; β-Alumina; γ-Alumina; Alumina; Aluminite 37; α-Aluminum oxide; β-Aluminum oxide; γ-Aluminum oxide; Aluminum oxide (2:3); Aluminum oxide C; Aluminum sesquioxide; Aluminum trioxide; Alumite; Alundum; Alundum 600; Backlap slurry; Bauxite; Bayerite; Boehmite; Brasivol; Brockmann, aluminum oxide; C-1; Cab-O-Grip; Catapal S; Compalox; Conopal; Corundum; D 201; Dialuminum trioxide; Diaspore dirubin; Dispal; Dispal alumina; Dispal M; Dotment 324; Dotment 358; Dural; Dycron; Exolon XW 60; F 360 (Alumina); Faserton; Fasertonerde; Fast cure 45 epoxy; Flame guard; G2 (Oxide); Gibbsite; GK (Oxide); GO (Oxide); Hypalox II; Itaclor; Jubenon R; KA 101; Ketjen B; KHP 2; LA 6; Lucalox; Ludox Cl; Maftecmartipol; Martisorb; Martoxin; Microgrit WCA; Micropolish alumina; Oxido aluminico (Spanish); PS-1; PS-1 (alumina); Purdox; Q-Loid A 30; RC 172DBM; Realox

CAS Registry Number: 7429-90-5 (aluminum powder); 1344-28-1 (aluminum oxide); 1333-84-2 (aluminum oxide hydrate); 1302-74-5 (emery/corundum, natural form of aluminum oxide)

RTECS® Number: BD0330000 (aluminum metal powder); BD1200000 (aluminum oxide)

UN/NA & ERG Number: UN1309 (Aluminum powder, coated)/170; UN1396 (Aluminum powder, uncoated); UN1383 [Pyrophoric metals (of Al)]/138

EC Number: 231-072-3 [*Annex I Index No.:* 013-001-00-6] (powder); 215-691-6 (aluminum oxide)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 100 (*powder*).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as aluminum, elemental, *alpha*-alumina, or aluminum oxide.

Clean Water Act: Section 313 (57FR41331) Water Priority Chemicals (Al, dust, or fume).

US EPA Hazardous Waste Number (RCRA No.): D003.

Safe Drinking Water Act: 47FR9352, regulated contaminants; 53FR1896, list of contaminants, 55FR1470, Priority List; 40 CFR143.3, SMLC, 0.05−0.2 mg/L.

SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0% (Al, dust, and fume); 0.1% (Aluminum oxide, fibrous form only).

European/International Regulations: Hazard Symbol: F; Risk phrases: R15; R17; Safety phrases: S2; S7/8; S43 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Aluminum is a combustible, light, silvery-white, soft, ductile, malleable, amphoteric metal. Molecular weight = 26.96 (aluminum); 101.96 [aluminum oxide (Al_2O_3)] and (corundum); Boiling point = 2470°C; Freezing/Melting point = 660°C; Autoignition temperature = 590°C. Ignition temperature of dust cloud = 650°C; Minimum Explosive concentration = 0.045 oz/ft^3.[USBM] Hazard Identification (*dust*): Health 0, Flammability 3, Reactivity 1. Insoluble in water. Relative explosion hazard of dust: Severe.

The primary sources are the ores cryolite, gibbsite, and bauxite, found as boehmite; aluminum is never found in the elemental state. Aluminum oxide is a noncombustible, white, crystalline powder or granules. Molecular weight = 101.96; Boiling point = about 3000°C; Freezing/Melting point = 2050°C. Insoluble in water.

Pyrophoric aluminums include aluminum powder, trimethyl aluminum (75-24-1), tripropyl aluminum (102-67-0).

Potential Exposure: Compound Description (aluminum): Reproductive Effector; Human Data; Hormone, (aluminum oxide) Tumorigen, Natural Product. Most hazardous exposures to aluminum occur in smelting and refining processes. Aluminum is mostly produced by electrolysis of Al_2O_3 dissolved in molten cryolite (Na_3AlF_6). Aluminum is alloyed with copper, zinc, silicon, magnesium, manganese, and nickel; special additives may include chromium, lead, bismuth, titanium, zirconium, and vanadium. Aluminum and its alloys can be extruded or processed in rolling mills, wire works, forges, or foundries; and are used in the shipbuilding, electrical, building, aircraft, automobile, light engineering, and jewelry industries. Aluminum foil is widely used in packaging. Powdered aluminum is used in the paints and pyrotechnic industries. Alumina, emery, and corundum have been used for abrasives, refractories, and catalysts; and in the past in the first firing of china and pottery.

Incompatibilities: Aluminum powder forms an explosive mixture with air and is a strong reducing agent that reacts violently with oxidizers, strong bases, strong acids, some halogenated hydrocarbons, nitrates, sulfates, metal oxides, and many other substances. Keep away from combustible materials.

Permissible Exposure Limits in Air

As aluminum metal and insoluble compounds

OSHA PEL: 15 mg[Al]/m^3, total dust; 5 mg[Al]/m^3, respirable fraction TWA.

NIOSH REL: 10 mg[Al]/m^3, total dust; 5 mg[Al]/m^3, respirable fraction TWA.

ACGIH TLV®[1]: 1 mg[Al]/m respirable fraction TWA.

Protective Action Criteria (PAC)

Aluminum

TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 60 mg/m^3

Aluminum oxide & aluminum oxide hydrate

TEEL-0: 1 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 25 mg/m^3

DFG MAK: 4 mg[Al]/m^3, total dust; 1.5 mg[Al]/m^3, respirable fraction; Pregnancy risk Group D.

Australia: TWA 10 mg/m^3, 1993; Australia: TWA 2 mg/m^3 (salts), 1993; Australia: TWA 5 mg/m^3 (fumes); TWA 5 mg/m^3 (resp. dust); MAK 6 mg/m^3, dust, 1999; Belgium: TWA 10 mg/m^3; TWA 2 mg/m^3 (salts); TWA 5 mg/m^3 (fumes), 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Denmark: TWA 10 mg/m^3, dust or fume, 1999; Finland: TWA 2 mg/m^3 (salts), 1993; France: VME 10 mg/m^3; VME 5 mg/m^3 (fumes); VME 5 mg/m^3 (resp. dust), 1993; Hungary: STEL 5 mg/m^3; TWA 2 mg/m^3; STEL 4 mg/m^3 (salts), 1993; Norway: TWA 5 mg/m^3, 1999; Russia: STEL 2 mg/m^3, 1993; Sweden: NGV 4 mg/m^3 (resp. dust); NGV 10 mg/m^3 (total dust), 1999; Switzerland: MAK-W 6 mg/m^3, 1999; United Kingdom: TWA 4 mg/m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3 (welding fumes-total particulates). Several states have set guidelines or standards for aluminum in ambient air[60]: 10 mg/m^3, total dust; 5 mg/m^3, respirable fraction (California), 3 mg/m^3 (Virginia), 4 mg/m^3 (Connecticut), 10 mg/m^3 (North Dakota), 23.8 mg/m^3 (Nevada), 10 mg/m^3.

Aluminum oxide

ACGIH 10 mg/m^3; Not suspected as a human carcinogen (for total dust containing no asbestos and less than 1% crystalline silica).

DFG MAK: 1.5 mg[Al]/m^3 [(fume) respirable fraction (previously "fine dust")] 4 mg[Al]/m^3 [(fume) inhalable fraction (previously "total dust")] Pregnancy Risk Group D; BAT: 200 μg[Al]/L in urine, end-of-shift.

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 5 mg/m^3, dust, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 10 mg[Al]/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 16 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Sweden: TWA 4 mg[Al]/m^3 (respirable dust); TWA 10 mg[Al]/m^3 (total dust), 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 10 mg/m^3, total inhalable dust; TWA 4 mg/m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: For alumina dusts use NIOSH Analytical Method #0500, total dusts, #0600, OSHA Analytical Method ID-109SG, ID-198SG. For aluminum, metal, powder, coated, and uncoated use NIOSH Analytical Method #7013, #7300, #7301, #7303, OSHA Analytical Method #ID-121. For aluminum, pyrophoric powders and welding fumes use NIOSH Analytical Method #7300, #7301, and #7303. For aluminum, soluble salts and alkyls use NIOSH Analytical Method #7013, #7300, #7301, #7303, OSHA Analytical Method #ID-12.

Permissible Concentration in Water: Under the Safe Drinking Water Act, secondary MCLs = 0.05–0.2 mg/L. Mexican drinking water criteria is 0.02 mg/L. In addition, guidelines for aluminum in drinking water have been set[61] ranging from 1430 μg/L (Maine) to 5000 μg/L (Kansas).

Routes of Entry: Inhalation, eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Aluminum dust can cause irritation, and particles can scratch the eyes. Aluminum oxide can irritate the eyes, nose, and respiratory tract. Particles of aluminum deposited in the eye may cause necrosis of the cornea. Salts of aluminum may cause dermatoses, eczema, conjunctivitis, and irritation of the mucous membranes of the upper respiratory system by the acid liberated by hydrolysis. The effects on the human body caused by inhalation of aluminum dust and fumes are not known with certainty at this time. Present data suggest that pneumoconiosis might be a possible outcome. In the majority of causes investigated, however, it was found that exposure was not only due to aluminum dust but also due to a mixture of aluminum, silica fume, iron dusts, and other materials.

Long Term Exposure: There is evidence of an increase in bladder, lung, and other cancers among aluminum smelter workers. The increase appears to be due to polycyclic aromatic compound (PAC) exposure, not to aluminum compounds. Aluminum salts are toxic to the animal fetus and cause fetal damage. Exposure to fine dust from aluminum or aluminum oxide can cause lung damage, pneumonia, and pulmonary fibrosis, with symptoms of coughing, wheezing, and shortness of breath. Very high levels of aluminum may cause brain damage.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Preemployment and periodic physical examinations should give special consideration to the skin, eyes, and lungs. Lung function should be followed, including chest X-ray, pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Actual working conditions will determine the need and type of personal protective equipment. Determine CPC based on working conditions. Dust masks are recommended in areas exceeding the nuisance levels. Aluminum workers generally should receive training in the proper use of personal protective equipment. Workers involved with salts of aluminum may require protective clothing, barrier creams, and where heavy concentrations exist, full face air supplied respirators may be indicated. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

Storage: Prior to working with this chemical you should be trained on its proper handling and storage. Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Keep aluminum powder dry and isolate from acids, caustics, chlorinated hydrocarbons, oxidizers, and combustible materials. Store both metal and oxide in tightly closed containers in a cool, well-ventilated area, protected from physical damage.

Shipping: Aluminum powder, uncoated, requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.4 and Packing Groups II. Aluminum powder, coated, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group II or III. For pyrophoric metals the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall into Hazard Class 4.2 and Packing Group I.

Spill Handling: For aluminum metal spills, special care must be taken with aluminum powder which may be very reactive. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not use water to clean up spilled aluminum powder. Do not raise dust level by sweeping. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. May be disposed of as an inert solid in a landfill.

Fire Extinguishing: With aluminum metal, do not use water or halogenated agents. Aluminum powder is a combustible solid. Aluminum oxide is not flammable. Use dry chemical, carbon dioxide, foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal of Aluminum Oxide-Disposal in a sanitary landfill. Mixing of industrial process wastes and municipal wastes at such sites is not encouraged however. Aluminum powder may be recovered and sold as scrap. Recycling and recovery is a viable option to disposal for aluminum metal and aluminum fluoride (A-57).

References

US Environmental Protection Agency. (September 1976). *Chemical Hazard Information Profile: Aluminum and Aluminum Compounds*. Washington, DC

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Aluminum and Its Compounds*, Report PB 274-073. Washington, DC, pp. 80−84

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Aluminum*, Report EPA 600/1-77-022. Research Triangle Park, NC, pp. 4−14

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 34 (Aluminum)

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 33−34 (Aluminum Oxide and Aluminum Silicate)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Aluminum Oxide*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Aluminum Oxide*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Aluminum*. Trenton, NJ

Aluminum chloride A:0670

Molecular Formula: $AlCl_3$

Synonyms: Aluminum chlorid (German); Aluminum chloride (1:3); Aluminum chloride, anhydrous; Aluminum chloride solution; Aluminum trichloride; Anhydrol forte; Anhydrous aluminum chloride; Chlorure d'aluminum (French); Clorato aluminico (Spanish); Driclor; PAC; PAC (Van); Pearsall; Praestol K2001; Trichloro aluminum

CAS Registry Number: 7446-70-0

RTECS® Number: BD0525000

UN/NA & ERG Number: UN1726 (anhydrous)/137; UN2581 (solution)/154

EC Number: 013-003-00-7

EC Number: 231-208-1 [*Annex I Index No.:* 013-003-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade) (*anhydrous*).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US EPA Gene-Tox Program, Positive: *In vivo* cytogenetics—nonhuman bone marrow.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S7/8; S28; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Aluminum chloride is a noncombustible but highly reactive whitish-gray, yellow, or green powder or liquid. Strong, acidic, irritating odor like hydrochloric acid. Sinks in water and reacts forming toxic and corrosive hydrogen chloride gas. Odor threshold = 6.31 ppm (as hydrogen chloride). Molecular weight = 133.34; Relative density = 2.5; Vapor pressure = 3×10^{-3} mmHg; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩ (water reactive).

Potential Exposure: Compound Description: Drug, Organometallic, Mutagen; Reproductive Effector; Hormone, Primary Irritant. It is used as ethylbenzene catalyst, dyestuff intermediate, and detergent alkylate; in making other chemicals and dyes, astringents, deodorants, in the petroleum refining, and the rubber industries.

Incompatibilities: Contact with air or water forms hydrochloric acid and hydrogen chloride gas. Reaction with water may be violent. Water, alcohol, and alkenes can cause polymerization. Incompatible with nitrobenzene, organic material, and bases. Attacks metal in the presence of moisture, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

As aluminum, soluble salts

OSHA PEL: None.

NIOSH REL: 2 mg[Al]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 9.88 mg/m^3

PAC-1: 9.88 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg[Al]/m^3.

Permissible Concentration in Water: An ambient water limit of 73 μg/L for aluminum compounds has been suggested by EPA[32] based on health effects.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to eyes, skin, and respiratory tract. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Ingestion can cause severe burns of mouth, throat, and stomach, vomiting, watery or bloody diarrhea, kidney damage, jaundice and liver damage, collapse and convulsions. Estimated lethal dose is about 8 oz for an average 150-lb adult.

Long Term Exposure: May cause pulmonary fibrosis and reduced lung function with symptoms of coughing, wheezing, and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid or solid, wear indirect vent, splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: If dust levels are high, wear a dust mask. If hydrogen chloride is present, use: *Up to 50 ppm:* CcrS* (APF = 10) (any NIOSH/MSHA- or European Standard EN 149-approved chemical cartridge respirator with cartridge(s) providing protection against the compound of concern) or GmFS (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern] or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard. Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry area in tightly closed container away from moisture, heat, and sunlight.

Shipping: Both anhydrous and solution require a shipping label of "CORROSIVE." The anhydrous form falls in Packing Group II, and the solution in Packing Group III. Both anhydrous and solution fall in DOT/UN Hazard Class 8.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Sweep carefully, being careful not to raise dust. Do not get water inside containers;

keep combustibles away. For liquid aluminum chloride, absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Do not use water or water-based foams; will form poisonous fumes of hydrochloric acid. On solid material use any extinguishing medium suitable for surrounding fire. On solution, use dry chemical, carbon dioxide, or polymer foam extinguishers. Poisonous gases are produced in fire, including hydrochloric acid, aluminum oxide, and nitrogen oxides. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be sprayed with aqueous ammonia in the presence of ice and, when reaction is complete, flushed down drain with running water.[22]

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Aluminum Chloride*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Aluminum Chloride.* Trenton, NJ

Aluminum fluoride A:0680

Molecular Formula: AlF_3

Synonyms: Aluminum fluoride, anhydrous; Aluminum fluorure (French); Aluminum trifluoride; Fluoruro aluminico hidratado (Spanish)

CAS Registry Number: 7784-18-1

RTECS® Number: BD0725000

UN/NA & ERG Number: UN3077/171

EC Number: 232-051-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as aluminum, water soluble salts.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Aluminum fluoride is a white, odorless powder or granule. Molecular weight = 83.98; Specific gravity = 2.88 at 25°C; Freezing/Melting point = 1291°C. Boiling point = 1537°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Used as component of electrolyte from which aluminum metal is produced; in the manufacture of ceramics, enamels, aluminum silicate; as flux in metallurgy; as a fermentation inhibitor.

Incompatibilities: Reacts violently with potassium or sodium.

Permissible Exposure Limits in Air

As aluminum soluble salts

OSHA PEL: None.

NIOSH REL: 2 mg/m^3 aluminum, soluble salts.

ACGIH TLV®[1]: 1 mg[Al]/m respirable fraction.

As fluorides

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 6.23 mg/m^3

PAC-1: 6.23 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction; [skin]; Peak Limitation Category I(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

European OEL: 2.5 mg[F]/m^3 (2004).

NIOSH IDLH: 250 mg[F]/m^3.

As aluminum, soluble salts

OSHA PEL: None.

NIOSH REL: 2 mg[Al]/m^3 TWA.

Permissible Concentration in Water: Fluoride is a safe drinking water act regulated chemical (47FR9352, 56FR 3594); MCL = 4.0 mg/L; MCLG = 4.0 mg/L; SMCL = 2.0 mg/L. The state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, cutaneous absorption.

Harmful Effects and Symptoms

Short Term Exposure: This chemical irritates eyes, skin, and respiratory tract. Skin and eye contact can cause severe burns. Inhalation can cause nose and throat irritation, with possible nose bleeding.

Long Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath, phlegm. This chemical may cause asthma-like allergy, and may lead to dense but brittle bones. It may also lead to stiffening of the joints.

Points of Attack: Lungs, bones, joints.

Medical Surveillance: NIOSH lists the following tests for fluorides, inorganic: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and post-shift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3*: Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) * *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sodium, potassium, and glass.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.

Spill Handling: Avoid contact with dust. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aluminum fluoride is not combustible. Poisonous gases, including fluorines, are produced in fire. Do not use water as flammable hydrogen gas if formed. Use any extinguishing agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Neutralize with soda ash; add slaked lime; let stand for 24 h. Transfer sludge to sewage facility.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Aluminum Hydride*. Trenton, NJ

Aluminum nitrate A:0690

Molecular Formula: $AlH_{18}N_3O_{18}$

Common Formula: $AlN_3O_9 \cdot 9H_2O$

Synonyms: Aluminum nitrate, nonahydrate; Aluminum(III) nitrate, nonahydrate (1:3:9); Aluminum trinitrate nonahydrate; Nitrato aluminico (Spanish); Nitric acid, aluminum salt; Nitric acid, aluminum(3 +) salt; Nitric acid, aluminum(III) salt

CAS Registry Number: 13473-90-0; 7784-27-2 (nonahydrate)

RTECS® Number: BD1040000

UN/NA & ERG Number: UN1438/140

EC Number: 236-751-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Aluminum nitrate is an odorless, white crystalline solid, often in liquid solution. Molecular weight = 375.98; Boiling point = 135°C (decomposes); Freezing/Melting point = 70–74°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = about 65 g/100 mL at 25°C.

Potential Exposure: Aluminum nitrate is used in tanning leather; as an antiperspirant, as a corrosion inhibitor, in the extraction of uranium and as a nitrating agent.

Incompatibilities: Aluminum nitrate is a strong oxidizer; avoid contact with flammable or combustible materials; and reducing agents. In solution this chemical is a strong acid; avoid contact with bases. Explosions may occur when aluminum nitrate is shocked or exposed to heat.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 15.8 mg/m^3

PAC-1: 15.8 mg/m^3

PAC-2: 15.8 mg/m^3

PAC-3: 75 mg/m^3

Nonahydrate

TEEL-0: 27.8 mg/m^3

PAC-1: 27.8 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

As aluminum soluble salts

OSHA PEL: None.

NIOSH REL: 2 $mg[Al]/m^3$ TWA.

Permissible Concentration in Water: An ambient water level of 73 μg/L for aluminum compounds has been suggested by EPA[32] based on health effects.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact may cause permanent damage. High exposures can cause unconsciousness. Prolonged contact can cause skin disorders. Ingestion can cause stomach cramps, nausea, blue skin, weakness, and possible blood problems due to formation of methemoglobin. The oral LD_{50} for rats is 264 mg/kg.

Long Term Exposure: Repeated contact can cause skin problems and eczema. This chemical is a corrosive, and it may cause lung problems.

Points of Attack: Respiratory system, eyes, skin, gastric system.

Medical Surveillance: Lung function tests. A qualified allergist should be consulted if skin problems occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Aluminum nitrate poisoning requires special first aid and antidote.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin contact. Rubber or Neoprene™ gloves will offer some hand protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly capped or sealed containers in a cool, well-ventilated area away from combustible materials, heat, or flame. Protect containers from physical shock. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: The required shipping label is "OXIDIZER." It falls into DOT/UN Hazard Class 5.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Sweep into a beaker. Dilute by adding slowly to water. Add soda ash then neutralize with HCl. Flush to sewer with large volume of water.[24] Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable *per se*. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or water spray. Vapors are heavier than air and will collect in low areas. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See Spill Handling above.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Aluminum Nitrate*. Trenton, NJ

Aluminum orthophosphate A:0700

Molecular Formula: $AlPO_4$; AlO_4P

Synonyms: Aluminophosphoric acid; Aluminum acid phosphate; Aluminum monophosphate; Aluminum phosphate; Aluphos; Fosfato aluminico (Spanish); Monoaluminum phosphate; Ortofosfato de alumino (Spanish); Phosphalugel; Phosphoric acid, aluminum salt (1:1), solution

CAS Registry Number: 7784-30-7

RTECS® Number: TB6450000

UN/NA & ERG Number: UN3260 (Corrosive solid, acidic, inorganic, n.o.s.)/154

EC Number: 232-056-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada: On DSL List; no WHMIS classification.

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S/24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Aluminum orthophosphate is a white crystalline solid which is often used in liquid or gel form. Molecular weight = 121.94; Freezing/Melting point ≥1450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Used as a flux in ceramics; in dental cements; in the manufacture of special glasses, paints and varnishes, cosmetics; making pulp and paper; as an antacid.

Incompatibilities: A strong oxidizer; keep away from combustible materials. Violent reaction with reducing agents and strong bases.

Permissible Exposure Limits in Air
As aluminum soluble salts
OSHA PEL: None.
NIOSH REL: 2 mg/m^3.
ACGIH TLV®[1]: withdrawn.
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 100 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

Permissible Concentration in Water: An ambient water level of 73 μg/L for aluminum compounds has been suggested by EPA[32] based on health effects.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Aluminum phosphate can affect you when breathed in. Aluminum phosphate is a corrosive substance. It can cause severe burns of the eyes and skin on contact. Exposure to the liquid or dust can irritate the eyes, nose, throat, and bronchial tubes. Fine powder can irritate the lungs.

Long Term Exposure: Can irritate the lungs, causing bronchitis with coughing, shortness of breath, and phlegm.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 2 mg/m^3 of aluminum, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases and combustible materials, such as wood, paper, and oil.

Shipping: Aluminum phosphate is not specifically cited in DOT regulations. However, aluminum phosphate solutions are covered under "CORROSIVE SOLID, ACIDIC, INORGANIC, N.O.S. or CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S."[19] and labeled "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Restrict persons not wearing protective equipment from area of spill until cleanup is complete. Ventilate area of spill or leak. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing aluminum phosphate in vermiculite, dry sand, earth or similar material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aluminum Phosphate is nonflammable. Poisonous gases, including phosphine, are produced in fire. Use dry chemical powder extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Aluminum Phosphate*. Trenton, NJ

Aluminum phosphide A:0710

Molecular Formula: AlP
Synonyms: AIP; Al-phos; Aluminum monophosphide; Celphide; Celphos; Delicia; Fosfuro aluminico (Spanish); Phosphures d'aluminum (French); Phostoxin®; Quickphos
CAS Registry Number: 20859-73-8; *(alt.)* 1302-45-0; 71751-04-7
RTECS® Number: BD1400000
UN/NA & ERG Number: UN1397/139
EC Number: 244-088-0 [*Annex I Index No.:* 015-004-00-8]
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
US EPA, FIFRA 1998 Status of Pesticides: Supported.
Banned or Severely Restricted (Belgium).[13]
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
US EPA Hazardous Waste Number (RCRA No.): P006.[5]
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (228 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations: Hazard Symbol: F, T + , N; Risk phrases: R15/29; R28; R32; R50; Safety phrases: S1/2; S3/9/14; S30; S36/37; S43; S45; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Aluminum phosphide is a pyrophoric, dark-gray or dark-yellow crystalline solid. Molecular weight = 57.95; Freezing/Melting point ≥ 1000°C; Specific gravity: 2.85 at 25°C. Decomposes in water, forming poisonous and flammable phosphine gas. NFPA-704 Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2, Water reactive; dangerous when wet.
Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Human Data. Used as a rodenticide; wood preservative; as a source of phosphine; as an insecticidal fumigant for grain, peanuts, processed food, animal feed, leaf tobacco, cottonseed; and as space fumigant for flour mills, warehouses, and railcars. Used in semiconductor research.
Incompatibilities: Forms explosive phosphine gas on contact with moisture in air. Reacts violently with water, steam, carbon dioxide, acids, alcohols, and foam fire extinguishers. Contact with water and bases slowly releases flammable phosphine gas. Can ignite spontaneously in air.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.442 ppm
PAC-1: 0.442 ppm
PAC-2: **2.0** ppm
PAC-3: **3.6** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
As aluminum soluble salts
OSHA PEL: None.
NIOSH REL: 2 mg/m^3 aluminum, soluble salts.
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Acute toxicity occurs primarily by the inhalation route when aluminum phosphide decomposes into the toxic gas, phosphine. The human median lethal dose for aluminum phosphide has been reported to be 20 mg/kg. Rated as super toxic: probable oral lethal dose is less than 5 mg/kg or less than 7 drops for a 70-kg (150 lb) person. Symptoms of phosphine gas poisoning include restlessness, headache, dizziness, fatigue, nausea, vomiting, coma, convulsions, lowered blood pressure, pulmonary edema, respiratory failure, and disorders of the kidney, liver, heart, and brain may be observed. LD_{50} (oral, male rat) = 13.9 mg/kg.
Short Term Exposure: A severe health hazard. Irritates the eye, skin, and respiratory tract. Inhalation can cause lung irritation with coughing, wheezing, and shortness of breath. Affects metabolism and the central nervous system; exposure can lead to death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.
Long Term Exposure: May cause lung, kidney, and liver damage. May be able to cause skin rash or eczema.
Points of Attack: Central nervous system, liver, kidney, lungs.
Medical Surveillance: Lung, liver, kidney, and nervous system function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 2 mg/m^3 (aluminum), use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed, or where any potential for exposures to Phosphine gas exist, use a NIOSH/MSHA- or European Standard EN149-approved gas mask (Approval number TC-14-98) equipped with a canister offering protection against phosphine, chlorine, hydrogen sulfide, organic vapors, acid gases, and dusts and mists. If the potential for exposure to more than 15 ppm of phosphine gas exists, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. See Phosphine entry.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Prior to working with aluminum phosphide you should be trained on its proper handling and storage. Store in a noncombustible, nonsprinklered building or location, in tightly closed containers in a cool well-ventilated area away from all forms of moisture and strong acids. Aluminum phosphide decomposes in water, forming phosphine gas. Consult the entry on Phosphine for more information.

Shipping: Aluminum phosphide requires a shipping label of "DANGEROUS WHEN WET, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.3 and 6.3 (subsidiary) and Packing Group I.[19, 20]

Spill Handling: Shut off ignition; no flares, smoking, or flames in hazard area. Do not touch spilled material. Do not get water on spilled material or inside container. Dike spill for later disposal. Blanket release with dry sand, clay, or ground limestone. Shovel small spill into clean, dry container, and cover. Move containers from spill area. Avoid breathing dust. Wear appropriate protective clothing and use appropriate respiratory protection. Cover large powder spill with plastic sheet or tarp to minimize spreading. Clean up only under supervision of an expert. DOT warns that this chemical is spilled in water: Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.2/1.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2000/600
Then: Protect persons downwind (miles/kilometers)
Day 3.6/5.8
Night 7.0 + /11.0 +

Fire Extinguishing: This chemical is a combustible solid. Poisonous gases are produced in fire, including phosphorus oxides and aluminum fumes. Do not use water or water-based foam, as phosphine gas is formed. Small fires can be extinguished with dry chemical, soda ash, clay, or ground limestone, or use an approved Class D extinguisher. *Large fires:* withdraw from area and let fire burn. Move container from fire only if you can do it without risk. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Wear self-contained breathing apparatus when fighting fires involving this material. If contact with the material is anticipated, wear full protective clothing.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Allow to react slowly with moisture in the open, being sure that phosphine gas evolved is dissipated. Alternatively, mix with dry diluent and incinerate at temperature above 1000°C with effluent gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Aluminum Phosphide*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Aluminum Phosphide*. Trenton, NJ

Aluminum sulfate A:0730

Molecular Formula: $Al_2S_3O_{12}$
Common Formula: $Al_2(SO_4)_3$
Synonyms: Alum; Aluminum alum; Aluminum sulphate; Aluminum trisulfate; Cake alum; Diaaluminum trisulfate; Dialuminum sulfate; Paper maker's alum; Sulfate d'aluminium (French); Sulfato aluminico (Spanish); Sulfuric acid, aluminum salt; Sulphuric acid, aluminum salt
CAS Registry Number: 10043-01-3
RTECS® Number: BD1700000
UN/NA & ERG Number: UN3264 (solution)
EC Number: 233-135-0
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 5000 lb (2270 kg).[4]
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Aluminum sulfate is a white powder, often used in water solution. The solution is a strong acid. Molecular weight = 342.12; Freezing/Melting point = 770°C (decomposes, forming corrosive sulfur trioxide). Soluble in water.
Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Primary Irritant. Widely used in the paper industry, in waste and water treatment and treating sewage; in antiperspirants, deodorants; in flame retardants; in tanning leather, sizing paper; mordant in dyeing, purifying water, waterproofing cloth, clarifying oils and fats; in agricultural pesticides; manufacturing aluminum salts and others.
Incompatibilities: In aqueous solution, aluminum sulfate forms sulfuric acid; reacts with bases and many other substances. Corrodes metals in the presence of moisture.
Permissible Exposure Limits in Air
As aluminum soluble salts
OSHA PEL: None.
NIOSH REL: 2 mg/m^3 aluminum, soluble salts.
Protective Action Criteria (PAC)
TEEL-0: 12.7 mg/m^3
PAC-1: 12.7 mg/m^3
PAC-2: 12.7 mg/m^3
PAC-3: 150 mg/m^3
Permissible Concentration in Water: An ambient water level of 73 μg/L for aluminum compounds has been suggested by EPA[32] based on health effects.
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Aluminum sulfate powder can irritate the eyes, skin, and respiratory tract. It is capable of causing eye damage. Ingestion of large doses can cause stomach irritation, nausea, and vomiting.
Long Term Exposure: Aluminum sulfate may cause skin disorders; and may cause lung problems.
Points of Attack: Lungs, skin.
Medical Surveillance: Lung function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with solid or powder wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any concentrations above 2 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a

pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). Wear a dust mask.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Aluminum sulfate powder should be kept dry since it forms sulfuric acid when wet.

Shipping: Aluminum sulfate is not specifically cited in DOT regulations. However, aluminum sulfate solutions are covered under "CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S."[19] and labeled "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Sweep up or vacuum powdered material being careful not to raise dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Poisonous gases, including sulfur oxides, are produced in fire. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. When involved in fire, wear goggles and self-contained breathing apparatus and rubber clothing including gloves.[41]

Disposal Method Suggested: Pretreatment involves hydrolysis followed by neutralization with NaOH. The insoluble aluminum hydroxide formed is removed by filtration and can be heated to decomposition to yield alumina which has valuable industrial applications. The neutral solution of sodium sulfate can be discharged into sewers and waterways as long as its concentration is below the recommended provisional limit of 250 mg/L.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Aluminum Sulfate*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Aluminum Sulfate*. Trenton, NJ

Stauffer Chemical Co. (1974). Microfiche: OTS0571939, EPA/OTS; Doc #88-920010792(CSST), Rhône-Poulenc Inc., *Initial Submission: Toxicology Lab Report T-4874 (regarding primary dermal and eye irritation of aluminum sulfate hydrate in rabbits with cover letter dated 102392)*

Ametryn A:0740

Molecular Formula: $C_9H_{17}N_5S$

Synonyms: Ametrex; Amyphyt; Cemerim; Doruplant; EPA pesticide code 080801; 2-Ethylamino-4-isopropylamino-6-methylmercarpo-*s*-triazine; 2 Ethylamino-4-isopropylamino-6-methylthio triazine; 2-Ethylamino-4-isopropylamino-6-methylthio-1,3,5-triazine; Evik®; Gesapax®; 2-Methylmercapto-4-ethylamino-6-isopropylamino-*s*-triazine; 2-Methylmercapto-4-isopropylamino-6-ethylamino-*s*-triazine; 2-Methylthio-4-ethylamino-6-isopropylamino-*s*-triazine

CAS Registry Number: 834-12-8

RTECS® Number: XY9100000

UN/NA & ERG Number: UN2763 (triazine, pesticides, solid, toxic)/151

EC Number: 212-634-7 [*Annex I Index No.:* 613-010-00-0]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.5 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S36; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ametryn, a triazine compound, is a colorless powder; Freezing/Melting point = 84−86°C; Vapor pressure = 2.7×10^{-6} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water; solubility = 200 mg/L at 20°C.

Potential Exposure: Those involved in the manufacture, formulation, and application of this selective herbicide.
Incompatibilities: Triazines are incompatible with nitric acid.
Permissible Concentration in Water: The No-Adverse-Effect-Level (NOAEL) has been found to be 100 mg/kg/day and on that basis a 10-day health advisory of 8.6 mg/L was determined for a 10-kg child. If, however, one assumes an NOAEL of 10 mg/kg/day one arrives at a long-term health advisory of 0.86 mg/L for a 70-kg adult. The lifetime health advisory for an adult is 0.06 mg/L using a NOAEL of 10.
Determination in Water: Extraction with methylene chloride may be followed by gas chromatography using a nitrogen phosphorus detector. The detection limits are in the range of 0.1−2.0 μg/L. Fish Tox: 989.94257000 ppb MATC (VERY LOW).
Routes of Entry: Ingestion, skin.
Harmful Effects and Symptoms
Short Term Exposure: Ametryn is an eye and skin irritant. It is mildly toxic by skin contact. Poisonous if swallowed or inhaled.
Long Term Exposure: It apparently causes liver degeneration. The LD_{50} value for male Charles River rats was 1207 mg/kg and 1543 mg/kg for female rats. Human Tox: 60.00000 ppb Health Advisory (LOW).
Points of Attack: Liver.
Medical Surveillance: Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Where there is no NIOSH REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids.
Shipping: Triazine pesticides, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and in Packing Group III.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid inhalation of dust; wear respirator. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Granular activated carbon will remove ametryn from water. Soil Adsorption Index (K_{oc}) = 300.
Fire Extinguishing: Poisonous gases are produced in fire, including carbon monoxide. Wear positive-pressure self-contained breathing apparatus when fighting fires involving this herbicide. Avoid breathing dusts and fumes from burning material. Keep upwind. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Use extinguishing agents suitable for surrounding fire or dry chemical, carbon dioxide, or alcohol foam. Use water in flooding quantities as fog.
Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Ametryn*. Washington, DC: Office of Drinking Water

Greene, S. A., & Pohanish, R. P. (2005). *Sittig's Handbook of Pesticides and Agricultural Chemicals*. Norwich, NY: William Andrew. pp. 35−36.

2-Aminoanthraquinone A:0750

Molecular Formula: $C_{14}H_9NO_2$
Common Formula: $C_6H_4(CO)_2C_6H_3NH_2$
Synonyms: AAQ; 2-Amino-9,10-aminoanthraquinone; 2-Amino-9,10-anthracenedione; β-Aminoanthraquinone; Aminoantraquinona (Spanish); β-Anthraquinonylamine
CAS Registry Number: 117-79-3
RTECS® Number: CB5120000
UN/NA & ERG Number: UN3143 (dye intermediates, solid, toxic, n.o.s.)/151
EC Number: 204-208-4
Regulatory Authority and Advisory Bodies
Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; IARC: Animal Limited Evidence; Human No Adequate Data; Group 3, 1987; NTP: Reasonably anticipated to be a human carcinogen.
US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.
CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.
California Proposition 65 Chemical: Cancer 10/1/89.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: 2-Aminoanthraquinone forms red or orange-brown needle-shaped crystalline solid. Molecular weight = 223.24; Freezing/Melting point = 302−306°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Boiling point = sublimes. Insoluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen. 2-Aminoanthraquinone is used as a dye intermediate; in the industrial synthesis of anthraquinone and pharmaceuticals. It is the precursor of five dyes and one pigment, including Color Index Vat Blues 4, 6, 12, and 24; Vat Yellow 1; and Pigment Blue 22. Because AAQ is used on a commercial scale solely by the dye industry, the potential for exposure to the compound is greatest for workers at dye manufacturing facilities. However, no additional data are available on the number of facilities using AAQ. The Consumer Product Safety Commission staff believes that trace amounts of unreacted AAQ may possibly be present in some dyes based on this chemical and in the final consumer product. Exposure even to trace amounts may be a cause for concern. This concern is based on experience with other dyes derived from aromatic amines.
Incompatibilities: Strong oxidizing and/or reducing agents.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 7.5 mg/m^3
PAC-1: 25 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 500 mg/m^3
Determination in Air: NIOSH Analytical Method #5013, Dyes.
Routes of Entry: Inhalation and skin contact.
Harmful Effects and Symptoms
Technical grade 2-aminoanthraquinone (impurities unspecified), administered in the feed, was carcinogenic in male Fisher "344" rats, causing a combination of hepatocellular carcinomas and neoplastic nodules of the liver. The compound was also carcinogenic in B6C3F1 mice, causing hepatocellular carcinomas in both sexes and malignant hematopoietic lymphomas in females. An IARC: working group considered that the evidence for the carcinogenicity in experimental animals of the material tested was limited. In view of another evaluation of NCl bioassay results, the evidence can be considered as sufficient.
Short Term Exposure: Irritates eyes and skin.
Long Term Exposure: A confirmed carcinogen in animals; causes liver and lymph system cancer. May cause mutations.
Medical Surveillance: This chemical may cause cancer. There are no specific tests. However, if illness occurs or overexposure is suspected, medical attention is recommended.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or

European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area away from strong oxidizers.

Shipping: Dye intermediates, solid, toxic, n.o.s. must be labeled “POISONOUS/TOXIC MATERIALS.” They fall into Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in vapor-tight, sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report* 4, No. 6, 66−70

New Jersey Department of Health and Senior Services. (January 2004). *Hazardous Substances Fact Sheet: 2-Aminoanthroquinone*. Trenton, NJ

Aminoazobenzene A:0760

Molecular Formula: $C_{12}H_{11}N_3$

Common Formula: $C_6H_5N{=}NC_6H_4NH_2$

Synonyms: AAB; *p*-Aminoazobenzene; 4-Amino-1,1′-azobenzene; 4-Aminoazobenzene; Aminoazobenzene; *p*-Aminoazobenzol; 4-Aminoazobenzol; *p*-Aminodiphenylimide; Aniline yellow; 4-Benzeneazoaniline; Brasilazina oil yellow G; Ceres yellow R; C.I. Solvent blue 7; C.I. Solvent yellow 1; Fast spirit yellow AAB; Oil soluble aniline yellow; Oil yellow AAB; Organol yellow; Paraphenolazoaniline; *p*-Phenolazoaniline; *p*-(Phenylazo)aniline; 4-(Phenylazo)aniline; 4-(Phenylazo)benzenamine’ *p*-phenylazophenylamine; Solvent yellow 1; Sudan yellow R

CAS Registry Number: 60-09-3

RTECS® Number: BY8225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (dyes, solid, toxic, n.o.s. or dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 200-453-6 [*Annex I Index No.:* 611-008-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Possibly carcinogenic to humans, Group 2B.

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 4-Aminoazobenzene forms yellow to tan crystals or orange needles. Molecular weight = 197.24; Freezing/Melting point = 126−128°C. Boiling point ≥ 360°C. Hazard Identification (based on NFPA-704 M Rating System) (in hydrocarbon solvent): Health 3, Flammability 2, Reactivity 1; (*dry*) Health 3, Flammability 0, Reactivity 0 [asu]. Slightly soluble in water.

Potential Exposure: Used in the form of salts in dyeing; used as intermediate in manufacture of acid yellow and diazo dyes; in insecticides, waxes, lacquers, varnishes, stains, styrene resins.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 75 mg/m^3

Harmful Effects and Symptoms

Carcinogenicity: as noted above.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This chemical is a solid, toxic, organic, n.o.s. should be labeled “POISONOUS/TOXIC MATERIALS.” This material falls in DOT/UN Hazard Class 6.1 and Packing Group I.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report* 1, No. 3, 27−28

Aminoazotoluene A:0770

Molecular Formula: $C_{14}H_{15}N_3$

Common Formula: $CH_3C_6H_4N{=}NC_6H_3(NH_2)CH_3$

Synonyms: *o*-AAT; *o*-Amidoazotoluol (German); Aminoazotoluene (Indicator); *o*-Aminoazotoluene; 4′-Amino-2,3′-azotoluene; 4′-Amino-2:3′-azotoluene; *o*-Aminoazotolueno (Spanish); *o*-Aminoazotoluol; 4-Amino-2′,3-dimethylazobenzene; 4′-Amino-2,3′-dimethylazobenzene; *o*-AT; Brasilazina oil yellow R; Butter yellow; C.I. 11160; C.I. 11160B; C.I. Solvent yellow 3; 2′,3-Dimethyl-4-Aminoazobenzene; Fast garnet GBC Base; Fast oil yellow; Fast yellow AT; Fast yellow B; Hidaco oil yellow; 2-Methyl-4-[(2-Methylphenyl)Azo] Benzenamine; OAAT; Oil yellow; Oil yellow 21; Oil yellow 2681; Oil yellow A; Oil yellow AT; Oil yellow C; Oil yellow I; Oil yellow 2R; Oil yellow T; Organol yellow 25; Somalia Yellow R; Sudan yellow RRA; *o*-Tolueneazo-*o*-toluidine; *o*-Toluol-Azo-*o*-toluidin (German); 5-(*o*-Tolylazo)-2-aminotoluene; 4-(*o*-Tolylazo)-*o*-toluidine; Tulabase fast garnet GB; Tulabase fast garnet GBC; Waxakol yellow NL

CAS Registry Number: 97-56-3

RTECS® Number: XU8800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-591-2 [*Annex I Index No.:* 611-006-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI:

IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1998; NTP: Reasonably anticipated to be a human carcinogen.

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1.

California Proposition 65 Chemical: Cancer 7/1/87.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R43; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Aminoazotoluene forms golden yellow or reddish-brown crystalline solid. Molecular weight = 225.31; Freezing/Melting point = 101.7°C; Vapor Pressure = 7.5×10^{-7} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 7.64 mg/L at 25°C.

Potential Exposure: Used in dyes, medicines; as a colorant in shoe polishes and other wax-based polishes.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category: 2; Germ Cell Mutagen Group 3B (2006).

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.89 (estimate).

Harmful Effects and Symptoms

Stated to be moderately toxic by several routes.[44]

Long Term Exposure: A known animal carcinogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This chemical is a solid, toxic, organic, n.o.s. should be labeled "POISONOUS/TOXIC MATERIALS." This class of materials falls in DOT/UN Hazard Class 6.1 and Packing Group I.[19, 20]

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report* 6, No. 4, 54−63

4-Aminobiphenyl A:0780

Molecular Formula: $C_{12}H_{11}N$

Common Formula: $C_6H_5C_6H_4NH_2$

Synonyms: *p*-Aminobifenilo (Spanish); 4-Aminobifenilo (Spanish); *p*-Aminobiphenyl; 4-Aminobiphenyl; 4-Aminodifenil (Spanish); *p*-Aminodiphenyl; 4-Aminodiphenyl; (1,1′-Biphenyl)-4-amine; *p*-Biphenylamine;

4-Biphenylamine; Biphenyline; *p*-Phenylaniline; 4-Phenylaniline; *p*-Xenylamine; Xenylamine

CAS Registry Number: 92-67-1

RTECS® Number: DU8925000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 202-177-1 [*Annex I Index No.*: 612-072-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC[9]: Animal Sufficient Evidence, Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987; OSHA: Carcinogen (29CFRn1910.1003).

US EPA Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity—mouse/rat; Positive: SHE—clonal assay; Cell transform.—mouse embryo; Positive: Cell transform—RLV F344 rat embryo; Host-mediated assay; Positive: *E. coli* polA with S9; Histidine reversion—Ames test; Positive: *In vitro* UDS in rat liver; *S. cerevisiae*—homozygosis; Negative: *In vitro* UDS—human fibroblast; Inconclusive: Mammalian micronucleus; *E. coli* polA without S9.

Banned or Severely Restricted (many countries) (UN).[13, 35]

Very Toxic Substance (World Bank).[15]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1011).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

RCRA 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.13; Nonwastewater (mg/kg), N/A.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested Methods (PQL μg/L): 8270 (10).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.455 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4-Aminobiphenyl is a combustible, colorless to tan crystalline solid that turns purple on exposure to air. May be used in a liquid solution. Floral odor. Molecular weight = 169.24; Freezing/Melting point = 49°C; Boiling point = 302°C; Autoignition temperature = 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Human Data. 4-Aminobiphenyl is no longer manufactured commercially and is only used for research purposes. 4-Aminobiphenyl was formerly used as a rubber antioxidant and as a dye intermediate. Is a contaminant in 2-aminobiphenyl.

Incompatibilities: Strong oxidizers, strong acids, and acid anhydrides.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 200 mg/m^3

NIOSH IDLH: Not determined. Potential occupational carcinogen.

ACGIH TLV®[1]: [skin] Confirmed Human Carcinogen.

DFG MAK: [skin] Carcinogen Category 1.

Australia: [skin] carcinogen, 1993; Austria: carcinogen, 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3 [skin] carcinogen, 1999; France: VME 0.001 ppm (0.007 mg/m^3), 1 carcinogen, 1999; Norway: TWA 0.1 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for 4-aminobiphenyl in ambient air[60]: zero for North Dakota, New York, and South Carolina; 0.8 μg/m^3 (Pennsylvania); 4.0 μg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (II-4) #P&CAM 269, OSHA Analytical Method 93.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water limit of 200 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.8$.

Routes of Entry: Inhalation and percutaneous absorption.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates the skin. Exposure may cause methemoglobinemia, which interferes with the blood's ability to carry oxygen. This can cause headache, dizziness, fatigue, fast heart rate, blue color of the lips and skin. Higher levels can cause difficult breathing, collapse and death.

Long Term Exposure: 4-Aminobiphenyl is a known human bladder carcinogen. An exposure of only 133 days has been reported to have ultimately resulted in a bladder tumor and blood in the urine. The latent period is generally 15−35 years. Acute exposure produces headaches, lethargy, cyanosis, urinary burning, and hematuria. Cystoscopy reveals diffuse hyperemia, edema, and frank slough.

Points of Attack: Bladder, skin, blood.

Medical Surveillance: OSHA mandates the following: *Increased Risk*; Reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; NIOSH lists the following tests: cystoscopy, urine (chemical/metabolite), urinalysis (routine). Blood test for hemoglobin levels. Placement and periodic examinations should include an evaluation of exposure to other carcinogens; use of alcohol, smoking, and medications; and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations. Blood methemoglobin level. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. These are designed to supplement engineering controls (such as the prohibition of open-vessel operations) and to prevent all skin or respiratory contact. Full-body protective clothing and gloves should be used by those employed in handling operations. Full-face supplied-air respirators of continuous-flow or pressure-demand type should also be used. On exit from a regulated area, employees should shower and change into street clothes, leaving their clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in accordance with OSHA Standard 1910.1011. Storage area should be marked, regulated, and maintained under negative pressure. Keep away from heat and sources of ignition, oxidizers.

Shipping: This chemical is a solid, toxic, organic, n.o.s. should be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover spills with dry lime or soda ash and collect powdered material, then collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal devices.[22]

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: 4-Aminodiphenyl*. Trenton, NJ

2-Amino-4-chlorophenol A:0790

Molecular Formula: C_6H_6ClNO

Common Formula: $HOC_6H_3(NH_2)Cl$

Synonyms: 2-Amino-4-clorofenol (Spanish); *p*-Chloro-*o*-aminophenol

CAS Registry Number: 95-85-2

RTECS® Number: SJ5700000

UN/NA & ERG Number: UN2673/151

EC Number: 202-458-9

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Amino-4-chlorophenol is a grayish to light brown crystalline solid or powder. Molecular weight = 143.57; Freezing/Melting point = 134−140°C; Autoignition temperature = 500°C. Insoluble in water; solubility = <0.1 g/100 mL at 20°C.

Potential Exposure: Used as a chemical raw material, especially in dye manufacture.

Incompatibilities: Keep away from oxidizers, iron, moisture, and temperatures above 43°C.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if inhaled or ingested. Exposure can lower the ability of the blood to carry oxygen. This can result in a bluish color to the skin and lips, headaches, dizziness, collapse, and even death.

Long Term Exposure: Unknown at this time.

Points of Attack: Blood.

Medical Surveillance: Test for blood hemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area way from iron, moisture, and temperatures above 110°C.

Shipping: DOT/UN label required is "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2-Amino-4-chlorophenol may burn, but does not readily ignite. Poisonous gases are produced in fire, including chlorides and nitrogen oxides. Use dry chemical, CO_2, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: 2-Amino-4-Chlorophenol*. Trenton, NJ

2-Amino-5-diethylaminopentane A:0800

Molecular Formula: $C_9H_{22}N_2$

Synonyms: *N*,*N*-Diethyl-1,4-pentanediamine; Novoldiamine; Tetramethylenediamine, *N*,*N*-diethyl-4-methyl-

CAS Registry Number: 140-80-7

RTECS® Number: SA0242000

UN/NA & ERG Number: UN2946/153

EC Number: 205-435-1

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Amino-5-diethylaminopentane is a light yellow, flammable liquid with a fishy odor. Molecular weight = 158.32; Flash point = 68°C. Boiling point = 200°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Used in the manufacture of quinacrine and other antimalarials having the same basic side chain.

Incompatibilities: Contact with oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: May cause irritation of the nose and throat. Contact with the eyes or skin may cause severe irritation and burns. Passes through the skin; exposure may be increased.

Long Term Exposure: Allergy can develop. Future exposures, even if low, can cause rash and itching. Very irritating substance; may injure the lungs.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to 2-Amino-5-Diethyl Aminopentane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved, self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where 2-amino-5-diethyl aminopentane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2-Amino-5-diethyl aminopentane is a flammable liquid. Poisonous gas, including nitrogen oxides, is produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerator with scrubber for nitrogen oxides absorption.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: 2-Amino-5-Diethyl Aminopentane*. Trenton, NJ

2-(2-Aminoethoxy)ethanol A:0810

Molecular Formula: $C_4H_{11}NO_2$

Synonyms: 2-Aminoethyoxyethanol; DGA; Diglycolamine; Ehhanol, 2-(2-aminoethioxy)-

CAS Registry Number: 929-06-6

RTECS® Number: KJ6125000

UN/NA & ERG Number: UN3055/154

EC Number: 213-195-4

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-(2-Aminoethoxy)ethanol is a combustible, colorless, thick liquid with a fish-like odor. Molecular weight = 105.15; Boiling point at 1 atm = 243°C[C]; Melting/Freezing point = −78°C[C]; Specific gravity = 1.028 at 25°C[C]; Relative vapor density (air = 1) = 3.59[C]; Latent heat of vaporization = (estimate) 4.85×10^5 J/kg[C]; Heat of combustion = (estimate) -287×10^5 J/kg[C]; Heat of solution = (estimate) -0.1×10^5 J/kg[C]; Vapor pressure = 0.001 mmHg at 20°C (approx.)[C]; Flash point = 127°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used to remove gases from natural gas; in coatings in plastics; textiles, fibers, and metals; and in making other chemicals.

Incompatibilities: Reacts with oxidizers, strong acids, and chemically active metals, such as potassium, sodium, magnesium, and zinc.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 12.5 mg/m^3

PAC-1: 35 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: No numerical value established. Data may be available.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical is highly corrosive. Contact can severely irritate and burn the eyes and skin. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath, coughing, and wheezing. Higher exposures can cause pulmonary edema, a medical emergency. This can cause death.

Long Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath, phlegm.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL:* (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: 2-(2-Aminoethoxy) ethanol should be labeled "CORROSIVE MATERIAL." It falls into DOT/UN Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2-(2-Aminoethoxy)ethanol may burn, but does not readily ignite. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam to extinguish fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: 2-(2-Aminoethoxy)Ethanol*. Trenton, NJ

3-Amino-9-ethylcarbazole A:0820

Molecular Formula: $C_{14}H_{14}N_2$; $C_{14}H_{14}N_2 \cdot ClH$ (hydrochloride)

Synonyms: 3-Amino-*N*-ethylcarbazole; 3-Amino-9-ethylcarbazole HCl (hydrochloride); NCI-C03043 (hydrochloride)

CAS Registry Number: 132-32-1; 6109-97-3 (hydrochloride); 57360-17-5 (hydrochloride)

RTECS® Number: FE3590000; FE3675000 (hydrochloride)

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-057-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Animal Positive (hydrochloride).

California Proposition 65 Chemical: (*hydrochloride*) Cancer 7/1/89.

European Directive 67/548/EEC: May cause cancer. Toxic if swallowed.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 3-Amino-9-ethylcarbazole is a tan, crystalline compound. The hydrochloride is a bluish-green powder. Molecular weight = 210.3; Freezing/Melting point = 99°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. The hydrochloride forms blue-green crystals.

Potential Exposure: Plant workers engaged in the manufacture of this compound and its use in pigment manufacture. Laboratory workers using this material in colorimetric enzyme assays and as a biological stain.

Permissible Exposure Limits in Air

No standards or TEEL available.

DFG MAK: Germ Cell Mutagen Group 3B.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if swallowed.

Long Term Exposure: Suspected carcinogen and mutagen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place. Protect from exposure to air.

Shipping: The material may be classified as TOXIC SOLIDS, ORGANIC, N.O.S. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and HCl (for the hydrochloride). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: 3-Amino-9-Ethylcarbazole*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report* 4, No. 6, 70−72 (1984) and 6, No. 2, 41−43 (hydrochloride) (1986)

Aminoethylethanolamine A:0830

Molecular Formula: $C_4H_{12}N_2O$

Synonyms: 2-(Aminoethyl)amino-; 2-[(2-Aminoethyl) amino]ethanol; (2-Aminoethyl)ethanolamine; *N*-(2-Aminoethyl)ethanolamine; Hidroxietiletilendiamina (Spanish); Hydroxyethylenediamine

CAS Registry Number: 111-41-1

RTECS® Number: KJ6300000

UN/NA & ERG Number: UN2735 (amines, liquid, corrosive, n.o.s.)/153

EC Number: 203-867-5 [*Annex I Index No.:* 603-194-00-0]

Regulatory Authority and Advisory Bodies

DOT Appendix B, §172.101.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R61; R34; R43; R62; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Aminoethylethanolamine is a combustible, colorless, liquid with an ammonia-like odor. A strong base [pH (10 M) = 12.3] Molecular weight = 104.2; Specific gravity = 1.0254 at 25°C; Boiling Point: 243°C; Vapor Pressure: 8.17×10^{-4} mmHg at 25°C; Vapor pressure = 0.01 mmHg at 20°C; Flash point = 132°C; Autoignition temperature = 368°C. Explosive limits: LEL = 1.0%, UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: Used to make textile finishing compounds, dyes, resins, rubber, insecticides, medicines, and other chemicals.

Incompatibilities: Contact with cellulose nitrate may cause fires upon contact. Reacts with oxidizers, strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 12.5 mg/m^3
PAC-1: 35 mg/m^3
PAC-2: 250 mg/m^3
PAC-3: 500 mg/m^3

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < -1.50$.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can severely irritate and burn the eyes and skin; this can lead to permanent damage. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath, coughing, and wheezing. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath, phlegm. May cause skin allergy. If allergy develops, very low future exposure can cause itching and skin rash.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Evaluation by a qualified allergist may diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL:* (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical should be labeled "CORROSIVE." It falls into DOT/UN Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aminoethylethanolamine is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol-resistant foam to extinguish fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location,

use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Aminoethylethanolamine*. Trenton, NJ

Schneider, A. L. (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

N-Aminoethylpiperazine A:0840

Molecular Formula: $C_6H_{15}N_3$

Synonyms: *N*-(2-Aminoethyl) piperazine; 1-(2-Aminoethyl) piperazine; Piperazine, 1-(2-aminoethyl)-; 1-Piperazine ethanamine

CAS Registry Number: 140-31-8

RTECS® Number: TK8050000

UN/NA & ERG Number: UN2815/153

EC Number: 140-31-8 [*Annex I Index No.:* 612-105-00-4]

Regulatory Authority and Advisory Bodies

DOT Appendix B, §172.101.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R21/22; R34; R43; R52/53; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *N*-Aminoethylpiperazine is a combustible and corrosive aliphatic amine. It is a colorless to light yellow liquid. Molecular weight = 129.2; Boiling point = 222°C; Melting/Freezing point = − 17.8; Flash point = 93°C; Autoignition temperature = >300°C; Vapor pressure = 0.076 mmHg at 20°C; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Very soluble in water.

Potential Exposure: Used as an epoxy curing agent and making pharmaceuticals; synthetic fibers, and other chemicals.

Incompatibilities: Solution is a strong base. Incompatible with nonoxidizing mineral acids, strong acids, organic acids, acid chlorides, acid anhydrides, organic anhydrides, isocyanates, chloroformates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution, strong oxidizers. Contact with copper alloys, zinc, or galvanized steel may cause violent reaction.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 2.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can severely irritate and burn the eyes and skin (can cause second- and third-degree burns); this can lead to permanent damage. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath, coughing, and wheezing. Exposure can cause headache, nausea, and vomiting. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath, phlegm. Mutation data reported.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear indirect vent, impact and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL:* (any NIOSH/MSHA- or European Standard

EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: *N*-Aminoethylpiperazine should be labeled "CORROSIVE MATERIAL." It falls into DOT/UN Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use dry chemical, water, or alcohol; or polymer foam to extinguish fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: N-Aminoethylpiperazine*. Trenton, NJ

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0, United Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

1-Amino-2-methyl-anthraquinone A:0850

Molecular Formula: $C_{15}H_{11}NO_2$

Synonyms: Acetate fast orange R; Acetoquinone light orange JL; 1-Amino-2-methyl-9,10-anthracenedione; 1-Amino-2-metilantraquinona (Spanish); 9,10-Anthracenedione, 1-amino-2-methyl-; Artisil orange 3RP; Celliton orange R; C.I. 60700; C.I. Disperse orange 11; Cilla orange R; Disperse orange; Duranol orange G; 2-Methyl-1-anthraquinonylamine; Microsetile orange RA; Nyloquinone orange JR; Perliton orange 3R; Serisol orange yl; Supracet orange R

CAS Registry Number: 82-28-0

RTECS® Number: CB5740000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 201-408-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence, Human No Adequate Data, Group 2B; NCI: Animal Positive; NTP: Reasonably anticipated to be a human carcinogen.

CERCLA/SARA Section 313, Form R *de minimis* Concentration Reporting Level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1-Amino-2-methylanthraquinone is a red crystalline substance or powder. Molecular weight = 237.27; Freezing/Melting point = 205−206°C. Practically insoluble in water; solubility = <1 mg/mL at 20°C.

Potential Exposure: 1-Amino-2-methylanthraquinone is used almost exclusively as a dye intermediate for the production of a variety of anthraquinone dyes. The Society of Dyers and Colorists reported that it can be used as a dye for a variety of synthetic fibers, especially acetates, as well as wool, sheepskins, furs, and surface dyeing of thermoplastics. None of the dyes that can be prepared from it are presently produced in commercial quantities. 1-Amino-2-methylanthraquinone had been produced commercially in the United States since 1948, but production was last reported by one company in 1970. The potential for exposure is greatest among workers engaged in the dyeing of textiles. 1-Amino-2-methylanthraquinone is not presently used in consumer products according to the CPSC.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may irritate the eyes and skin.

Long Term Exposure: There is evidence that this chemical causes liver and kidney cancer. A mutagen. Technical-grade 1-amino-2-methylanthraquinone (impurities unspecified), administered in the feed, was carcinogenic in Fischer 344 rats, inducing hepatocellular carcinomas in rats of both sexes, and kidney tumors (such as tubular-cell adenomas and adenocarcinomas) in males.

Points of Attack: Liver, kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Should be stored in a refrigerator in a tightly closed container under an inert atmosphere.[52]

Shipping: The material may be classified as Toxic solids, organic, n.o.s. They require a label, "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (January 2004). *Hazardous Substances Fact Sheet: 1-Amino-2-Methylanthraquinone*

4-Amino-2-nitrophenol A:0860

Molecular Formula: $C_6H_6N_2O_2$

Common Formula: $C_6H_3NO_2NH_2OH$

Synonyms: C.I.-76555; Fourrine 57; Fourrine brown PR; Fourrine brown propyl; 4-Hydroxy-3-nitroaniline;

2-Nitro-4-amenophenol; *o*-Nitro-*p*-aminophenol; *o*-Nitro-*p*-aminofenol (Spanish)

CAS Registry Number: 119-34-6

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

RTECS® Number: SJ6303000

EC Number: 204-316-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: rat: positive, mouse: negative. TSCA 40CFR704.225.

California Proposition 65 Chemical: Cancer 1/29/99.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex I (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4-Amino-2-nitrophenol is a dark red crystalline or reddish-purple solid. Molecular weight = 154.12; Freezing/Melting point = 125−131°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = <1 mg/mL at 21°C.

Potential Exposure: In dye formulation for furs and hair.

Incompatibilities: Strong oxidizers, mineral acids, strong bases. It is unknown if this nitro compound is explosive; some are flammable and explosive, and the contact with alkali increases thermal sensitivity of these materials.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] Carcinogen Category 3B.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation of dust; eye and/or skin contact.

Harmful Effects and Symptoms

Severe eye irritant in rabbits. A suspected carcinogen. LD_{50} (oral, rat) = 1.470 mg/kg.

Short Term Exposure: Poisonous if swallowed or upon skin contact. Irritates eyes and may irritate skin and respiratory tract.

Long Term Exposure: May be carcinogenic in humans. Similar compounds can cause chronic poisoning with fatigue, headache, dizziness, insomnia, cyanosis, anemia, and weight loss. May result in liver and kidneys damage, with toxic hepatitis and fatty degeneration of the kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in cool dry place away from air and from mineral acids and bases.[52]

Shipping: Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust and remove to sealed containers for disposal.[52] Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No.7, 34−35

Aminophenols A:0870

Molecular Formula: C_6H_7NO

Common Formula: $C_6H_4(OH)(NH_2)$

Synonyms: *ortho-isomer:* 2-Amino-1-hydroxybenzene; *o*-Hydroxyaniline

meta-isomer: 3-Amino-1-hydroxybenzene; 3-Hydroxyaniline

para-isomer: 4-Amino-1-hydroxybenzene; *p*-Hydroxyaniline

CAS Registry Number: 95-55-6 (*o*-isomer); 591-27-5 (*m*-isomer); 123-30-8 (*p*-isomer); 27598-85-2 (mixed isomers)

RTECS® Number: SJ4950000 (*o*-isomer); SJ4900000 (*m*-isomer); SJ5075000 (*p*-isomer)

UN/NA & ERG Number: UN2512 (aminophenols)/152

EC Number: 202-431-1 [*Annex I Index No.:* 612-033-00-3] (*o*-isomer); 209-711-2 [*Annex I Index No.:* 612-127-00-4] (*m*-isomer); 204-616-2 [*Annex I Index No.:* 612-128-00-X] (*p*-isomer)

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (*m*-, *o*-, *p*-isomers).

TSCA CFR721.5820.

European/International Regulations: Hazard Symbol (*o-isomer*): Xn; Risk phrases: R20/22; R68; Safety phrases: S28; S36/37; (*m*-isomer): Hazard Symbol: Xn, N; Risk phrases: R20/22; R51/53; Safety phrases: S2; S28; S61.

(*p*-isomer): Hazard Symbol: Xn, N; Risk phrases: R20/22; R50/53; R68; Safety phrases: S2; S28; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*o*-isomer); 3—Highly water polluting (*p*-isomer).

Description: *o*-Aminophenol appears as colorless needles or as white crystalline substance turning brown on exposure to air. Molecular weight = 109.13; Boiling point = 164°C (sublimes); Freezing/Melting point = 170−174°C. Soluble in water. *p*-Aminophenol is a white or reddish yellow crystalline substance. Molecular weight = 109.14; Freezing/Melting point = 190°C (decomposes). Boiling point = 284°C. Slightly soluble in water. *m*-Aminophenol is a white crystalline substance. Molecular weight = 143.57; Freezing/Melting point = 122−123°C. Hazard Identification (based on NFPA-704 M Rating System) (*mixed isomers*): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Workers may be exposed to *o*-Aminophenol during its use as a chemical intermediate, in the manufacture of azo and sulfur dyes, and in the photographic industry. There is potential for consumer exposure to *o*-Aminophenol because of its use in dyeing hair, fur, and leather. The compound is a constituent of 75 registered cosmetic products suggesting the potential for widespread consumer exposure. *p*-Aminophenol is used mainly as a dye and dye intermediate and as a photographic developer; and in small quantities in analgesic drug preparation. Consumer exposure to *p*-aminophenol may occur from use as a hair dye or as a component in cosmetic preparations. *m*-Aminophenol is used mainly as a dye intermediate.

Incompatibilities: Strong oxidants.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Danger of sensitization of the skin.

Permissible Concentration in Water: Russia[43] has set MAC values in water used for domestic purposes. The value for *o*-aminophenol is 0.01 mg/L and for *p*-aminophenol is 0.05 mg/L.

Routes of Entry: Inhalation, ingestion, and skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Aminophenols can be absorbed through the skin, thereby increasing exposure. Can cause lung irritation. Poisonous if swallowed. These chemicals lower the blood's ability to carry oxygen (methemoglobinemia). This condition causes a bluish color to the skin and lips, headaches, dizziness; higher exposures can result in unconsciousness and death. Irritates eyes, skin, and respiratory tract. Skin contact can cause burning sensation and rash. The *o*-isomer can affect the nervous system. *o*-Aminophenol has an oral LD_{50} for rats of 1300 mg/kg and *p*-aminophenol has produced LD_{50} values in rats of 375, 671, and 1270 mg/kg which are all of low acute toxicity. The oral LD_{50} in rats for *m*-aminophenol is 1000 mg/kg. May produce dermatitis, methemoglobinemia, bronchial asthma, and restlessness.

Long Term Exposure: Prolonged or repeated contact can cause blood damage, skin disorders, and liver, kidney, and brain damage. Aminophenols may cause mutations, and there is limited teratogenic evidence. Skin allergy or asthma may develop; future exposures, even in low doses can cause symptoms to occur.

Points of Attack: Blood, liver, kidneys, brain, skin, and lungs.

Medical Surveillance: Blood methemoglobin level; lung function tests. Evaluation by a qualified allergist. Any person who develops asthma from these aminophenols should avoid all future contact with them.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Aminophenols must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur.

Shipping: The DOT/UN label requirement for *o*-, *m*-, and *p*-aminophenols is "POISONOUS/TOXIC MATERIALS." The aminophenols fall in Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Keep dust under control. Use a vacuum or wet method to reduce dust during cleanup. Do not sweep. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aminophenols may burn, but do not readily ignite. Use dry chemical, CO_2, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (March 29, 1984). *Chemical Hazard Information Profile Draft Report: o-Aminophenol, Sulfate and Hydrochloride*. Washington, DC

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Aminophenols (Mixed Isomers)*. Trenton, NJ

Aminopterin A:0880

Molecular Formula: $C_{19}H_{20}N_8O_5$

Synonyms: 4-Amino-4-deoxypteroyl glutamate; 4-Aminofolic acid; 4-Amino-PGA; Aminopteridine; 4-Aminopteroylglumatic acid; APGA; Folic acid, 4-amino-

CAS Registry Number: 54-62-6

RTECS® Number: MA1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-209-9

Regulatory Authority and Advisory Bodies

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Developmental/ Reproductive toxin (female) 7/1/87.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Aminopterin is a white to yellow powder; commonly used as the dihydrate which forms clusters of yellow needles. Molecular weight = 440.46; Melting point: 228–235°C; 260–265°C; Vapor pressure = 2.3×10^{-19} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health -, Flammability 1, Reactivity 0. Soluble in water; solubility = 3.0 × 103 mg/L at 25°C.

Potential Exposure: Aminopterin is used as a medicine (as a folic acid antagonist), rodenticide, and agricultural chemical.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 25 mg/m^3

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Acts as antimetabolite; antagonizes the utilization of folic acid by the body. Highly toxic by ingestion. Has an LD_{low} = (oral-rat) 2.5 mg/kg.

Long Term Exposure: A mutagen and a questionable carcinogen. Listed as a developmental and reproductive toxicant by the state of California (Proposition 65). NIOSH has listed it as a suspected neurotoxin; liver and skin toxin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Storage temperature: 2–8°C. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: The DOT/UN regulations do not set out any specific label requirements or maximum shipping quantities for this chemical. However, this material may be classified as Toxic solids, organic, n.o.s. They require a label, "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Do not create dust. Use a vacuum and water spray to reduce vapors. *Small wet spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Aminopterin.* Washington, DC: Chemical Emergency Preparedness Program

2-Aminopyridine A:0890

Molecular Formula: $C_5H_6N_2$
Synonyms: α-Aminopyridine; Amino-2-Pyridine; 1,2-Dihydro-2-Iminopyridine; α-Piridilamina (Spanish); α-Pyridinamine; 2-Pyridylamine
CAS Registry Number: 504-29-0
RTECS® Number: US1575000
UN/NA & ERG Number: UN2671(aminopyridines)/153
EC Number: 207-988-4
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: 2-Aminopyridine is a flammable, colorless crystalline solid, or white leaflets or powder, or colorless liquid with a characteristic odor. Molecular weight = 91.13; Freezing/Melting point = 58°C; Boiling point = 211°C; Flash point = 68°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Highly soluble in water; solubility = 10−50 mg/mL at 19°C.
Potential Exposure: Compound Description: Human Data. 2-Aminopyridine is used in the manufacture of pharmaceuticals; especially antihistamines.
Incompatibilities: Strong oxidizers.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.85 mg/m^3
OSHA PEL: 0.5 ppm/2 mg/m^3 TWA
NIOSH REL: 0.5 ppm/2 mg/m^3 TWA
ACGIH TLV®[1]: 0.5 ppm/2 mg/m^3 TWA
NIOSH IDLH: 5 ppm
No TEEL available.
DFG MAK: No numerical value established. Data may be available.
Australia: TWA 5 ppm (2 mg/m^3), 1993; Austria: MAK 0.5 ppm (2 mg/m^3), 1999; Belgium: TWA 0.5 ppm (2 mg/m^3), 1993; Denmark: TWA 0.5 ppm (2 mg/m^3), 1999; Finland: TWA 0.5 ppm (2 mg/m^3); STEL 1.5 ppm (6 mg/m^3), 1999; France: VME 0.5 ppm (2 mg/m^3), 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; the Philippines: TWA 0.5 ppm (2 mg/m^3), 1993; Poland: MAC (TWA) 2 mg/m^3, 1999; Switzerland: MAK-W 0.5 ppm (2 mg/m^3), 1999; United Kingdom: TWA 0.5 ppm (2 mg/m^3); STEL 2 ppm (7.8 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm. Several states have set guidelines or standards for 2-aminopyridine in ambient air[61]: 0.5 ppm (2 mg/m^3) TWA (California), 2 mg/m^3 (North Dakota), 3 mg/m^3 (Virginia), 4 mg/m^3 (Connecticut), 4.8 mg/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (II-4) #S-158.
Permissible Concentration in Water: No criteria set.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.22$.
Routes of Entry: Inhalation, ingestion, eye, and skin contact (absorption through the skin).
Harmful Effects and Symptoms
Headaches, dizziness, excited state, nausea, flushed appearance, high blood pressure, respiratory distress, weakness, convulsions, stupor.
Short Term Exposure: LD_{50} = (oral-rat) 0.2 g/kg. Skin contact contributes significantly to overall exposure. Irritates eyes, skin, and respiratory tract. Inhalation or skin exposure can cause a fatal reaction that begins with a headache, dizziness, heaviness, and weakness of the limbs, and may progress to convulsions, stupor, and coma.
Long Term Exposure: May cause lung allergy.
Points of Attack: Central nervous system, respiratory system.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Interview for brain effects including recent memory loss, change in mood, concentration, headache, listless feeling, altered sleep patterns. Consider cerebellar, autonomic, and peripheral nervous system evaluation. Positive and borderline individuals should be referred for neuropsychological testing.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *up to 5 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece

and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere[52] or store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Aminopyridines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group II.[19−21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use water spray to reduce dust or vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Dike *large spills*. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with nitrogen oxides removal from effluent gas.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 2-Aminopyridine*. Trenton, NJ

4-Aminopyridine A:0900

Molecular Formula: $C_5H_6N_2$

Synonyms: 4-Aminopiridina (Spanish); γ-Aminopyridine; *p*-Aminopyridine; Amino-4-pyridine; Avitrol; 4-Pyridinamin; 4-Pyridylamine; VMI 10-3

CAS Registry Number: 504-24-5

RTECS® Number: US1750000

UN/NA & ERG Number: UN2671(aminopyridines)/153

EC Number: 207-987-9

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P008.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4-Aminopyridine is white to tan or brown crystalline material. Odorless. Molecular weight = 94.12; Specific gravity: 1.2607 at 25.3°C; Boiling point = 274°C; Freezing/Melting point = 155−158°C; Flash point = 164°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Moderately soluble in water.

Potential Exposure: Used as a chemical intermediate in pharmaceuticals, as an agricultural chemical for field crops, and as a bird repellent and poison.

Incompatibilities: Sodium nitrite, strong oxidizers. Avoid contact with acid anhydrides, acid chlorides, and strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) 504-24-5

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

Permissible Concentration in Water: No criteria set. Harmful to aquatic life in very low concentrations.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.28$.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 21 mg/kg. May be fatal if swallowed or absorbed through the skin. Symptoms of exposure include rapid onset of disagreeable taste, immediate burning of throat, and abdominal discomfort; in addition, weakness, dizziness, disorientation, and seizures may occur. Delayed symptoms of oral ingestion include elevated liver enzymes and respiratory arrest. Material may be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. Material affects neural transmission. In sufficient concentration, material may cause metabolic acidosis, respiratory arrest, and cardiac arrhythmias. The fatal dose to a 70-kg person is about 5 g.

Long Term Exposure: High exposure or repeated exposure may cause liver damage.

Points of Attack: Central nervous system, liver.

Medical Surveillance: Preemployment and regular physical examinations with emphasis on central nervous system. Liver function tests. Persons exposed to *strychnine* or other chemicals capable of causing seizures are probably at increased risk.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *For reference, the information for 2-Aminopiridine follows:* Up to *5 ppm*: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Avoid contact with acid anhydrides, acid chlorides, strong acids, and strong oxidizers (such as halogens). Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Aminopyridines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group II.[19−21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce dust or vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Dike *large spills*. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with nitrogen oxides removal from effluent gas.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report* 5, No. 5, 39−41

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 4-Aminopyridine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2004). *Hazardous Substances Fact Sheet: Avitrol*. Trenton, NJ

3-Amino-1,2,4-triazole A:0910

Molecular Formula: $C_2H_4N_4$

Synonyms: Amerol; 2-Amino-1,3,4-triazole; 2-Aminotriazole; 3-Amino-*s*-triazole; 3-Amino-1,2,4-triazole; 3-Amino-1H-1,2,4-triazole; 3-Aminotriazole; Aminotriazole; Aminotriazole Bayer; Amino triazole weedkiller 90; Amitol; Amitril; Amitrol 90; Amitrole; Amitrol-T; Amizol; Amizol DP NAU; Amizol F; 3-AT; AT; AT (Liquid); AT-90; ATA; Atlazin; Atlazine flowable; Atraflow plus; Azaplant; Azaplant kombi; Azolan; Azole; Boroflow A/ATA; Boroflow S/ATA; Campaprim A 1544; Caswell No. 040; CDA Simflow plus; Chipman path weedkiller; Clearway; Cytrol; Cytrol Amitrole-T; Cytrole; Diurol; Diurol 5030; Domatol; Domatol 88; Elmasil; Emisol; Emisol F; ENT 25445; EPA pesticide chemical code 004401; Farmco; Fenamine; Fenavar; Herbazin plus SC; Herbicide total; Herbizole; Kleer-lot; Mascot highway; MSS aminotriazole; MSS simazine; Orga-414; Primatol AD 85 WP; Primatrol SE 500 FW; Radoxone TL; Ramizol; Rassapron; Simazol; Simflow plus; Solution concentre T271; Synchemicals total weed killer; Syntox total weed killer; Torapron; 1,2,4-Triazol-3-amine; 1H-1,2,4-Triazol-3-amine; Triazolamine; *s*-Triazole, 3-amino-; δ-2-1,2,2,4-Triazoline, 5-imino-; 1H-1,2,4-Triazol-3-ylamine; Vorox; Vorox AS; Weedar ADS; Weedar AT; Weedazin; Weedazin arginit; Weedazol; Weedazol GP2; Weedazol super; Weedazol T; Weedazol TL; Weedex granulat; Weedoclor; X-All (liquid)

CAS Registry Number: 61-82-5; (alt.) 155-25-9

RTECS® Number: XZ3850000

UN/NA & ERG Number: UN2588/151

EC Number: 200-521-5 [*Annex I Index No.:* 613-011-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, Evidence, *not classifiable as carcinogenic to humans*, Group 3.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—RLV F344 rat embryo; Host-mediated assay; Negative: *D. melanogaster*—whole sex chrom. loss; Negative: *D. melanogaster*—nondisjunction; *N. crassa-aneuploidy*; Negative: *E. coli* polA without S9; *E. coli* polA with S9; Negative: Histidine reversion—Ames test; Sperm morphology—mouse; Negative: *In vitro* UDS—human fibroblast; *S. cerevisiae*—homozygosis; Inconclusive: Mammalian micronucleus; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Banned or Severely Restricted (UN) (Scandinavia).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U011.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Regulated Marine Pollutant.

California Proposition 65 Chemical: Cancer 7/1/87.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R48/22; R63; R51/53; Safety phrases: S2; S13; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Amitrole is a colorless to off-white crystalline solid. Odorless when pure. Molecular weight = 84.10; Freezing/Melting point = 158−159°C; Specific gravity: 1.138 at 20°C; Vapor pressure = 4.4×10^{-7} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water; solubility = 280 g/L at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector. Those involved in the manufacture, formulation, and application of this herbicide, which is now limited to noncrop applications as a herbicide and plant growth regulator. Some triazoles have been used as rubber components.

Incompatibilities: Strong oxidizers, strong acids, and light (decomposes). Corrosive to iron, aluminum, and copper.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.2 ppm TWA; suspected occupational carcinogen.

ACGIH TLV®[1]: 0.2 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: 0.2 ppm, inhalable fraction; ; Peak limitation Category II(8); Carcinogen Category 3B; Pregnancy Risk Group C.
Australia: TWA 0.2 mg/m^3, 1993; Austria: MAK 0.2 mg/m^3, 1999; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.2 mg/m^3, 1999; Finland: carcinogen, 1999; Switzerland: MAK-W 0.2 mg/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; Argentina, Bulgaria, Colombia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for amitrole in ambient air[60]: 0.2 mg/m^3 (California), 0.476 μg/m^3 (Kansas), 1.8 μg/m^3 (Pennsylvania), 2.0 μg/m^3 (North Dakota), 3000 μg/m^3 (Virginia).

Permissible Concentration in Water: No criteria set. Fish toxicity (threshold).

Determination in Water: Fish Tox = 12422.37656000 ppb MATC (VERY LOW). Octanol−water coefficient: Log $K_{ow} = < -0.6$.

Harmful Effects and Symptoms

Carcinogenicity is the primary observed effect. Amitrol is carcinogenic in mice and rats, producing thyroid and liver tumors following oral or subcutaneous administration. Railroad workers who were exposed to amitrole and other herbicides showed a slight (but statistically significant) excess of cancer when all sites were considered together. Because the workers were exposed to several different herbicides, however, no conclusions could be made regarding the carcinogenicity of amitrole alone.

Short Term Exposure: Amitrol can be absorbed through the skin, thereby increasing exposure.

Long Term Exposure: Causes liver, thyroid, and pituitary cancer in animals. May damage the developing fetus. May cause liver, thyroid gland (possible goiter or underactive thyroid), and pituitary gland damage. Human Tox = 0.30973 ppb CHCL (Chronic Human Carcinogen Level) (EXTRA HIGH).

Points of Attack: Liver, thyroid, and pituitary gland.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: Physical examination of the thyroid and thyroid function tests (T_4, TSH, and T_3). If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Pituitary gland function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Shipping: The DOT/UN label requirement for pesticides, solid, toxic, n.o.s. is "POISONOUS/TOXIC MATERIALS." Amitrole is a carcinogen. Packing Group I. The DOT/UN Hazard Class is 6.1.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Contain and isolate spill. Product residues and sorbent media may be packaged in epoxy-lined drums. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Amitrol is resistant to hydrolysis and the action of oxidizing agents. Burning the compound with polyethylene is reported to result in >99% decomposition.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 34−35 (1981) and 4, No. 2, 41−43 (1984)

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Amitrol*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Amiton (Agent VG, WMD) A:0920

Molecular Formula: $C_{10}H_{24}NO_3PS$

Common Formula: $(C_2H_5O)_2POSCH_2CH_2N(C_2H_5)_2$

Synonyms: Chipman 6200; Citram; *S*-(2-Diethylamino) ethyl]phosphorothioic acid, *O*,*O*-diethyl ester; *O*,*O*-Diethyl *S*-2-diethylaminoethyl phosphorothioate; Diethyl *S*-2-diethylaminoethyl phosphorothioate; *O*,*O*-Diethyl *S*-(β-diethylamino)ethyl phosphorothiolate; *O*,*O*-Diethyl *S*-2-diethylaminoethyl phosphorothiolate; *O*,*O*-Diethyl *S*-diethylamino ethyl phosphorothiolate; *O*,*O*-Diethyl *S*-(2-diethylaminoethyl) thiophosphate; DSDP; Inferno; Metramac; Metramak; R-5,158; Rhodia-6200; Tetram; VG (military designation)

CAS Registry Number: 78-53-5

RTECS® Number: TF0525000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 2.2 (≥30.00% concentration).

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

CERCLA/SARA Section 304 Reportable Quantity (RQ): 1 lb (0.454 kg).

Classified by EPA as a Restricted Use Pesticide (RUP).

US DOT 49CFR172.101, Inhalation Hazardous Chemical, as organophosphates.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amiton is a liquid organophosphate. Molecular weight = 269.38; Boiling point = 110°C at 0.2 mmHg; Vapor pressure = 0.01 mmHg at 80°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Amiton is used as an acaricide and an insecticide; exposure may occur in manufacture and in application and use. VG has been used as a military nerve agent.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.3 mg/m^3

PAC-3: 3.3 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Danger—poisonous; can be fatal if swallowed, inhaled, or absorbed through the skin or eyes. This material is highly toxic orally. It is a cholinesterase inhibitor. The LD_{50} = (oral-rat) 5.4 mg/kg. The toxic effects are similar to parathion. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMB-4) have been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See entry on Parathion.

Respirator Selection: NIOSH: (*for Parathion*) *0.5 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTOvHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* Sa:Pd, Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." This material falls in DOT/UN Hazard Class 6.1.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

VG, when used as a weapon No Initial Isolation and Protective Action Distances have been assigned to amiton. This material is similar to parathion and may be considered a nerve agent.

Here, *for user reference*, is a sample of Initial Isolation and Protective Action Distances used for similar nerve agents:

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.1/0.2

Fire Extinguishing: Amiton is a combustible liquid. Poisonous gases, including nitrogen oxides, sulfur oxides, and phosphorus oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration. Hydrolysis may also be used.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (October 2002). *Chemical Hazard Information Profile: Amiton.* Washington, DC: Chemical Emergency Preparedness Program

Amiton oxalate A:0930

Molecular Formula: $C_{12}H_{26}NO_7PS$

Common Formula: $(C_2H_5O)_2POSCH_2CH_2N(C_2H_5)_2 \cdot HOOCCOOH$

Synonyms: Acid oxalate; Chipman® 6199; Chipman® R-6, 199; Citram; 2-(2-diethylamino)ethyl] *O*,*O*-diethyl ester, oxalate (1:1); *S*-(2-Diethylaminoethyl) *O*,*O*-diethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(β-diethylamino)ethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(2-diethylamino)ethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(2-ethyl-*N*,*N*-diethylamino)ethyl phosphorothioate hydrogen oxalate; Hydrogen oxalate of amiton; Phosphorothioc acid; Tetram; Tetram monooxalate, *S*-

CAS Registry Number: 3734-97-2

RTECS® Number: TF1400000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 223-100-8

Regulatory Authority and Advisory Bodies

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

CERCLA/SARA Section 304 Reportable Quantity (RQ): 1 lb (0.454 kg).

Classified by EPA as a Restricted Use Pesticide (RUP).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations *not listed in Annex I: however, as an organophosphate, the following may apply*: Hazard Symbol: T+, N; Risk phrases R24; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amiton oxalate is a crystalline solid. Molecular weight = 359.39; Freezing/Melting point = 98−99°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Those involved in manufacture and application of this insecticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 3 mg/m^3

PAC-3: 3 mg/m^3

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Amiton oxalate is a cholinesterase inhibitor. Symptoms include headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, miosis, tearing, salivation and other excessive respiratory tract secretion; vomiting, cyanosis, uncontrollable muscle twitching followed by muscular weakness; convulsions, coma, loss of reflexes, and loss of muscular control. LD_{50} = (oral-rat) 3 mg/kg.

Points of Attack: See entry on "Parathion" as referred to under "Amiton." Bear in mind that the oxalate is a solid whereas amiton is a high-boiling liquid.

Medical Surveillance: See entry on "Parathion" as referred to under "Amiton." Bear in mind that the oxalate is a solid whereas Amiton is a high-boiling liquid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See entry on Parathion. Bear in mind that the oxalate is a solid whereas amiton is a high-boiling liquid.

Respirator Selection: NIOSH: (*for Parathion*) *0.5 mg/m³*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *1.25 mg/m³*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 mg/m³*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m³* Sa:Pd, Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. should be labeled "POISONOUS/TOXIC MATERIALS." It falls in Packing Group I and Hazard Class 6.1.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: Poisonous gases, including nitrogen oxides, sulfur oxides, and phosphorus oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Amiton Oxalate*. Washington, DC: Chemical Emergency Preparedness Program

Amitraz A:0940

Molecular Formula: $C_{19}H_{23}N_3$

Synonyms: A13-27967; Acarac; Amitraz estrella; BAAM; *N*, *N*-Bis(2,4-xylyliminomethyl)methylamine; Boots® BTS 27419; BTS 27,419; 1,5-Di-(2,4-dimethylphenyl)-3-methyl-1,3,5-triazapenta-1,4-diene; *N*′-(2,4-Dimethylphenyl)-*N*-([(2,4-dimethylphenyl)imino]methyl)-*N*-methylmethanimidamide; *N*′-(2,4-Dimethylphenyl)-3-methyl-1,3,5-triazapenta-1,4-diene; *N*,*N*-Di-(2,4-xylyliminomethyl)methylamine; ENT 27967; EPA pesticide chemical code 106201; Formamidine, *N*-Methyl-*N*′-2,4-xylyl-*N*-(N-2,4-xylylformimidoyl)-; *N*-Methylbis(2,4-xylyliminomethyl)amine; 2Methyl-1,3-di(2,4-xylylimino)-2-azapropane; *N*,*N*′-[(Methylimino)dimethylidyne]bis(2,4-xylidine); *N*,*N*′-[(Methylimino)dimethylidyne] D-2,4-xylidine; Mitac®; NSC 324552; R.D. 27419; Taktic®; Triatox®; Upjohn® U-36059; 2,4-Xylidine, *N*,*N*′-(methyliminodimethylidyne)bis-

CAS Registry Number: 33089-61-1

RTECS® Number: ZF0480000

UN/NA & ERG Number: UN2763 (triazine pesticides, solid toxic)/151

EC Number: 251-375-4 [*Annex I Index No.:* 612-086-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA and California Proposition 65 (pending) suspected carcinogen.[13]

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Banned or Severely Restricted (Argentina, United States).[13]

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin 3/3/99.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R43; R48/22; R50/53; Safety phrases: S2; S22; S24; S60; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amitraz forms colorless needle-like crystals. Liquid formulations may contain flammable organic solvents. Molecular weight = 293.45; Freezing/Melting point = 86−87°C; Vapor pressure = 2.6×10^{-6} mmHg. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Human Data. Those engaged in the manufacture, formulation, and application of this insecticide and acaricide. A rebuttable presumption against registration for amitraz was issued on April 6, 1977 by US EPA on the basis of oncogenicity.

Incompatibilities: Keep away from strong oxidizers and strong acids. Acids may render this material unstable.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set. Fish toxicity: 2.00272 ppb, MATC (Maximum Acceptable Toxicant Concentration) (HIGH).

Harmful Effects and Symptoms

Amitraz metabolizes to 2,4-dimethylaniline which is a potential human carcinogen. A mouse oncogenic bioassay was conducted by Boots Chemical Company and reported by EPA; the results of that study have been disputed. Acute oral LD_{50} for rats is 800 mg/kg; for mice is greater than 1600 mg/kg.

Short Term Exposure: Poisonous if ingested or absorbed through the skin. Eye or skin contact can cause irritation. May affect the central nervous system causing dizziness and a lowering of consciousness.

Long Term Exposure: May affect the liver and central nervous system. Human toxicity (long term):1.75 ppb, Health Advisory (HIGH).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention

immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use only NIOSH/MSHA- or European Standard EN 149-approved air-purifying respirators for pesticides.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, away from fertilizers, seed, and other pesticides, flammable materials and sources of heat and flame. Do not reuse containers.

Shipping: Triazine pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." These materials fall in DOT/UN Hazard Class 6.1 and Packing Groups I or II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). Soil Adsorption Index (K_{oc}) = 1000 Estimate.

Fire Extinguishing: Poisonous gases, including nitrogen oxides, are produced in fire. Small fires: dry chemical, carbon dioxide, water spray, or foam. Large fires: water spray, fog, or foam. Stay upwind; keep out of low areas. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (April 6, 1977). *Rebuttable Presumption Against Registration (RPAR) of Pesticide Products Containing Amitraz*. Washington, DC

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Ammonia A:0950

Molecular Formula: NH_3

Synonyms: Am-Fol; Ammonia, anhydrous; Ammoniac (French); Ammonia gas; Ammoniale (German); Ammonium amide; Ammonium hydroxide; Amoniaco (Spanish); Amoniaco anhidro (Spanish); Anhydrous ammonia; Aqua ammonia; Daxad-32S; Liquid ammonia; Pro 330 clear thin spread; R717; Spirit of hartshorn; STCC 4904210

CAS Registry Number: 7664-41-7

RTECS® Number: BO0875000

UN/NA & ERG Number: UN1005 (anhydrous) and UN 3318 (Ammonia solution, relative density less than 0.880 at

15°C in water, with >50% ammonia)/125; UN2073 (35−50% solutions)/125; UN2672 (10−35% solutions)/154

EC Number: 231-635-3 [*Annex I Index No.:* 007-001-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration) (anhydrous); 20,000 (≥20.00% concentration).

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA 1998 Status of Pesticides: Active registration.

Toxic Substance (World Bank).[15]

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 10,000 lb (4540 kg) (anhydrous); TQ = 15,000 lb (6815 kg) (solution >44% NH_3).

Clean Air Act: 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130); (anhydrous) TQ = 10,000 lb (4540 kg) (anhydrous); (concentrations ≥20% NH_3) TQ = 20,000 lb (9150 kg).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 500 lb (228 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%; includes anhydrous ammonia and aqueous ammonia from water-dissociable ammonium salts and other sources; 10% of total aqueous ammonia, and 100% of anhydrous forms of ammonia is reportable under this listing. If a facility manufactures, processes, or otherwise uses anhydrous ammonia or aqueous ammonia, they must report under the ammonia listing. Solutions containing aqueous ammonia at a concentration in excess of 1% of the 10% reportable under this listing should be factored into threshold and release determinations.

US DOT 49CFR172.10; Poisonous by inhalation substances (anhydrous UN1005).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R10; R23; R34; R50; Safety phrases: S1/2; S9; S16; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (anhydrous).

Description: Ammonia is a colorless, strongly alkaline, and extremely soluble gas with a pungent, suffocating odor. Odor threshold = 5.75 ppm. Molecular weight = 17.03. Boiling point = −33.35°C; Vapor pressure = 2070 kPa at 50°C; Flash point = (flammable gas); Autoignition temperature = 630°C. Explosive limits: LEL = 13%; UEL = 28%. Hazard Identification (based on NFPA-704 M Rating System): (*strong solution >27% <31% in water*) Health 4, Flammability 1, Reactivity 2d (*also:* highly corrosive); (*ammonia solution >10% <35% with density >0.880* at *15°C*) Health 3, Flammability 0, Reactivity 1. Anhydrous ammonia is a colorless, highly irritating gas at room temperature with a pungent, suffocating odor. Ammonia gas is lighter than air; hugs the ground when cool; and flammable at high concentrations and temperatures. Easily compressed, it forms a clear, colorless liquid under pressure. Floats and "boils" on water. Readily dissolves in water, forming ammonium hydroxide, an alkaline, corrosive solution. Poisonous, visible vapor cloud is produced.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. Ammonia is used as a nitrogen source for many nitrogen-containing compounds. It is used in the production of ammonium sulfate and ammonium nitrate for fertilizers; and in the manufacture of nitric acid, soda, synthetic urea, synthetic fibers, dyes, and plastics. It is also utilized as a refrigerant and in the petroleum refining and chemical industries. It is used in the production of many drugs and pesticides. Other sources of occupational exposure include the silvering of mirrors, gluemaking, tanning of leather, and around nitriding furnaces. Ammonia is produced as a by-product in coal distillation and by the action of steam on calcium cyanamide, and from the decomposition of nitrogenous materials.

Incompatibilities: Violent reaction with strong oxidizers and acids. Shock-sensitive compounds may be formed with gold, halogens, mercury, mercury oxide, and silver oxide. Fire and explosions may be caused by trimethylammonium amide, 1-chloro-2,4-dinitrobenzene, *o*-chloronitrobenzene, platinum, trioxygen difluoride, selenium difluoride dioxide, boron halides, mercury, chlorine, iodine, bromine, hypochlorites, chlorine bleach, amides, organic anhydrides, isocyanates, vinyl acetate, alkylene oxides, epichlorohydrin, and aldehydes. Attacks some coatings, plastics, rubber, copper, brass, bronze, aluminum, steel, tin, zinc, and their alloys.

Permissible Exposure Limits in Air

OSHA PEL: 50 ppm/35 mg/m^3 TWA.

NIOSH REL: 25 ppm/18 mg/m^3 TWA; 35 ppm/27 mg/m^3 STEL.

ACGIH TLV®[1]: 25 ppm/17 mg/m^3 TWA; 35 ppm/24 mg/m^3 STEL.

Protective Action Criteria (PAC) ammonia*

TEEL-0: 25 ppm

PAC-1: **30** ppm

PAC-2: **160** ppm

PAC-3: **1100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)
ERPG-1: 25 ppm
ERPG-2: 150 ppm
ERPG-3: 750 ppm
DFG MAK: MAK: 20 ppm/14 mg/m^3; Peak Limitation Category I(2); Pregnancy Risk Group: C (2006).
NIOSH IDLH: 300 ppm.
Arab Republic of Egypt: TWA 25 ppm (18 mg/m^3), 1993; Australia: TWA 25 ppm (18 mg/m^3); STEL 35 ppm, 1993; Austria: MAK 25 ppm (18 mg/m^3), 1999; Belgium: TWA 25 ppm (17 mg/m^3); STEL 35 ppm (24 mg/m^3), 1993; Denmark: TWA 25 ppm (18 mg/m^3), 1999; Finland: TWA 25 ppm (18 mg/m^3); STEL 40 ppm (30 mg/m^3), 1993; France: VME 25 ppm (18 mg/m^3), VLE 50 ppm (36 mg/m^3), 1999; the Netherlands: MAC-TGG 14 mg/m^3, 2003; India: TWA 25 ppm (18 mg/m^3); STEL 35 ppm (27 mg/m^3), 1993; Japan: 25 ppm (17 mg/m^3), 1999; Norway: TWA 25 ppm (18 mg/m^3), 1999; the Philippines: TWA 50 ppm (30 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; MAC (STEL) 27 mg/m^3, 1999; Russia: TWA 25 ppm; STEL 20 mg/m^3, 1993; Sweden: NGV 25 ppm (18 mg/m^3), TGV 50 ppm (35 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (18 mg/m^3), KZG-W 50 ppm (36 mg/m^3), 1999; Thailand: TWA 50 ppm (35 mg/m^3), 1993; Turkey: TWA 25 ppm (35 mg/m^3), 1993; United Kingdom: TWA 25 ppm (18 mg/m^3); STEL 35 ppm (25 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 35 ppm. Several states have set airborne guidelines or standards for ammonia in ambient air[60]: 25 ppm (18 mg/m^3) TWA and STEL of 35 ppm (27 mg/m^3) (California), 0.024 mg/m^3 (Massachusetts), 0.042857 mg/m^3 (Kansas), 0.18−0.27 mg/m^3 (North Dakota), 0.25 mg/m^3 (Virginia), 0.36 mg/m^3 (Connecticut, Florida, New York, South Dakota), 0.429 mg/m^3 (Nevada, Wyoming), 2.7 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #6015, and #6016, OSHA Analytical Method ID-164; ID-188.

Permissible Concentration in Water: Russia[43] set a MAC of 2.0 mg/mL in water bodies used for domestic purposes and 0.05 mg/mL in water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin, and eye contact.

Harmful Effects and Symptoms

LC_{50} (inh/4 h, mice) = 2115 ppm.

Short Term Exposure: Eye or skin contact with ammonia can cause irritation, burns, frostbite (anhydrous), and permanent damage. Irritates the respiratory tract causing coughing, wheezing, and shortness of breath. Higher exposure can cause pulmonary edema, a medical emergency, that can be delayed for several hours and is life threatening. Exposure can cause headache, loss of sense of smell, nausea, and vomiting. *Inhalation:* Nose and throat irritation have been reported at 72 ppm after 5 min exposure. Exposures of 500 ppm for 30 min have caused upper respiratory irritation, tearing, increased pulse rate and blood pressure. Death has been reported after an exposure to 10,000 ppm for an unknown duration.

Skin: Solutions of 2% ammonia can cause burns and blisters after 15 min of exposure. These burns may be slow to heal. Anhydrous ammonia may cause skin to freeze. *Eyes:* Levels of 70 ppm (gas) have caused eye irritation. If not flushed with water immediately, contact with eye may cause partial or complete blindness. *Ingestion:* Ammonia will cause pain if swallowed and burning of the throat and stomach. May cause vomiting. One teaspoon of 28% aqua ammonia may cause death.

Long Term Exposure: Repeated exposure can cause chronic eye, nose, and throat irritation. Repeated lung irritation can result in bronchitis with coughing, shortness of breath, and phlegm. Levels of 170 ppm of ammonia vapor has caused mild changes in the spleens, kidneys, and livers of guinea pigs.

Points of Attack: Skin, respiratory system, eyes.

Medical Surveillance: Preemployment physical examinations for workers in ammonia exposure areas should be directed toward significant changes in the skin, eyes, and respiratory system. Persons with corneal disease, glaucoma, or chronic respiratory diseases may suffer increased risk. Periodic examinations should include evaluation of skin, eyes, respiratory system, and pulmonary function test to compare with baselines established at preemployment examination. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots; Viton™ gloves, suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 hr** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min.): nitrile rubber gloves, suits, boots. Appropriate clothing should be worn to prevent any possible skin contact with liquids of >10% content or reasonable probability of contact with liquids of <10% content. Wear eye protection to prevent any potential for eye contact with liquids of $>10\%$ NH_3 content. Employees should wash immediately when skin is wet or contaminated with liquids of $>10\%$ content. Remove nonimpervious clothing immediately if wet or contaminated with liquids containing $>10\%$ and promptly remove if liquid contains $<10\%$ NH_3 are involved. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas- or splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *250 ppm*: CcrS* (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern) or Sa* (APF = 10) (any supplied-air respirator). *300 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS* (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern) or CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White stripe (*strong solution $>27\%$ $<31\%$*): Contact Hazard; not compatible with materials in solid white category. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a cool, well-ventilated, noncombustible location, preferably with automatic monitoring systems, away from all possible sources of ignition. Separate from other chemicals, particularly oxidizing gases, chlorine, bromine, iodine, and acids.

Shipping: Shipped in tank cars, tank trucks, barges, and steel cylinders. Labeling and restrictions vary with concentration[19, 20]:

UN 3318 and UN 1005: Label For domestic: "INHALATION HAZARD; TOXIC GAS." For international: "POISON (TOXIC) GAS, CORROSIVE." Hazardous Class or Division for international: 2.3, subsidiary 2.2; For international: 2.3; subsidiary hazard 8.

Note: For other solutions, see Ammonium hydroxide (1336-21-6).

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Stop the flow of gas if it can be done safely. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and full protective clothing. If the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty. For small liquid spills, neutralize with hydrochloric acid. Wipe or mop or use water aspirator. Drain into sewer with sufficient water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Ammonia (used as a weapon): not listed in current DOT tables.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.4/2.3

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. Poisonous gases, including nitrogen oxides, are produced in fire. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Vapors may travel long distances to ignition sources and flash back. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. *Do not put water on liquid ammonia; will increase evaporation. Small fires:* dry chemical or carbon dioxide. *Large fires:* water spray, fog or foam. Apply water gently to the surface. Do not get water inside container. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Isolate area until gas has dispersed.

Disposal Method Suggested: Dilute with water, neutralize with HCl and discharge to sewer. Recovery is an option to disposal which should be considered for paper manufacture, textile treating, fertilizer manufacture, and chemical process wastes.

References

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US Environmental Properties Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ammonia.* Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Ammonia*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Ammonia.* Trenton, NJ

Ammonium acetate A:0960

Molecular Formula: $C_2H_7NO_2$
Common Formula: CH_3COONH_4
Synonyms: Acetic acid, ammonium salt
CAS Registry Number: 631-61-8
RTECS® Number: AF3675000
UN/NA & ERG Number: UN3077/171
EC Number: 211-162-9

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%: Source of aqueous ammonia. Molecular weight 77.08. NH_3 Equivalent weight 22.09.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium acetate is a white crystalline solid with an acetic odor. Molecular weight = 77.08; Boiling point = Decomposes; Specific gravity = 1.17 at 20°C. Heat of solution = -0.13×10^5 J/kg; Freezing/Melting point = 114°C. Soluble in water.

Potential Exposure: Ammonium acetate is used as a chemical reagent; to make drugs, foam rubber, vinyl plastics, explosives; and to preserve meats.

Incompatibilities: Sodium hypochlorite, potassium chlorate; sodium nitrite; strong oxidizers; strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 2.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Can irritate the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Inhalation can irritate the nose, throat, and lungs; high levels can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposures can cause lung irritation and the development of bronchitis with coughing, shortness of breath, and phlegm.

Points of Attack: Respiratory system, eyes, skin.
Medical Surveillance: Lung function tests. Consider chest X-ray following acute exposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wash thoroughly immediately after exposure to Ammonium Acetate.
Respirator Selection: Where there is the potential for exposure to ammonium acetate: SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sodium hypochlorite, potassium chlorate, and sodium nitrite since violent reactions occur.
Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of “CLASS 9.” It falls in Hazard Class 9 and Packing Group III.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Ammonium Acetate may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including ammonia and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties Of Industrial Materials Report,* 2, No. 3, 30−31

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Ammonium Acetate*. Trenton, NJ

Ammonium arsenate A:0970

Molecular Formula: $AsH_3O_4 \cdot 2H_3N$
Synonyms: Ammonium acid arsenate; Arsenic acid, diammonium salt; Diammonium arsenate; Diammonium monohydrogen arsenate; Dibasic ammonium arsenate
CAS Registry Number: 7784-44-3
RTECS® Number: CG0850000
UN/NA & ERG Number: UN1546/151
EC Number: 232-067-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (arsenic compounds).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Clean Water Act Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as arsenic compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (arsenic compounds).

Reportable Quantity (RQ): 1 lb (0.454 kg) (arsenic compounds).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds); Form R *de minimis* concentration reporting level: 1.0%. Source of aqueous ammonia. Molecular weight 176. NH_3 Equivalent weight 19.35.

California Proposition 65 Chemical: Cancer 2/27/87.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) arsenic compounds.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ammonium arsenate a combustible, white powder or plate-like colorless crystal. Molecular weight = 176.03; Freezing/Melting point = (decomposes). Soluble in water.

Incompatibilities: Hydrogen gas forms highly toxic arsine gas on contact with inorganic arsenic.

Permissible Exposure Limits in Air

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.

No TEEL available.

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/ end-of-shift; Carcinogen Category 1.

NIOSH IDLH: 5 mg[As]/m^3.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen.

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301, #7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact can contribute to overall exposure. Irritates eyes, skin, and respiratory tract. Eye contact may cause burns and permanent damage. Inhalation may irritate the nose and throat causing coughing and wheezing. Repeated exposures may cause an ulcer or hole in the cartilage dividing the inner nose and may lead to poor appetite, a metallic or garlic taste, nausea, vomiting, stomach pain, and diarrhea.

Long Term Exposure: May cause liver damage. Prolonged or repeated exposure may cause disturbed sleep, with a feeling of "pins and needles" and loss of coordination. While ammonium arsenate has not been identified as a carcinogen, arsenic and certain arsenic compounds have been determined to be carcinogens. This chemical should be handled with extreme care.

Points of Attack: Liver, central nervous system, eyes, skin.

Medical Surveillance: Liver function, nervous system, and skin tests. Urine tests for arsenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where ammonium arsenate is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Ammonium arsenate requires a shipping label of "POISONOUS/TOXIC MATERIALS." Ammonium arsenate is in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium arsenate is a combustible solid. Poisonous gases, including arsenic, ammonia, and nitrogen oxides are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Ammonium Arsenate*. Trenton, NJ

Ammonium bicarbonate A:0980

Molecular Formula: CH_5NO_3

Common Formula: NH_4HCO_3

Synonyms: ABC-Trieb; Acid ammonium carbonate; Acid ammonium carbonate, monoammonium salt; Ammonium hydrogen carbonate; Bicarbonato amonico (Spanish); Carbonic acid, monoammonium salt

CAS Registry Number: 1066-33-7

RTECS$^{®}$ Number: BO0860000

UN/NA & ERG Number: UN3077/171

EC Number: 213-911-5

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium bicarbonate is a white crystalline solid with a faint ammonia odor. Molecular weight 79.07; Boiling point = Decomposes; Freezing/Melting point = 107.5°C (if heated very rapidly, decomposition may start at 35−60°C); Heat of solution = 3.3×10^5 J/kg. Soluble in water; solubility = 17.4% at 20°C.

Potential Exposure: It is used in leavening for some baked goods, in baking powders and fire extinguishers, to make dyes and pigments, in the manufacture of porous plastics, and as an expectorant.

Incompatibilities: Contact with strong caustics, such as potassium hydroxide, or sodium hydroxide will cause the release of ammonia gas.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 200 mg/m^3

Harmful Effects and Symptoms
The dust can irritate skin, eyes, and mucous membranes. Higher concentrations can cause temporary blindness, pulmonary edema, and cyanosis. It can severely injure respiratory membranes with possible fatal results.

Short Term Exposure: Irritates eyes, skin, and respiratory tract.

Long Term Exposure: Prolonged or repeated exposure may cause lung damage.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from caustics (such as sodium hydroxide or potassium hydroxide) because ammonia gas is released.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bicarbonate may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia gas and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank

discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be buried in a chemical waste landfill, if neutralized ammonium bicarbonate is amenable to treatment at a municipal sewage treatment plant.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report,* 4, No. 2, 43–45

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Ammonium Bicarbonate*. Trenton, NJ

Ammonium bifluoride A:0990

Molecular Formula: F_2H_5N

Common Formula: NH_4HF_2, $NH_3 \cdot H_2F_2$

Synonyms: Acid ammonium fluoride; Ammonium acid fluoride; Ammonium hydrogen difluoride; Ammonium hydrogen fluoride; Bifluoruro amonico (Spanish)

CAS Registry Number: 1341-49-7

RTECS® Number: BQ9200000

UN/NA & ERG Number: UN1727 (solid)/154; UN2817 (ammonium hydrogendifluoride, solution)/154

EC Number: 215-676-4 [*Annex I Index No.:* 009-009-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 29.86.

European/International Regulations: Hazard Symbol: T, C; Risk phrases: R25; R34; Safety phrases: S1/2; S22; S26; S37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium bifluoride. Molecular weight = 57.04; Boiling point = 239.5°C; Melting/Freezing point = 125.6°C; Specific gravity = 1.5 at 20°C; Heat of solution = 3.59×10^5 J/kg is a white crystalline compound that is commonly found in solution. Molecular weight = 57.04; Boiling point = 239.5°C; Melting/Freezing point = 125.6°C; Specific gravity = 1.5 at 20°C; Heat of solution = 3.59×10^5 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: It is used as a sterilizer, in dairy and brewery operations, in ceramic, glass, and electroplating industries, and as a laundry sour.

Incompatibilities: Strong oxidizers, acids. In the presence of moisture, it corrodes concrete, metals, glass.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

NIOSH IDLH: 250 mg[F]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 3.75 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 375 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Fluorides (as F) may be collected on a filter and measured by an ion-specific electrode according to NIOSH Analytical Method 7902.[18]

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: The dust irritates and burns the eyes, skin, nose, throat, and lungs. Eye contact may cause permanent damage. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Between 1 teaspoonful and 1 oz may be fatal to humans by ingestion. Ingestion will in any case cause irritation of the mouth and stomach and can cause vomiting, convulsions, collapse, and acute toxic nephritis. If absorbed through the skin this chemical may cause added exposure.

Long Term Exposure: May cause chronic lung irritation and kidney and liver damage. Bronchitis may develop. Chronic exposure may cause weight loss, nausea, vomiting, weakness, shortness of breath.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), pelvic X-ray, sputum cytology, urine (chemical/metabolite), urine (chemical/metabolite) pre- and postshift, urinalysis (routine), complete blood count/differential. Intake of fluoride from natural sources in food or water should be known. In the case of exposure to fluoride dusts, periodic urinary fluoride excretion levels have been very useful in evaluating industrial exposures and environmental dietary sources.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95X* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:*100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine and fluorine) since highly poisonous hydrogen fluoride gas is released. Keep in plastic, rubber or paraffined containers (because it easily etches glass).

Shipping: Ammonium hydrogendifluoride, solid, requires a shipping label of "CORROSIVE MATERIAL" and for solutions is "CORROSIVE MATERIAL, POISON INHALATION HAZARD Zone A or B." The Hazard Class is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bifluoride may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be buried in a specially designated chemical landfill. Aqueous wastes may be reacted with an excess of lime followed by lagooning and by either recovery or land disposal of the separated calcium fluoride.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluoride*, NIOSH Document No. 76-103

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report,* 3, No. 5, 34−37

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Bifluoride*. Trenton, NJ

Ammonium bisulfite A:1000

Molecular Formula: $H_3N \cdot H_2O_3S$

Synonyms: Ammonium hydrogen sulfite; Ammonium monosulfite; Monoammonium sulfite; Sulfurous acid, monoammonium salt

CAS Registry Number: 10192-30-0

RTECS® Number: WT3595000

UN/NA & ERG Number: UN2693 (bisulfites, inorganic, aqueous solution, n.o.s.)/154

EC Number: 233-469-7

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) Molecular weight: 99.10; NH_3 Equivalent weight: 17.18.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium bisulfite is a white crystalline solid or colorless to yellow solution. Molecular weight = 99.1; Melting/Freezing point = 150°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 26.7%.

Potential Exposure: Used as a preservative, in drilling fluids, making industrial explosives, hair waving and bleaching agents, for making other chemicals. A source of sulfur in liquid fertilizers.

Incompatibilities: Sulfites react explosively on contact with oxidizers. Reacts with acids, acid fumes, and water. Corrosive to metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

DFG MAK: Sensitizing substances*, as sulfites.*

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium bisulfite is highly corrosive. Eye and skin contact can cause severe irritation and burns with possible permanent damage. Inhalation can irritate the lungs, causing coughing and shortness of breath. Higher exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung damage.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, combustible materials.

Shipping: Bisulfites, inorganic, aqueous solutions, n.o.s. require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bisulfite is noncombustible. Poisonous gases, including ammonia, sulfur oxides, and nitrogen oxides, are produced in fire. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate. It may be possible to dispose of waste material at a municipal facility if treated, neutralized, and oxidized.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Ammonium Bisulfite*. Trenton NJ

Ammonium carbamate A:1010

Molecular Formula: $CH_6N_2O_2$

Common Formula: NH_4COONH_2

Synonyms: Ammonium aminoformate; Anhydride of ammonium carbonate; Carbamato amonico (Spanish); Carbamic acid, ammonium salt; Carbamic acid, monoammonium salt

CAS Registry Number: 1111-78-0

RTECS® Number: EY8575000

UN/NA & ERG Number: UN2757 (carbamate pesticide, solid, toxic)/151

EC Number: 214-185-2

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) Molecular weight: 99.10; NH_3 Equivalent weight: 21.81.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium carbamate is a colorless crystalline powder or white powder with an ammonia odor; Freezing/Melting point = about 60°C (sublimes). The odor threshold is 5 ppm as NH_3 (detection) and 46.8 ppm as NH_3 (recognition). Molecular weight = 78.07; Boiling point = 60°C; Heat of combustion: (estimate) at 25°C: −2612 Btu/lb; Heat of solution: (endothermic) 86.9 Btu/lb. Highly soluble in water.

Potential Exposure: It is used as a fertilizer and ammoniating agent.

Incompatibilities: Strong bases, strong oxidizers. Keep away from heat (forms urea), moisture, and direct sunlight.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.3 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 6 mg/m^3
PAC-3: 35 mg/m^3

Harmful Effects and Symptoms

Irritates skin, respiratory tract, and mucous membranes on contact.

Short Term Exposure: Exposure can irritate the eyes and skin, causing redness and tearing. Inhalation can irritate the nose and lungs with coughing and/or shortness of breath.

Long Term Exposure: Repeated or prolonged exposure can cause lung irritation and the development of bronchitis.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Lung function testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, moisture, and direct sunlight. See also Incompatibilities.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It is in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia, urea, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 31−33

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Carbamate*. Trenton, NJ

Ammonium carbonate A:1020

Molecular Formula: $CH_8N_2O_3$

Common Formula: $(NH_4)_2CO_3$

Synonyms: Ammoniumcarbonat (German); Carbonato amonico (Spanish); Carbonic acid, ammonium salt; Carbonic acid, diammonium salt; Crystal ammonia; Diammonium carbonate; Hartshorn; Sal volatile

CAS Registry Number: 506-87-6
RTECS® Number: BP1925000
UN/NA & ERG Number: UN3077/171
EC Number: 208-058-0
Regulatory Authority and Advisory Bodies
Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA).
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 35.45.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium carbonate is a colorless crystal or white lumpy powder with a strong ammonia odor. The odor threshold is <5 ppm as ammonia gas. Molecular weight: 96.09; Freezing/Melting point = 58°C and volatilizes at about 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: It is used in dyeing, tanning, medicines, fire extinguishers and in making casein glue, ammonia salts, and baking powders. A laboratory reagent.

Incompatibilities: Acids, acid salts, salts of iron and zinc, alkaloids, calomel, and tartar emetic. Keep cool, below 38°C.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.75 mg/m^3
PAC-1: 2.5 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 75 mg/m^3

Routes of Entry: Inhalation, ingestion, eye and skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Contact can irritate eyes and nose. Breathing Ammonium Carbonate can irritate the nose, throat, and lungs, causing a cough and difficulty in breathing.
Long Term Exposure: May cause lung problems.
Points of Attack: Lungs, eyes, skin.
Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from temperatures above 38°C.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of “CLASS 9.” It falls in Hazard Class 9 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Slowly deposit in a large container of water. Add excess amounts of soda ash and let stand for 24 h. Decant to another container, neutralize with hydrochloric acid, and drain with an excess of water. Ship to landfill.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 33−34

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Ammonium Carbonate*. Trenton, NJ

Ammonium chloride A:1030

Molecular Formula: NH_4Cl

Synonyms: Amchlor; Amchloride; Ammoneric; Ammonium muriate; AM solder flux; Cloruro amonico (Spanish); Salamac; Sal ammoniac; Salmiac; Slago

CAS Registry Number: 12125-02-9

RTECS® Number: BP4550000

UN/NA & ERG Number: UN3077/171

EC Number: 235-186-4 [*Annex I Index No.*: 017-014-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) Molecular weight: 53.49; NH_3 Equivalent weight: 31.38.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36; Safety phrases: S2; S22 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium chloride is a white crystalline solid. Odorless. Molecular weight = 53.50; Boiling point = 520°C; Freezing/Melting point = 338°C (sublimes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water; solubility = 37%.

Potential Exposure: Compound Description: Drug, Mutagen, Human Data; Primary Irritant. Ammonium chloride is used as an industrial chemical, pharmaceutical, and veterinary drug; to make dry batteries; in galvanizing; and as a soldering flux.

Incompatibilities: Acids, alkalis, and silver salts.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: (fume) 10 mg/m^3 TWA; 20 mg/m^3 STEL.

ACGIH TLV®[1]: (fume) 10 mg/m^3 TWA; 20 mg/m^3 STEL

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 10 mg/m^3; STEL 20 mg/m^3 (fume), 1993; Denmark: TWA 10 mg/m^3, 1999; Russia: STEL 10 mg/m^3 (fume), 1993; United Kingdom: TWA 10 mg/m^3 (fume) STEL 20 mg/m^3 (fume), 2000; Belgium: TWA 10 mg/m^3; STEL 20 mg/m^3 (fume), 1993; France: VME 10 mg/m^3 (fume), 1999; Poland: TWA 10 mg/m^3; STEL 20 mg/m^3 (vapors and fumes), 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 20 mg/m^3, fume. Several states have set guidelines or standards for ammonium chloride in ambient air[60]: 0.1 mg/m^3 (North Dakota), 0.15 mg/m^3 (Virginia), 0.2 mg/m^3 (Connecticut, South Dakota), 0.238 mg/m^3 (Nevada) to 0.25 mg/m^3 (South Carolina).

Determination in Air: Collection on a filter and colorimetric analysis.

Permissible Concentration in Water: Russia[43] set a MAC of 1.2 mg/L in water for fishery purposes. May be toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium chloride is an eye, skin, and respiratory system irritant with a low-grade systemic toxicity by ingestion.

Points of Attack: Skin, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked everyday before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, alkalis, and silver salts. Protect against physical damage.[17]

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia, chlorine gas, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves addition of sodium hydroxide to liberate ammonia and form the soluble sodium salt. The liberated ammonia can be recovered and sold. After dilution to the permitted provisional limit, the sodium salt can be discharged into a stream or sewer.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 34−36

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Ammonium Chloride*. Trenton, NJ

Ammonium chloroplatinate A:1040

Molecular Formula: $Cl_6H_8N_2Pt$

Common Formula: $(NH_4)_2PtCl_6$

Synonyms: Ammonium platinic chloride; Diammonium hexachloroplatinate(2-); Diammonium hexachloroplatinate (VI); Platinate(2-), platinic ammonium chloride

CAS Registry Number: 16919-58-7

RTECS® Number: BP5425000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 240-973-0 [*Annex I Index No.:* 078-008-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Dropped from CERCLA/SARA EHS listing in 1988.

European/International Regulations: Hazard Symbol: T; Risk phrases: R25; R41; R42/43; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium chloroplatinate is an orange-red crystalline cubic solid or yellow powder which decomposes when heated. Molecular weight = 443.5. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1. Soluble in water; solubility = 0.7 g/100 mL at 15°C.

Potential Exposure: It is used in photography, platinum plating, and in the manufacture of platinum sponge.

Incompatibilities: This material is unstable and potentially explosive. Incompatible with alkali, acids, and strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.002 mg[Pt]/m^3 TWA.

NIOSH REL: 0.002 mg[Pt]/m^3 TWA.

ACGIH TLV®[1]: 10.002 mg[Pt]/m^3 TWA.

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

NIOSH IDLH: 4 mg [Pt]/m^3.

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye and skin irritation can cause irritation and burns. Inhalation can cause respiratory tract irritation, causing coughing and shortness of breath. First symptoms are pronounced irritation of the nose and upper respiratory passages, with sneezing, running of eyes, and coughing. Later, "asthmatic syndrome," with cough, tightness of chest, wheezing, and shortness of breath develops. It is toxic by inhalation or ingestion. Toxic concentrations for inhalation are 0.9 μ/min. LD$_{50}$ = (oral-rat) 195 mg/kg.

Long Term Exposure: Platinum salts can cause asthma-like allergy and skin allergy. Symptoms begin during exposure and grow worse with chronic exposure.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. Like treatment for other platinum salts remove victim to fresh air and give oxygen. Nasal washing to remove salts is recommended. In case of skin or eye contact, irrigate with water immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration above 0.05* mg/m^3: Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or 0.1 mg/m^3: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *4 mg/m^3:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids and strong oxidizers.

Shipping: Toxic solid, inorganic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific

recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium chloroplatinate may burn but is hard to ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including ammonia, nitrogen oxides, chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Because of the high value of the metal, recovery is the economically indicated disposal method.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Ammonium Chloroplatinate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Ammonium Chloroplatinate*. Trenton, NJ

Ammonium chromate A:1050

Molecular Formula: $CrH_8N_2O_4$

Common Formula: $(NH_4)_2CrO_4$

Synonyms: Ammonium chromate(VI); Chromic acid, diammonium salt; Cromato amonico (Spanish); Diammonium chromate; Neutral ammonium chromate

CAS Registry Number: 7788-98-9; 52110-72-2

RTECS® Number: GB2880000

UN/NA & ERG Number: UN3288 (Toxic solids inorganic)/151

EC Number: 232-138-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA (*inhalation*): Known human carcinogen; EPA (*oral*): Not classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as chromium compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (chromium compounds).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight = 22.04. *Also must be reported as a chromium compound:* "Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ammonium chromate is a yellow crystalline compound which can be used in solution, which is yellow with an ammonia odor. Molecular weight = 152.07; Boiling point = 180°C; Heat of solution (endothermic at 25°C) = 68.6 Btu/lb; Freezing/Melting point = 185°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0, Oxidizer. Soluble in water.

Potential Exposure: It is used to inhibit corrosion, in dyeing, in photography, and in many chemical reactions. Used as a fungicide and fire retardant.

Incompatibilities: A strong oxidizer and an explosive. Contact with combustible, organic, and other readily oxidizable substances may cause fire and explosions. Hydrazine, other reducing agents. Corrosive to metals.

Permissible Exposure Limits in Air

as chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m$^{3.}$

Protective Action Criteria (PAC)

TEEL-0: 0.0146 mg/m^3

PAC-1: 1.25 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 43.9 mg/m^3
DFG MAK: Inhalable fraction; [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.
Russia has set a MAK value of 0.01 mg/m^3 for chromates and bichromates in the workplace.[43]

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: To protect human health, hexavalent chromium should be held below 0.05 mg/L according to EPA[6] in studies on priority toxic pollutants. This is also a WHO recommendation for total chromium in drinking water.

Determination in Water: Chromium (VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide).

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause severe damage with possible loss of vision. Breathing ammonium chromate can cause a sore or hole through the inner nose (septum), sometimes with bleeding, discharge, or crusting. Irritation of nose, throat, and bronchial tubes can also occur, with cough and/or wheezing. Skin contact can cause deep ulcers or an allergic skin rash.

Long Term Exposure: Some water-soluble chromium[16] compounds are inferred noncarcinogens; the water-insoluble compounds are generally deemed to be carcinogens but the border line is neither precise nor universally agreed to. Ammonium chromate is a hexavalent chromium compound which may be carcinogenic and should be handled with extreme caution. Breathing ammonium chromate can cause sores or hole in the septum dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. May cause skin allergy and kidney damage.

Points of Attack: Blood, respiratory system, liver, kidneys, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count; chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Also consider skin and nose examination, kidney function tests, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact (as chromic acid and chromates). **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue (carcinogen): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and away from contact with easily oxidized or combustible materials; heat or any condition which could shock it. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic solid, inorganic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium chromate explodes when heated. Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. Use water only. *Do not* use dry chemical, carbon dioxide, halon, or foam extinguishers. Storage containers may explode and parts of containers may rocket great distances in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Addition of a large volume of a reducing agent solution (hypo, bisulfite, or ferrous salt, and acidify with 3M sulfuric acid). When reduction is complete, flush to drain with large volumes of water.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report,* 2, No. 3, 36−38

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Chromium* (*VI*), NIOSH Document No. 76-129

US Environmental Protection Agency. (1980). *Chromium: Ambient Water Quality Criteria*. Washington, DC

Agency for Toxic Substances and Disease Registry. (1988). *Toxicological Profile for Chromium*. Atlanta, GA

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Ammonium Chromate*. Trenton, NJ

Ammonium citrate A:1060

Molecular Formula: $C_6H_{14}N_2O_7$

Common Formula: $NH_4COOCH_2C(OH)(COOH)CH_2COONH_4$

Synonyms: Ammonium citrate, dibasic; Citrato amonico dibasico (Spanish); Citric acid, ammonium salt; Citric acid, diammonium salt; Diammonium citrate; Diammonium hydrogen citrate; Dibasic ammonium citrate; 1,2,3-Propane tricarboxylic acid, 2-hydroxy-, ammonium salt

CAS Registry Number: 7632-50-0; 3012-65-5 (dibasic); 3458-72-8 (tribasic)

RTECS® Number: GE7573000

UN/NA & ERG Number: UN3077/171

EC Number: 221-146-3

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 15.06.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium citrate, dibasic, is a white powdery material with a slight ammonia odor. Molecular weight: 226.19. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: It is used in pharmaceuticals, to make rust-proofing compounds and plasticizers, and as a food additive.

Incompatibilities: Contact with strong caustics causes the release of ammonia gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 150 mg/m^3

Dibasic
TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 200 mg/m^3

Tribasic
TEEL-0: 1.5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 35 mg/m^3
PAC-3: 185 mg/m^3

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate eyes, nose, throat, and lungs. Contact may irritate the skin.

Points of Attack: Eyes, lungs, skin.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to ammonium citrate.

Respirator Selection: *At any detectable concentration:* PaprTHie (APF = 50) (any NIOSH/MSHA- or European Standard EN 149-approved air-purifying respirator with a tight-fitting full face-piece and a high-efficiency particulate filter) or SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from caustics (such as sodium hydroxide or potassium hydroxide) because ammonia gas is released.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium citrate may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia gas and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with large volumes of water.

References

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Ammonium Citrate*. Trenton, NJ

Ammonium dichromate A:1080

Molecular Formula: $Cr_2H_8N_2O_7$

Common Formula: $(NH_4)_2Cr_2O_7$

Synonyms: Ammonium bichromate; Ammonium dichromate(VI); Bicromato amonico (Spanish); Chromic acid, diammonium salt; Diammonium dichromate

CAS Registry Number: 7789-09-5

RTECS® Number: HX7650000

UN/NA & ERG Number: UN1439/141

EC Number: 232-143-1 [*Annex I Index No.:* 024-003-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA (*inhalation*): Known human carcinogen; EPA (*oral*): Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as chromium compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (chromium compounds).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical.

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 13.51. *Also must be reported as a chromium compound:* "Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%. Form R Toxic Chemical Category Code: N090.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: E, T + , N; Risk phrases: R45; R46; R60; R61; R2; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ammonium dichromate is a combustible, orange-red crystalline solid which is used in solution. Molecular weight = 252.10; Freezing/Melting point = 170°C (see Incompatibilities); Autoignition temperature = 225°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1 (oxidizer). Soluble in water; solubility = 36% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. It is used in dyeing, leather tanning, to make fireworks and chromic oxide, in lithography and photoengraving, and in manufacture of special mordants and catalysts.

Incompatibilities: An unstable oxidizer; Freezing/Melting point = (decomposes below MP) 180°C; decomposition becomes self-sustaining and violent at about 225°C. Contact with combustible, organic or other easily oxidized materials, strong acids, hydrazine and other reducing agents, alcohols, and sodium nitrite may cause fire and explosions.

Permissible Exposure Limits in Air

As chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

Protective Action Criteria (PAC).

TEEL-0: 0.0121 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 36.4 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Russia[43] has set a MAK value of 0.01 mg/m^3 for chromates and bichromates in work-place air.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: To protect human health, hexavalent chromium should be held below 50 μg/L according to EPA[6] in studies on priority toxic pollutants. This is also a WHO recommendation for total chromium in drinking water.

Determination in Water: Chromium(VI) may be determined by extraction and atomic absorption or colorimetry using diphenylhydrazole.

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

LC_{50} (in h, 4 h; rat) = 0.094 mg/L [Merck].

Short Term Exposure: Should be handled as a carcinogen, with extreme caution. Ammonium dichromate can pass through the skin and may cause overexposure. Eye contact can cause severe damage with possible loss of vision. Irritation of nose, throat, and bronchial tubes can also occur, with cough and/or wheezing. Skin contact can cause deep ulcers or an allergic skin rash. Skin sensitization in humans.

Long Term Exposure: Ammonium dichromate is a hexavalent chromium compound which may be carcinogenic and should be handled with extreme caution. Breathing ammonium chromate can cause sores or hole in the septum dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. May cause skin allergy and kidney damage.

Points of Attack: Blood, respiratory system, liver kidneys, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Also consider skin and nose examination, kidney function tests, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. (as chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$)*:* polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and away from contact with easily oxidized or combustible materials; heat or any condition which could shock it. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: The UN/DOT label required is "OXIDIZER." The DOT/UN Hazard Class is 5.1 and the Packing Group is II.[20, 21]

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

Fire Extinguishing: Ammonium chromate is a combustible solid and explodes when heated. Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. Use water only. *Do not* use dry chemical, carbon dioxide, halon, or foam extinguishers. Storage containers may explode and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Add a large volume of a reductant solution (hypo, bisulfite, or ferrous salt and acidify with sulfuric acid). Neutralize when reduction is complete and flush to sewer with large volume of water.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Chromium* (*VI*), NIOSH Document No. 76-129

US Environmental Protection Agency. (1980). *Chromium: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.) *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 38−40 (1982) (as ammonium dichromate) and 3, No. 5, 29−32 (as ammonium bichromate)

Agency for Toxic Substances and Disease Registry. (1988). *Toxicological Profile for Chromium*, Atlanta, GA

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Ammonium Dichromate*. Trenton, NJ

Ammonium fluoride A:1090

Molecular Formula: FH_4N

Common Formula: NH_4F

Synonyms: 777 etch; Ammonium fluorure (French); B-etch; BOE (buffered oxide etch); Fluouro amonico (Spanish); Glass etch; Imahe etch; KTI buffered oxide etch 50:1; KTI buffered oxide etch 6:1; Neutral ammonium fluoride; Pad etch; Poly silicon etch

CAS Registry Number: 12125-01-8

RTECS® Number: BQ6300000

UN/NA & ERG Number: UN2505/154

EC Number: 235-185-9 [*Annex I Index No.:* 009-006-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants (as inorganic fluorides).

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L) 8100 (200): 8270 (10) (as inorganic fluorides).

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4 (as inorganic fluorides).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight = 45.98.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as fluoride compounds, inorganic.

Mexico, Wastewater (inorganic fluorides).

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium fluoride is a white crystalline solid. Molecular weight: 37.05; Freezing/Melting point = sublimes. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Ammonium fluoride is used in printing and dyeing textiles, glass etching, moth-proofing and wood preserving, in analytical chemistry and agriculture, and as antiseptic in brewing.

Incompatibilities: Acids, alkalis, chlorine trifluoride. Corrodes glass, cement, most metals.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 4.88 mg/m^3

PAC-1: 4.88 mg/m^3

PAC-2: 4.88 mg/m^3

PAC-3: 4.88 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Fluoride aerosols may be measured by collection on a filter followed by fluoride ion measurement using an ion-specific electrode. Use NIOSH Analytical Method 7902.

Routes of Entry: Inhalation, skin and/or eye contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the nose, throat, and lungs. Contact can irritate or burn the skin and eyes. Higher exposures could cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: With repeated exposure, some persons may notice poor appetite, nausea, constipation or diarrhea. Repeated overexposure to fluoride can cause brittle bones, stiff muscles and joints, and eventual crippling fluorosis. This usually takes years to develop. High or repeated exposure may scar the lungs, causing shortness of breath and reduced lung function. These effects do not occur with prescribed fluoride levels in drinking water or dental use to prevent cavities.

Points of Attack: Skin, eyes, respiratory system, bones, muscles.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), pelvic X-ray, sputum cytology, urine (chemical/metabolite), urine (chemical/metabolite) pre- and postshift, urinalysis (routine), complete blood count/differential. Urine fluoride level (should be less than 5 mg/L of urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Ammonium fluoride must be stored to avoid contact with acids or alkalis since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Keep in plastic, rubber, or paraffined containers (because it easily etches glass).

Shipping: Ammonium fluoride requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium fluoride may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 32−34

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Fluoride*. Trenton, NJ

Ammonium hexafluoro-silicate A:1100

Molecular Formula: $F_6H_8N_2Si$

Common Formula: $(NH_4)_2SiF_6$

Synonyms: Ammonium fluorosilicate; Ammonium hexafluorosilicate; Ammonium silicon fluoride; Diammonium fluosilicate; Diammonium silicon hexafluoride; Fluosilicate de ammonium (French); Fluosilicato amonico (Spanish); Picrato amonico (Spanish); Silicofluoruro amonico (Spanish)

CAS Registry Number: 16919-19-0; 1309-32-6

RTECS® Number: GQ9450000

UN/NA & ERG Number: UN2856 (fluorosilicates, n.o.s.)/151

EC Number: 240-968-3 [*Annex I Index No.:* 009-012-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Priority Pollutants (as inorganic fluorides)

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4 (as inorganic fluorides).

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10) (as inorganic fluorides).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 19.12.

Canada, WHMIS, Ingredients Disclosure List 1% as fluoride compounds, inorganic.

Canada's DSL List.

Mexico, Wastewater (inorganic fluorides).

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ammonium hexafluorosilicate is a white crystalline powder. Odorless. Molecular weight: 178.18; Boiling point = decomposes at 100°C; Melting/Freezing point = decomposes at 100°C; Heat of solution = 85 Btu/lb; Vapor pressure: <0.075 mm. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Sinks and mixes with water.

Potential Exposure: This material is used as a pesticide and miticide, wood preservative, soldering flux, light metal casting, and in the etching of glass.

Incompatibilities: Liquid is corrosive. Contact with acids and reacts to form hydrogen fluoride, which is a highly corrosive and toxic gas. Corrosive to aluminum. Keep away from strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC) 16919-19-0

TEEL-0: 3.91 mg/m^3

PAC-1: 11.7 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 391 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Fluorides may be measured by collection on a filter and measurement by ion-specific electrode according to NIOSH Analytical Method 7902.[18]

Permissible Concentration in Water: No criteria set for ammonium fluorosolicate as such. Russia[43] has set a limit of 1.5 mg/L for fluorine in water used for domestic purposes.

Routes of Entry: Inhalation, eyes and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause difficult breathing and burning of the mouth, throat, and nose which may result in bleeding. These may be felt at 7.5 mg/m^3. Nausea, vomiting, profuse sweating, and excess thirst may occur at higher levels. May cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Skin contact may cause rash, itching and burning, and ulceration of skin. Solutions of 1% strength may cause sores if not removed promptly. Eye contact may cause severe irritation. Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. A dose of 5−40 mg may cause nausea, diarrhea, and vomiting. More severe symptoms of burning and painful abdomen, sores in mouth, throat and digestive tract, tremors, convulsions, and shock will occur around a dose of 1 g. Death may result by ingestion of 2−5 g. Also reported as 1 teaspoon to 1 oz.

Long Term Exposure: May cause chronic lung irritation and kidney and liver damage. Bronchitis may develop. Chronic exposure may cause weight loss, nausea, vomiting, weakness, shortness of breath. Fluoride may increase bone density, stimulate new bone growth, or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 mg/m^3 or higher. May cause mottling of teeth at this level.

Points of Attack: Lungs, eyes.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), pelvic X-ray, sputum cytology, urine (chemical/metabolite), urine (chemical/metabolite) pre- and postshift, urinalysis (routine), complete blood count/differential. Intake of fluoride from natural sources in food or water should be known. In the case of exposure to fluoride dusts, periodic urinary fluoride excretion levels have been very useful in evaluating industrial exposures and environmental dietary sources.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a physician or authorized paramedic may consider administering a corticosteroid spray. *Note to physician:* Ingestion: Give aluminum hydroxide gel, if conscious. Inject intravenously 10 mL of 10% calcium gluconate solution. Gastric lavage with lime water of 1% calcium chloride.

Personal Protective Methods: Use only with an effective and properly maintained exhaust ventilation or with a fully enclosed process. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators.

The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine) since highly poisonous hydrogen fluoride gas is released. Keep in plastic, rubber, or paraffined containers (because it easily etches glass).

Shipping: Fluorosilicates, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Treat with soda ash or slaked lime. Use an industrial vacuum cleaner to remove the spill. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including fluorine, ammonia, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Water may be used but should be contained to prevent fluoride run-off.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides*, NIOSH Document No. 76-103

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 36−38 (ammonium silicofluoride)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ammonium Hexafluorosilicate*. Albany, NY: Bureau of Toxic Substance Assessment

Ammonium hydroxide A:1110

Molecular Formula: H_5NO

Common Formula: NH_4OH

Synonyms: Ammonia aqueous; Ammonia water; Aqua ammonia; Aqueous ammonia; Burmar lab clean; Enplate NI-418B; Enstrip NP-1; Hidroxido amonico (Spanish); Household ammonia; Poly silicon etch; PPD 5932 developer; Premetal etch; RCA clean (step 1); Scan kleen; Scrubber-Vapox

CAS Registry Number: 1336-21-6

RTECS® Number: BQ9625000

UN/NA & ERG Number: UN2672/154

EC Number: 215-647-6 [*Annex I Index No.:* 007-001-01-2]

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 48.59.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R34; R50; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ammonium Hydroxide is a colorless to milky-white solution of ammonia, with a strong, irritating odor. Molecular weight: 35.05; Boiling point = 37.8°C (25% NH_3)NH_3; Freezing/Melting point = −77°C; −58°C (25% NH_3); Vapor pressure = 11.9 mm; 48 (25% NH_3) Hg at 20°C. The odor threshold for ammonia is 0.043−47 ppm. Hazard Identification (based on NFPA-704 M Rating System) (*strong solution*): Health 3, Flammability 1, Reactivity 2. Soluble in water.

Potential Exposure: It is used in detergents, stain removers, bleaches, dyes, fibers, and resins.

Incompatibilities: Solution is strongly alkaline. Violent reaction with strong oxidizers, acids (exothermic reaction with strong mineral acids). Shock-sensitive compounds may be formed with halogens, mercury oxide, silver oxide. Fire and explosions may be caused by contact with β-propiolactone, silver nitrate, ethyl alcohol, silver permanganate, trimethylammonium amide, 1-chloro-2,4-dinitrobenzene, *o*-chloronitrobenzene, platinum, trioxygen difluoride, selenium difluoride dioxide, boron halides, mercury, chlorine, iodine, bromine, hypochlorites, chlorine bleach, amides, organic anhydrides, isocyanates, vinyl acetate, alkylene oxides, epichlorohydrin, aldehydes. Attacks some coatings, plastics, and rubber. Attacks copper, brass, bronze, aluminum, steel, zinc, and their alloys.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 25 ppm/17 mg/m^3 TWA; 35 ppm/24 mg/m^3 STEL.

NIOSH REL: 25 ppm/18 mg/m^3 TWA; 35 ppm/27 mg/m^3 STEL.

OSHA PEL: 50 ppm/35 mg/m^3 TWA.

NIOSH IDLH: 300 ppm.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 6 ppm

PAC-2: 40 ppm

PAC-3: 100 ppm

DFG MAK: MAK: 20 ppm/14 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C (2004).

Arab Republic of Egypt: TWA 25 ppm (18 mg/m^3), 1993; Australia: TWA 25 ppm (18 mg/m^3); STEL 35 ppm, 1993; Austria: MAK 25 ppm (18 mg/m^3), 1999; Belgium: TWA 25 ppm (17 mg/m^3); STEL 35 ppm (24 mg/m^3), 1993; Denmark: TWA 25 ppm (18 mg/m^3), 1999; Finland: TWA 25 ppm (18 mg/m^3); STEL 40 ppm (30 mg/m^3), 1993; France: VME 25 ppm (18 mg/m^3), VLE 50 ppm (36 mg/m^3), 1999; the Netherlands: MAC-TGG 14 mg/m^3, 2003; India: TWA 25 ppm (18 mg/m^3); STEL 35 ppm (27 mg/m^3), 1993; Japan: 25 ppm (17 mg/m^3), 1999; Norway: TWA 25 ppm (18 mg/m^3), 1999; the Philippines: TWA 50 ppm (30 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; MAC (STEL) 27 mg/m^3, 1999; Russia: TWA 25 ppm; STEL 20 mg/m^3, 1993; Sweden: NGV 25 ppm (18 mg/m^3), TGV 50 ppm (35 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (18 mg/m^3), KZG-W 50 ppm (36 mg/m^3), 1999; Thailand: TWA 50 ppm (35 mg/m^3), 1993; Turkey: TWA 25 ppm (35 mg/m^3), 1993; United Kingdom: TWA 25 ppm (18 mg/m^3); STEL 35 ppm (25 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 35 ppm.

Determination in Air: Sampling by absorption in sulfuric acid followed by measurement by ion chromatography, conductivity. Use NIOSH Analytical Method #6015, #6016.

Permissible Concentration in Water: Russia[43] set a MAC of 2.0 mg/mL in water bodies used for domestic purposes and 0.05 mg/mL in water bodies used for fishery purposes.

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium hydroxide is a corrosive chemical and can severely burn the skin and eyes, causing permanent damage. Exposure can severely irritate the nose, throat, and lungs. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long Term Exposure: Long-term exposure at low levels may cause chronic bronchitis. Repeated skin contact can cause dermatitis, dryness, itching, and redness.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended for ammonia by NIOSH in criteria document #74-136 (Ammonia).

Respirator Selection: NIOSH: *250 ppm*: CcrS* (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern) or Sa* (APF = 10) (any supplied-air respirator). *300 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS* (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern) or CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White stripe (*strong solution*): Contact Hazard; not compatible with materials in solid white category. Prior to working with this chemical you should be trained on its proper handling and storage. Store in temperatures below 25°C/77°F. Do not fill bottles completely. Store in tightly closed, strong glass, plastic, or rubber-stoppered containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Ammonium hydroxide−ammonia solution [rel. density between 0.880 and 0.957 at15°C in H_2O, with 10−35% NH_3]. UN/DOT label required “CORROSIVE MATERIAL.” This material is in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. If professional environmental engineering assistance is required, contact the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilute with water, neutralize with HCl, and discharge to sewer.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 41−44

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Hydroxide*. Trenton, NJ

Ammonium metavanadate A:1120

Molecular Formula: H_4NO_3V

Common Formula: NH_4VO_3

Synonyms: Ammonium vanadate; Vanadate (V031-), ammonium; Vanadato amonico (Spanish); Vanadic acid, ammonium salt

CAS Registry Number: 7803-55-6

RTECS® Number: YW0875000

UN/NA & ERG Number: UN2859/154

EC Number: 232-261-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA Hazardous Waste Number (RCRA No.): P119.

RCRA 40CFR261, Appendix 8, Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ammonium metavanadate is a white or slightly yellow crystalline powder. It is an inorganic acidic salt.

Molecular weight = 116.97; Freezing/Melting point = 200°C (decomposes). Slightly soluble in water, with decomposition.

Potential Exposure: It is used in the metals industry to make alloys, chemical reactions, dyes, inks, varnishes, printing, medicines, and photography.

Incompatibilities: Moisture forms an acidic solution. React with bases and may generate heat and may form flammable hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.05 mg[V_sO_5]/m^3 TWA (*dust*); respirable fraction; 0.1 mg[V_sO_5]/m^3 Ceiling Concentration, (fume).

NIOSH REL: 1.0 mg[V]/m^3 TWA.

ACGIH TLV®[1]: 0.05 mg[V_sO_5]/m^3 TWA, Not classifiable as a human carcinogen, (dust or fume).

NIOSH IDLH = 35 mg[V]/m^3

Protective Action Criteria (PAC)

TEEL-0: 0.0322 mg/m^3

PAC-1: 0.04 mg/m^3

PAC-2: 3.22 mg/m^3

PAC-3: 22.5 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Group 2 (2005) vanadium inorganic compounds.

These levels are for air levels only. When skin contact also occurs, overexposure is possible even though air levels are less than the airborne permissible limits. For fume limits see "vanadium metal" (CAS 7440-62-2).

Determination in Air: Use NIOSH Analytical Method 7300,[18] #7504, Vanadium oxides.

Permissible Concentration in Water: Russia has set[43] a MAC of 0.1 mg/L for pentavalent vanadium in water for domestic purposes.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, nose, and respiratory tract. Inhalation can cause coughing, wheezing, and phlegm. Exposure may cause headache and a green coating on the tongue. Higher exposures may cause pneumonia and/or pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. The oral LD_{50} for rats is 160 mg/kg.

Long Term Exposure: Ammonium metavanadate may be a reproductive hazard. Repeated exposure may cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, and lungs.

Medical Surveillance: Lung function tests. Consider X-ray following acute overexposure. Regulatory examinations that include lung function, X-ray, and skin tests are proposed in criteria document NIOSH 77-222.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 mg/m^3:* 100XQ* (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators] or SA* (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full-face-piece) or SaF (APF = 50) (any supplied-air respirator with a full-face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

**Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Ammonium metavanadate requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including ammonia, vanadium oxides, and nitrogen oxides, are produced in fire. Extinguish fire using an agent suitable for the type of surrounding fire. Ammonium metavanadate itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Vanadium*, NIOSH Document No. 77-222

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Ammonium Metavanadate*. Trenton, NJ

Ammonium molybdate A:1130

Molecular Formula: $H_8MoN_2O_4$

Common Formula: $(NH_4)_2MoO_4$

Synonyms: Ammonium paramolybdate; Diammonium molybdate; Molibdato amonico (Spanish); Molybdic acid, diammonium salt

CAS Registry Number: 13106-76-8

RTECS® Number: QA4900000

EC Number: 236-031-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia); Molecular weight: 57.04; NH_3 Equivalent weight: 17.38.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium molybdate is a colorless, white, or slightly greenish-yellow powder. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: It is used as an analytical reagent, in pigments, and in the production of molybdenum metal and ceramics.

Incompatibilities: Contact with strong oxidizers or chemically active metals (such as potassium, sodium, magnesium, and zinc) may cause a violent reaction.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Mo]/m^3 TWA soluble compounds, confirmed animal carcinogen with unknown relevance to humans.

OSHA PEL: 5 mg[Mo]/m^3 TWA soluble compounds.

NIOSH IDLH: 1000 mg[Mo]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 30.7 mg/m^3

PAC-1: 61.3 mg/m^3

PAC-2: 102 mg/m^3

PAC-3: 300 mg/m^3

DFG MAK: 5 mg[Mo]/m^3 TWA soluble compounds.

Russia[43] set a MAC for molybdenum in work-place air at 2.0 mg/m^3 for aerosol condensates and 4 mg/m^3 for soluble compounds in the form of dust.

Determination in Air: Molybdenum may be sampled by filter and measured by inductively coupled argon plasma atomic emission spectroscopy as described in NIOSH Analytical Method 7300 for Metals.[18]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Symptoms of molybdenum poisoning include stomach upset, diarrhea, coma; death from heart failure can occur. Exposure to high concentrations may cause irritation of the eyes, nose, and throat. Very high exposure may cause kidney and liver damage.

Long Term Exposure: May cause kidney and liver damage. Inhalation of dust can cause lung disease.

Points of Attack: Skin, lungs.

Medical Surveillance: Kidney, liver, and lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at this site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA (for soluble compounds of molybdenum) *25 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *50 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *125 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 mg/m^3*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store to avoid possible contact with active metals.

Shipping: There are no UN/DOT restrictions.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent for type of surrounding fire. Ammonium molybdate itself does not burn. Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. Use dry chemical appropriate for extinguishing metal fires. *Do not* use water. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Ammonium Molybdate*. Trenton, NJ

Ammonium nitrate A:1140

Molecular Formula: $H_4N_2O_3$
Common Formula: NH_4NO_3

Synonyms: Ammonium(I) nitrate(1:1); Ammonium saltpeter; Ansax; Herco prills; Nitram; Nitrato amonico (Spanish); Nitric acid, ammonium salt; Norway saltpeter; Varioform I

CAS Registry Number: 6484-52-2

RTECS® Number: BR9050000

UN/NA & ERG Number: UN1942/140 Ammonium nitrate, with not >0.2% combustible substances; UN2067/140 Ammonium nitrate fertilizers; UN2069/140 Ammonium nitrate mixed fertilizers; UN2071/140 Ammonium nitrate fertilizer, with not >0.4% combustible material; UN2071/140 Ammonium nitrate fertilizers; 2072/140 Ammonium nitrate fertilizer, n.o.s.; UN2072/140 Ammonium nitrate fertilizers; UN2426/140 Ammonium nitrate, liquid (hot concentrated solution); UN3375/140 Ammonium nitrate emulsion; UN3375/140 Ammonium nitrate gel; UN3375/140 Ammonium nitrate suspension; No DOT ID/112 Ammonium nitrate-fuel oil mixtures

EC Number: 229-347-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade) (explosive: with more than 0.2% combustible substances, including any organic substances calculated as carbon, to the exclusion of any other substance); *Theft hazard* 2000 (*33% concentration*) (fertilizer: solid, with nitrogen concentration of ≥23% nitrogen).

Highly Reactive Substance and Explosive (World Bank)[15].

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as nitrate compounds.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent weight: 21.28 also reportable as a nitrate compound, water dissociable, (reportable only when in an aqueous solution), at the same reporting level (1.0%).

Canada, National Pollutant Release Inventory (solution only).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium nitrate is a white to gray to brown, beads, pellets, or flakes. Odorless. Molecular weight: 80.06; Boiling point = about 210°C (decomposes below BP); Freezing/Melting point = about 169°C with slow decomposition; the decomposition accelerates as it reaches boiling point and may become explosive. Hazard Identification (based on NFPA-704 M Rating System): (*<23%*) Health 1, Flammability 0, Reactivity 3, Oxidizer. Soluble in water.

Potential Exposure: Used in the manufacture of liquid and solid fertilizer compositions, industrial explosives and blasting agents from ammonium nitrate, matches, antibiotics, and in the production of nitrous oxide.

Incompatibilities: A strong oxidizer. Reducing agents; combustible materials; organic materials; finely divided (powdered) metals may form explosive mixtures or cause fire and explosions. When contaminated with oil, charcoal or flammable liquids, can be considered an explosive which can be detonated by combustion or shock.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.015 mg/m^3

PAC-1: 0.04 mg/m^3

PAC-2: 0.3 mg/m^3

PAC-3: 500 mg/m^3

Russia: MAC 0.3 mg/m^3 on a daily average basis in ambient air.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for fishery purposes.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The potential for ammonia poisoning in the course of NH_4NO_3 and fertilizer manufacture is the chief toxic effect associated with ammonium nitrate. Exposure may irritate the skin, eyes, nose, throat, and lungs. Overexposure can cause nausea and vomiting, headaches, weakness, faintness, and collapse. Severe overexposure may lower the ability of the blood to carry oxygen. This can result in a bluish color to skin and lips, headaches, dizziness, collapse, and even death.

Long Term Exposure: Unknown at this time.

Points of Attack: Inhalation, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any* *detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a well-ventilated area, away from sparks and flames preferably in a noncombustible location equipped with automatic sprinkler protection. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Keep well closed, dry, separated from materials and labeled "oxidizer." Storage of 500 tons or more should be avoided[35] or at least very carefully regulated. See NFPA 490, *Code for the Storage of Ammonium Nitrate.*

Shipping: Ammonium nitrate [with not more than 0.2% of combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance] requires a shipping label of "OXIDIZER." It falls in DOT/UN Hazard Class 5.1 and Packing Group III.[19, 20] Ammonium nitrate liquid [(hot concentrated solution)] requires the same label. It falls in DOT/UN Hazard Class 5.1 and Packing Group is not given.

Spill Handling: Evacuate and isolate the area of the spill and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with dry lime or soda ash and collect powdered material in the most convenient and safe manner and deposit in sealed containers. Flush area with water. Ventilate area after cleanup is complete. Keep ammonium nitrate out of confined space, such as a sewer, because of the potential for an explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not burn but supports combustion. May explode under confinement and high temperatures. Exercise extreme caution. Use flooding amounts of water. Poisonous gases are produced in fire, including nitrogen oxides and ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves addition of sodium hydroxide to liberate ammonia and form the soluble sodium salt. The liberated ammonia can be recovered and sold. After dilution to the permitted provisional limit, the sodium salt can be discharged into a stream or sewer.[22]

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazard for Criteria Document Priorities: Ammonium Nitrate*, Report PB-274,073, Washington, DC, pp. 281-285

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 44−46

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Ammonium Nitrate*. Trenton, NJ

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Ammonium Nitrate*. Albany, NY: Bureau of Toxic Substance Assessment

Ammonium oxalate A:1150

Molecular Formula: $C_2H_8N_2O_4$

Common Formula: $NH_4OOCCOONH_4$

Synonyms: Ethanedioic acid, diammonium salt; Oxalato amonico (Spanish)

CAS Registry Number: 1113-38-8

RTECS® Number: RO2750000

UN/NA & ERG Number: UN2811/154

EC Number: 214-202-3

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 2000 lb (2270 kg); Section

313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 27.45.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium oxalate is an odorless, colorless crystalline material or powder. Molecular weight = 124.12; Freezing/Melting point = decomposes below MP of 70°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Corrosive. Slightly soluble in water.

Potential Exposure: It is used in chemical analysis and to make blueprint paper, explosives, and to make a rust-removal ingredient in metal polishes.

Incompatibilities: Ammonium oxalate reacts as a base to neutralize acids and reacts with strong oxidizers (acts as a reducing agent) generating carbon dioxide. Reacts vigorously with sodium hypochlorite solutions.[Mellor]

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.15 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Breathing ammonium oxalate can irritate the nose, throat, and lungs. Contact can irritate the skin. Overexposure may cause a kidney stone and kidney damage.

Long Term Exposure: Repeated exposures may cause bronchitis, kidney stones, and kidney damage. Repeated contact may cause cracking of the skin and slow-healing ulcers.

Points of Attack: Lungs, skin, kidneys.

Medical Surveillance: Lung function tests, urinalysis, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium oxalate may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and ammonia gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Ammonium Oxalate*. Trenton, NJ

Ammonium perfluoro-octanoate

A:1160

Molecular Formula: $C_8H_{19}NO_2$

Common Formula: $C_7H_{15}COONH_4$

Synonyms: Ammonium pentadecafluorooctanoate; Ammonium perfluorocaprilate; Ammonium perfluorocaprylate; APFO; Perfluoroammonium octonate

CAS Registry Number: 3825-26-1

UN/NA & ERG Number: UN2811/154

RTECS® Number: RH0782000

EC Number: 223-320-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: ACGIH confirmed animal carcinogen with unknown relevance to humans.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ammonium perfluoro-octanate is a free-flowing powder. Molecular weight = 431.12. Boiling point = 125°C (sublines). Highly soluble in water.

Potential Exposure: This compound is used commercially in the polymerization of fluorinated monomers.

Incompatibilities: Keep away from strong oxidizers; strong acids.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.01 mg/m^3 TWA [skin] confirmed animal carcinogen with unknown relevance to humans.

No TEEL available.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium perfluoro-octanoate is an inhalation poison and has a moderate oral toxicity[53] with an LD_{50} in rats of 540 mg/kg. The material was nonirritating to the skin and produced moderate eye irritation characterized by iridal and conjunctival effects which persisted for at least 7 days. Lethality was produced dermally in rats and rabbits only following large doses, but repeated doses of 20−2000 mg/kg in rats produced liver damage in a dose-related fashion and elevated blood organofluoride levels. Blood levels were reduced but still detectable 42 days after the last exposure.

Long Term Exposure: A suspected human carcinogen and reproductive toxin. NIOSH suspected neuro-, gastrointestinal, or liver- and respiratory toxicant.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Toxic solid, organic, n.o.s, requires a label of "INHALATION HAZARD, POISON INHALATION

HAZARD ZONE A OR B," Hazard Class 6.1, Packing Group II.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Ammonium permanganate A:1170

Molecular Formula: H_4MnNO_4

Common Formula: NH_4MnO_4

Synonyms: Permanganato amonico (Spanish); Permanganic acid ammonium salt

CAS Registry Number: 13446-10-1

RTECS® Number: SD6400000

Regulatory Authority and Advisory Bodies

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as manganese compounds).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium permanganate is a violet-brown or dark purple crystalline (sugar-like or sand-like) solid. Molecular weight = 136.98; Freezing/Melting point = 110°C. It explodes when heated to 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 0, Reactivity 3, Oxidizer. Soluble in water.

Potential Exposure: This material is used in bleaching and dyeing operations in the textile and leather industries.

Incompatibilities: A strong oxidizing agent. Contact with reducing agents, fuels and other combustible materials, heat, or friction may cause a violent reaction.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, skin and/or eye contact, ingestion.

Harmful Effects and Symptoms

Ammonium permanganate can affect you when breathed in. Exposure to ammonium permanganate can cause irritation of the eyes, nose, throat, and lungs. Contact can irritate the skin and eyes.

Short Term Exposure: Highly irritating to eyes, skin, and respiratory tract.

Long Term Exposure: Very irritating substances may cause lung effects and possible damage.

Points of Attack: Skin, eyes, nasal passages, throat, and lungs.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Ammonium Permanganate, use a MSHA/NIOAH approved respirator equipped with particulate (dust/fume/mist) filters. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Ammonium Permanganate must be stored to avoid contact with heat, friction, organic and oxidizable material, fuels and combustibles, since violent reactions occur. Always store Ammonium Permanganate at temperatures below

60°C/140°F. Protect containers from shock as ammonium permanganate may explode. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Ammonium permanganate is in the Hazard class of "FORBIDDEN."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Keep ammonium permanganate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is highly reactive and heat sensitive. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and ammonia. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Ammonium Permanganate*. Trenton, NJ

Ammonium persulfate A:1180

Molecular Formula: $H_8N_2O_8S_2$

Common Formula: $(NH_4)_2S_2O_8$

Synonyms: Ammonium perosycisulfate; Ammonium perosysulfate; Ammonium peroxydisulfate; Ammonium peroxysulfate; Ammonium persulphate; Diammonium peroxydisulfate; Diammonium persulfate; Peroxydisulfuric acid diammonium salt; Persulfate d'ammonium (French); Persulfato amonico (Spanish)

CAS Registry Number: 7727-54-0

RTECS® Number: SE0350000

UN/NA & ERG Number: UN1444/140

EC Number: 231-786-5 [*Annex I Index No.:* 016-060-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). Molecular weight: 228.19; NH_3 Equivalent weight: 14.93.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R8; R22; R36/37/38; R42/43; Safety phrases: S2; S22; S24; S26; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium persulfate is a colorless or white crystalline solid. Molecular weight = 228.22; Freezing/Melting point = decomposes below MP of 120°C; Specific gravity = 1.982 at 20°C; Heat of decomposition = 120°C; Heat of solution = 1.8×10^5 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1, Oxidizer, ₩. Decomposes in water.

Potential Exposure: It is used as a bleaching agent, in photographic chemicals, and to make dyes. It is also used as an ingredient of polymerization catalysts.

Incompatibilities: Decomposes in water, forming oxygen gas. A strong oxidizer; reacts with reducing agents; organic and combustible materials. Incompatible with heat, sodium peroxide (produces a friction-, heat-, and water-sensitive explosive), aluminum powder.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 100 mg/m^3

ACGIH TLV®[1]: 0.1 mg/m^3 TWA *as persulfates.*

DFG MAK: Danger of sensitization of the airways and skin.

United Kingdom: TWA 1 mg(S_2O_8), 2000; the Netherlands: MAC-TGG 1 mg/m^3, 2003.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the skin, eyes, nose, throat, and lungs. Exposure may cause an allergy-like reaction, with eye tearing, nose congestion, asthma-like wheezing and difficulty in breathing.

Life-threatening shock may result. The oral LD_{50} for rats is 820 mg/kg.[9]

Points of Attack: Eye, lungs.

Medical Surveillance: Lung function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended; effects may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to Ammonium persulfate.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Ammonium persulfate must be stored to avoid contact with combustibles (such as wood, paper, and oil), sodium peroxide, aluminum and water, since violent reactions occur. Store in tightly closed containers in a cool, dry, and well-ventilated area. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This chemical requires a shipping label of "OXIDIZER" by DOT.[19] Ammonium persulfate is in DOT/UN Hazard Class 5.1 and Packing Group III.[19, 20]

Spill Handling: Restrict persons not wearing protective equipment from area of spill until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Wash area down with water.

Fire Extinguishing: Ammonium persulfate is a strong oxidizing agent that can cause combustible materials, such as wood, paper, and oil to ignite. Heat above 120°C forms oxygen and sulfur dioxide. In addition, other poisonous gases are produced in fire, including ammonia and oxides of nitrogen. Use dry chemical, CO_2, or water spray extinguishers.

Disposal Method Suggested: May be treated with large volumes of water, neutralized, and flushed to sewer.[22] This applies to small quantities only.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 48−49

New Jersey Department of Health and Senior Services. (July 2000). *Hazardous Substances Fact Sheet: Ammonium Persulfate*. Trenton, NJ

Ammonium phosphate A:1190

Molecular Formula: $H_9N_2O_4P$

Common Formula: $(NH_4)_2HPO_4$

Synonyms: Ammonium orthophosphate, dibasic; Ammonium orthophosphate, monohydrogen; Ammonium phosphate, dibasic; Ammonium phosphate, hydrogen; Diammonium orthophosphate; Diammonium orthophosphate, hydrogen; Diammonium phosphate; Diammonium phosphate, hydrogen; Diammonium phosphate, monohydrogen; Dibasic ammonium phosphate; Secondary ammonium phosphate

CAS Registry Number: 7783-28-0 (dibasic); 7722-76-1 (monobasic)

RTECS® Number: TB9375000

EC Number: 231-987-8

Regulatory Authority and Advisory Bodies

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 25.79.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium phosphate is a white crystalline or powdery substance. Molecular weight: 132.06 (dibasic); Boiling point = 100°C (decomposes); Melting/Freezing point = decomposes below melting point at 102°C; Specific Gravity = 1.8 at 20°C (dibasic); Heat of solution = 42 Btu/lb. Hazard Identification (based on NFPA-704 M Rating System): (*dibasic*) Health 1, Flammability 0, Reactivity 0; (*monobasic*) Health 1, Flammability 0, Reactivity 1. Highly soluble in water.

Potential Exposure: Used in fireproofing of textiles, wood and paper, in soldering flux, as a fertilizer, a buffer, in baking powder, and as food additives.

Incompatibilities: Incompatible with strong oxidizers, strong bases, strong acids. Contact with air causes this chemical to produce anhydrous ammonia fumes.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 10 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: On short-term exposure, may cause skin and eye irritation; ammonia fumes can cause eye irritation above 70 ppm. In closed spaces, inhalation of ammonia fumes may cause nose and throat irritation (70 ppm, 5 min). Levels of 500 ppm for 30 min may cause irritation to throat and lungs. High levels may result in accumulation of fluid in the lung and suffocation. Ammonia poisoning upon ingestion is characterized by sagging of facial muscles, tremors, anxiety, difficulty in controlling muscles, stupor, and coma. There is only a slight chance of this happening from ingestion of ammonium phosphates, except in persons with impaired liver function. Large doses may cause calcium imbalance and an increased flow of urine.

Points of Attack: Liver, skin, eyes.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Seek medical attention, if necessary. Give large quantities of water or milk. *Inhalation:* Move to fresh air. Give oxygen or artificial respiration if required. Seek medical attention, if necessary.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a dust mask if necessary. A self-contained breathing apparatus may be necessary if ammonia fumes are present.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly sealed containers in a cool location away from oxidizers, bases.

Shipping: There are no DOT/UN requirements for labels or for maximum allowable shipping quantities.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Poisonous gases, including ammonia, phosphorus oxides, and nitrogen oxides, are produced in fire. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with huge volumes of water.

Reference

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ammonium Phosphate*. Albany, NY: Bureau of Toxic Substance Assessment

Ammonium picrate A:1200

Molecular Formula: $C_6H_6NO_7$
Common Formula: $NH_4OC_6H_2(NO_2)_3$
Synonyms: Ammonium carbazoate; Ammonium picrate, dry; Ammonium picrate, wet; Ammonium picrate (yellow); Ammonium picronitrate; Explosive D; Obeline picrate;

Phenol, 2,4,6-trinitro-, ammonium salt; Picratol; Picric acid, ammonium salt; Pictarol; 2,4,6-Trinitrophenol ammonium salt

CAS Registry Number: 131-74-8

RTECS® Number: BS3855000

UN/NA & ERG Number: UN1310 (wetted with not <10% water, by mass)/113

EC Number: 205-038-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

US EPA Hazardous Waste Number (RCRA No.): P009.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 10 lb (4.54 kg).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ammonium picrate is a bright yellow crystalline solid, that turns red if contaminated; Freezing/Melting point = decomposes on heating and explodes at 423°C. Slightly soluble in water. A high explosive when dry, and flammable when wet. Hazard Identification (Based on NFPA Rating System): Health 3, Flammability 3, Reactivity 3, Oxidizer.

Potential Exposure: Used in explosives, fireworks, and rocket propellants.

Incompatibilities: A powerful oxidizer that reacts violently with reducing agents. Dangerous when heated or shocked.

Keep away from metals, sodium nitrite, perchlorates, peroxides, permanganates, and any form of shock.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Routes of Entry: Inhalation of dust, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium picrate can pass through the skin. This chemical can irritate the eyes and skin, and is an allergen. Ingestion can cause a bitter taste, nausea, diarrhea, vomiting, abdominal pain, skin eruptions, stupor, and possible death. Breathing high levels can damage the kidneys, liver, and red blood cells. Urine may become reddish, scant, or even stop; there may be drowsiness, coma, and even death.

Long Term Exposure: Repeated exposure can cause the skin and eyes to turn yellow; skin allergy; liver, kidney, and blood cell damage.

Points of Attack: Eyes, skin, respiratory system, kidneys, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Complete blood count. Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ammonium picrate, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Incompatible with strong oxidizers, strong bases. Contact with air causes substance to give off corrosive anhydrous ammonia fumes. Outside, detached storage is recommended. Store to avoid heat, shock, or the presence of reducing materials. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: The label requirement for UN0004 (dry or wetted with <10% water, by mass) material is "EXPLOSIVES." FORBIDDEN. It falls into Hazard Class 1.1D and is in Packing Group II. The label requirement for UN1310 (wetted with not <10% water, by mass) is "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group I.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Flood area with water. *Keep Material Wet. Do not dry sweep.* Keep ammonium picrate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. If necessary, seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: Use extreme care as ammonium picrate will explode when heated or shocked, especially when dry. This chemical is a flammable solid. Use flooding quantities of water, applied from a distance. Poisonous gases are produced in fire, including ammonia and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. May be poured onto soda ash, packaged in paper, and burned. May also be mixed with flammable solvent and sprayed into an incinerator equipped with afterburner and scrubber.[24]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 49−51 (1982) and 8, No. 2, 42−44 (1988)

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances fact sheet: Ammonium Picrate*. Trenton, NJ

Ammonium sulfamate A:1210

Molecular Formula: $H_6N_2O_3S$

Common Formula: $NH_2SO_3NH_4$

Synonyms: Amcide®; Amicide®; Ammat; Ammate®; Ammate herbicide; Ammonium amidosulfonate; Ammonium amidosulphate; Ammonium aminosulfonate; Ammonium salz der amidosulfonsaure (German); Ammonium sulphamate; AMS; Ikurin; Monoammonium salt of sulfamic acid; Monoammonium sulfamate; Sulfamate; Sulfamato amonico (Spanish); Sulfamic acid, monoammonium salt; Sulfaminsaure (German)

CAS Registry Number: 7773-06-0

RTECS® Number: WO6125000

UN/NA & ERG Number: UN3077/171

EC Number: 231-871-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg). Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 14.92.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium sulfamate is a white to yellow crystalline solid. Molecular weight: 114.14; Freezing/Melting point = 131°C (with decomposition); Boiling point = 160°C.

Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2. Very soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical. Ammonium sulfamate is used as a herbicide and in compositions for retarding flame in textiles and paper products; a softener for paper, cotton textiles.

Incompatibilities: Strong oxidizers, potassium, potassium chlorate, sodium nitrite, metal chlorates, and hot acid solutions. Elevated temperatures cause a highly exothermic reaction with water.

Permissible Exposure Limits in Air

OSHA PEL: 10 mg/m^3, total dust/5 mg/m^3, respirable fraction TWA.

NIOSH REL: 10 mg/m^3, total dust/5 mg/m^3, respirable fraction TWA.
ACGIH TLV®[1]: 10 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 50 mg/m^3
PAC-2: 350 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: No numerical value established. Data may be available.
Australia: TWA 10 mg/m^3, 1993; Austria: MAK 15 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 10 mg/m^3, 1999; Finland: TWA 10 mg/m^3, STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Russia: STEL 10 mg/m^3, 1993; Switzerland: MAK-week 10 mg/m^3, 1999; Turkey: TWA 15 mg/m^3, 1993; United Kingdom LTEL 10 mg/m^3, STEL 20 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3. Several states have set guidelines or standards for ammonium sulfamate in ambient air[60]: (total dust) 15 mg/m^3 TWA and, respirable fraction. The California PEL is 5 mg/m^3 TWA. Several states have set guidelines or standards for ammonium sulfamate in ambient air[60]: 0.1 mg/m^3 (North Dakota), 0.15 mg/m^3 (Virginia), 0.2 mg/m^3 (Connecticut), 0.238 mg/m^3 (Nevada).

Determination in Air: Collection on a filter followed by gravimetric analysis. Use NIOSH Analytical Method #S348.

Permissible Concentration in Water: The No-Observed-Adverse-Effect-Level (NOAEL) is 250 mg/kg/day according to the EPA Health Advisory cited below. From this a health advisory of 21.4 mg/L of water was derived for a 10-kg child on a 1-day, 10-day, or longer term basis. An acceptable daily intake has been determined to be 0.214 mg/kg/day and a lifetime health advisory for a 70 kg adult is 1.5 mg/L.

Determination in Water: There is no standard method for determining ammonium sulfamate in water. There is, however, a method for detection in foods which is a colorimetric method based on liberation of SO_4, reduction to H_2S which is measured after treatment with zinc, *p*-aminodimethylaniline, and ferric chloride to give methylene blue.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is moderately toxic by ingestion and may cause gastrointestinal disease. High levels may irritate the eyes, skin, and respiratory tract, and may cause nausea and vomiting. The oral LD_{50} for rat is 3900 mg/kg.

Long Term Exposure: Unknown at this time.

Medical Surveillance: Nothing special indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *100 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *250 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or if *not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *500 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1500 mg/m^3*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), water, potassium, potassium chlorate, sodium nitrite, metal chlorates, and hot acid solutions.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium sulfamate may burn but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dilute with water, make neutral with acid or base, and flush into sewer with more water.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 52−54

US Environmental Protection Agency. (August 1987). *Health Advisory: Ammonium Sulfamate*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Ammonium Sulfamate*. Trenton, NJ

Ammonium sulfide A:1220

Molecular Formula: H_8N_2S; H_5NS

Common Formula: $(NH_4)_2S$

Synonyms: Ammonium bisulfide; Ammonium hydrogensulphide; Ammonium sulfide, hydrogen; Diammonium sulfide; Sulfuro amonico (Spanish); True ammonium sulfide

CAS Registry Number: 12135-76-1 (solution); 12124-99-1 (solid)

RTECS® Number: BS4900000 (solid); BS4920000 (solution)

UN/NA & ERG Number: UN2683 (solution)/132

EC Number: 235-223-4 (solution); 235-184-3 (solid)

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA).

CERCLA/SARA Section 313: 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg); Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 33.32.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ammonium sulfide is a yellow crystalline (sugar- or sand-like) material, commonly found in liquid solution, which is flammable, and with an odor of rotten eggs. Molecular weight: 51.12; Flash point = 72°C; Freezing/Melting point = (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Soluble in water.

Potential Exposure: It is used in photographic developers, synthetic flavors, coloring metals (i.e., to apply patina to bronze), and to make textiles.

Incompatibilities: Strong oxidizers, acids, acid fumes (forms hydrogen sulfide). Keep away from moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3.5 ppm

PAC-1: 10 ppm

PAC-2: 15 ppm

PAC-3: 15 ppm

Routes of Entry: Ingestion, skin absorption, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Ammonium sulfide can be absorbed through the skin, thereby increasing exposure. This substance is a corrosive chemical and contact can irritate and burn the eyes and skin. Exposure can irritate the nose, throat and lungs, causing a cough and difficulty in breathing. Very high levels could cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Very high levels could cause you to feel dizzy, lightheaded, and cause you to pass out.

Long Term Exposure: Repeated exposure can cause lung irritation and bronchitis.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention

immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to ammonium sulfide and at the end of the work shift.

Respirator Selection: *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store to avoid contact with acids and acid fumes, since violent reactions can occur. Store in tightly closed containers in cool, well-ventilated area away from moisture. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Ammonium sulfide solution, requires a shipping label "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." The DOT/UN Hazard Class for this chemical is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Add Ferric Chloride solution to spilled material. Stir and add Soda Ash. Sweep solid material up and deposit in sealed containers. Keep ammonium sulfide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium sulfide solution is a flammable liquid. Poisonous gases are produced in fire, including flammable hydrogen sulfide and ammonia. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to a large volume of ferric chloride solution with stirring. Neutralize with soda ash. Flush to drain with water.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 27−29

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Sulfide*. Trenton, NJ

Ammonium sulfite A:1230

Molecular Formula: $H_8N_2O_3S$

Common Formula: $(NH_4)_2SO_3$

Synonyms: *monoammonium salt:* Ammonium acid sulfite; Ammonium hydrogen sulfite; Ammonium hydrosulfite; Ammonium monosulfite; Ammonium sulfite, hydrogen; Monosodium sulfite; Sulfito amonico (Spanish); Sulfurous acid, monoammonium salt. *diammonium salt:* Diammonium sulfite; Sulfito amonico (Spanish); Sulfurous acid, diammonium salt

CAS Registry Number: 10196-04-0; 10192-30-0 (bisulfite)

RTECS® Number: WT3505000 (diammonium); WT3595000 (monoammonium)

UN/NA & ERG Number: UN3077/171

EC Number: 233-484-9 (diammonium salt); 233-469-7 (monoammonium salt/ammonium hydrogensulfite)

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA).

(*diammonium salt*) Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) Molecular weight: 99.10; NH_3 Equivalent weight: 17.18.

(*monoammonium salt*) Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) Molecular weight: 116.13; NH_3 Equivalent weight: 29.33.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium sulfite is a colorless to yellow crystalline (sand-like or sugar-like) solid, normally sold or used in a 40% solution. Molecular weight = 99.10; Freezing/Melting point = 150°C (sublimes); Specific gravity = 2.03 (solid); 1.40 (72% aqueous solution); Heat of solution = (endothermic) = 1.01×10^5 J/kg (For dilute solution 1 mole/0.300 moles water, which is equal to 1.833 lb/volume lb of water); Vapor pressure = 395 mmHg at 20°C. Soluble in water.

Potential Exposure: Ammonium sulfite is used in medicines, metal lubricants; explosives, photography, hair wave solutions; and to make other chemicals. It is also used as a preservative and for treating agricultural grain.

Incompatibilities: A strong reducing agent. Reacts violently with strong oxidizers, acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) TEEL-0: 10 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 10 mg/m^3

Bisulfite

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Ammonium sulfite can affect you when breathed in; exposure can irritate the nose, throat, bronchial tubes, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Ammonium sulfite may cause an asthma-like allergy. Future exposures could then cause asthma attacks with cough, shortness of breath, and wheezing. Very severe (anaphylactic) reactions could also occur, and could be fatal.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure, the following are recommended: lung function tests; seek prompt medical attention if symptoms are suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over ammonium sulfite, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposures to ammonium sulfite, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ammonium sulfite must be stored in tightly closed containers in a cool, well-ventilated place to avoid contact with oxidizers and acids as flammable hydrogen sulfide gas is produced.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium sulfite may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia and oxides of sulfur and nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be buried in a chemical waste landfill in accordance with federal, state, and local statutes; or, if oxidized and neutralized, it may be sent to a municipal sewage treatment plant for biological treatment incineration.

Reference

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Ammonium Sulfite*. Trenton, NJ

Ammonium tartrate A:1240

Molecular Formula: $C_4H_{12}N_2O_6$

Common Formula: $NH_4OOCCHOHCHOHCOONH_4$

Synonyms: Ammonium D-tartrate; Ammonium tartrate; Butanedioic acid, 2,3-dihydroxy-[R-(R*,R*)]-, diammonium salt; Diammonium tartrate; 2,3-Dihydroxy-butanedioic acid, diammonium salt; Tartaric acid, ammonium salt; 1-Tartaric acid, diammonium salt; Tartaric acid, diammonium salt; Tartrato amonico (Spanish)

CAS Registry Number: 14307-43-8; 3164-29-2 (diammonium salt)

RTECS® Number: WW8050000

UN/NA & ERG Number: UN3077/171

EC Number: 238-245-2 [ammonium [R-(R*,R*)]-tartrate]; 221-618-9 (diammonium salt)

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA).

Reportable Quantity (RQ): 5000 lb (2270 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ammonium tartrate is a colorless crystalline or white granular solid. Molecular weight = 184.18. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: It is used in the textile industry and in medicine.

Incompatibilities: Strong oxidizers, especially potassium chlorate, sodium nitrite.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Diammonium salt

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 200 mg/m^3

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Contact can irritate the eyes and skin, and cause permanent damage. May irritate the nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Unknown at this time. However, corrosive substances may cause lung effects and damage.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids.

Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium chloride and sodium nitrite.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of “CLASS 9.” It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium tartrate may burn but does not readily ignite. Poisonous gases are produced in fire, including ammonia and oxides of nitrogen. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be buried in a chemical waste landfill in accordance with federal, state, and local statutes; or, if oxidized and neutralized, it may be sent to a municipal sewage treatment plant for biological treatment.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Ammonium Tartrate*. Trenton, NJ

Ammonium tetrachloro-platinate A:1250

Molecular Formula: $Cl_4H_8N_2Pt$
Common Formula: $(NH_4)_2PtCl_4$
Synonyms: Ammonium chloropalladate(2 +); Ammonium chloropalladate(II); Ammonium palladium chloride; Ammonium tetrachloropalladate(2 +); Ammonium tetrachloropalladate(II); Diammonium tetrachloropalladate; Tetramine platinum(II) chloride
CAS Registry Number: 13820-41-2
RTECS® Number: TP1840000
UN/NA & ERG Number: UN3077/171
EC Number: 237-499-1 [*Annex I Index No.:* 078-002-00-6]
Regulatory Authority and Advisory Bodies
Listed on the TSCA inventory.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 11.98.
European/International Regulations: Hazard Symbol: T; Risk phrases: R25; R38; R41; R42/43; Safety phrases: S2; S22; S26; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Ammonium tetrachloroplatinate is a dark ruby-red crystalline solid. Molecular weight = 372.96; Specific gravity = 2.93; Freezing/Melting point = 140−150°C. Soluble in water.
Potential Exposure: This material is used in photography.
Incompatibilities: Oxidizers, strong acids, strong bases.
Permissible Exposure Limits in Air
OSHA PEL: 0.002 mg[Pt]/m^3 TWA.
NIOSH REL: 0.002 mg[Pt]/m^3 TWA.
ACGIH TLV®[1]: 1 0.002 mg[Pt]/m^3 TWA.
No TEEL available.
DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.
NIOSH IDLH: 4 mg [Pt]/m^3.
Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts).
Routes of Entry: Inhalation of vapor or dust, skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Ammomium tetrachloroplatinate can affect you when breathed in. Ammonium Tetrachloroplatinate may irritate the eyes, nose, and throat; high exposures can cause irritability and even seizures ("fits").
Long Term Exposure: Skin and air passage sensitizer; severe allergy can develop to ammonium tetrachloroplatinate. Symptoms may include asthma (with cough, wheezing, and/or shortness of breath), runny nose, and/or skin rash, sometimes with hives. If allergy develops, even small future exposure can trigger significant symptoms. Some persons exposed to this type of chemical have developed lung scarring.
Points of Attack: Eyes, skin, nose, throat.
Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if a person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray every 3 years should be considered if above tests are not normal. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures over 0.002 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Green: General storage may be used. It is a skin and inhalation sensitizer; the Color Code—Blue may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases.
Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However,

based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, CO_2, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia, chlorine, and platinum. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Tetrachloroplatinate*. Trenton, NJ

Ammonium thiocyanate A:1260

Molecular Formula: CH_4N_2S

Common Formula: NH_4SCN

Synonyms: Ammonium isothiocyanate; Ammonium rhodanate; Ammonium rhodanide; Ammonium sulfocyanate; Ammonium sulfocyanide; Carbo-Tech ammonium thiocyanate; Degussa ammonium thiocyanate; Rhodanid; Thiocyanic acid, ammonium salt; Tiocianato amonico (Spanish)

CAS Registry Number: 1762-95-4

RTECS® Number: XK7875000

UN/NA & ERG Number: UN2672/154

EC Number: 217-175-6

Regulatory Authority and Advisory Bodies

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as cyanide compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants (as cyanide compounds).

US EPA Hazardous Waste Number (RCRA No.): P030.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent weight: 22.37. *Note:* May also be reportable as a cyanide compound ($X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur). Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide compounds.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ammonium thiocyanate is a colorless solid which absorbs moisture and becomes liquid. Molecular weight: 76.12; Boiling point = 115°C; Freezing/Melting point = 160°C, decomposes at 170°C; Heat of solution = 3.1×10^5 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1, Corrosive. Soluble in water.

Potential Exposure: It has many uses in making matches, fabric processing, metals processing, chemical manufacturing, electroplating, zinc coating, liquid rocket propellants, herbicides, weed killers, defoliants, fabric dyeing, polymerization catalyst, in photography. Used as a laboratory chemical.

Incompatibilities: Lead nitrate, chlorates, nitric acid, acid, acid fumes. In the presence of moisture, corrosive to brass, copper, iron.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 12.5 mg/m^3

PAC-1: 35 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 200 mg/m^3

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides.

Routes of Entry: Skin and/or eyes; may be absorbed through unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact with dust irritates the eyes and cause burns to the eyes and skin. This chemical can be absorbed through the skin, and significantly to overall exposure; prolonged contact may produce various skin eruptions, nausea, dizziness, cramps, and mild to severe disturbance of the nervous system. Ingestion causes dizziness, cramps, nervous disturbances.

Long Term Exposure: Repeated exposure may cause nausea, loss of appetite; runny nose, abdominal problems, loss of weight, weakness, and skin rashes. Prolonged exposure may cause thyroid gland problems, blood cell damage, nervous system damage with personality, and mood changes.

Points of Attack: Thyroid, nervous system, blood cells.

Medical Surveillance: Thyroid function tests, complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nonabsorbent materials are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as cyanides): *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Ammonium thiocyanate must be stored to avoid contact with Potassium chlorate and Lead nitrate, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, acid, acid fumes, or chlorine because toxic fumes are released. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Ammonia solutions, relative density between 0.880 and 0.957 at 15°C in water, with $>$10% but not $>$35% ammonia require a shipping label of "CORROSIVE." They fall in Hazard Class 8 and Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use vacuum to reduce dust during clean up. *Do not dry sweep.* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium Thiocyanate may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including ammonia, hydrogen cyanide, hydrogen sulfide, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Slowly add to large container of water. Stir in slight excess of soda ash. Decant or siphon liquid from sludge, neutralize with HCl, and flush to sewer. Sludge may be landfilled.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report* 2, No. 3, 54−55

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Ammonium Thiocyanate*. Trenton, NJ

Ammonium thiosulfate A:1270

Molecular Formula: $H_8N_2O_3S_2$
Synonyms: Ammonium hyposulfite; Amthio; Diammonium thiosulfate; Hypo; Thiosulfuric acid, diammonium salt; Tiosulfato amonico (Spanish)
CAS Registry Number: 7783-18-8
RTECS® Number: XN6465000
EC Number: 231-982-0
Regulatory Authority and Advisory Bodies
CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 22.98.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Ammonium thiosulfate is a white crystalline solid with an ammonia odor. Molecular weight: 148.21; Freezing/Melting point = 150°C [decomposes <50°C (solution); >100°C (anhydrous crystals)]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Highly soluble in water.
Potential Exposure: Used as an agricultural chemical and fungicide, metal lubricant, in cleaning metals, in photographic chemicals, and in making other chemicals. A laboratory reagent.
Incompatibilities: Contact with sodium chlorate may cause a violent reaction. Corrodes brass, copper, and copper-based metals.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 7.5 mg/m^3
PAC-1: 25 mg/m^3
PAC-2: 200 mg/m^3
PAC-3: 500 mg/m^3
Routes of Entry: Skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Exposure can irritate eyes, skin, and respiratory tract.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, or combustible materials.
Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium thiosulfate may burn, but does not readily ignite. Poisonous gases, including ammonia, hydrogen sulfide, sulfur oxides, and nitrogen oxides, are produced in fire. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate. It may be possible to dispose of waste material at a municipal facility if treated, neutralized, and oxidized.

Reference

New Jersey Department of Health and Senior Services. (June 1988). *Hazardous Substances Fact Sheet: Ammonium Thiosulfate*. Trenton, NJ

Amphetamine A:1280

Molecular Formula: $C_9H_{13}N$

Common Formula: $C_6H_5CH_2CH(NH_2)CH_3$

Synonyms: Actedron; Adipan; Allodene; DL-Amphetamine; Anfetamina (Spanish); Anorexide; Benzedrine; Deoxynorephedrine; racemic-Desoxynorephedrine; DL-Benzedrine; DL-α-Methylbenzeneethaneamine; DL-1-Phenyl-2-aminopropane; Elastonon; Isoamycin; Isomyn; Mecodrin; α-Methylbenzeneethaneamine; Norephedrane; Novydrine; Ortedrine; Phenedrine; 1-Phenyl isopropyl amine; Profamina; Propisamine; Psychedrine; Raphetamine; Simpatedrin; Sympamine; Sympatedrine; Weckamine

CAS Registry Number: 300-62-9

Note: There are various other "amphetamines" listed in the literature; however this CAS is specifically regulated by EPA. RTECS lists this CAS as "Benzedrine."

RTECS® Number: SH9450000

UN/NA & ERG Number: UN3249 (medicine, solid, toxic, n.o.s.)/151

EC Number: 206-096-2

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (UN) (US).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

SUPERFUND/CERCLA 40CFR302.4 Reportable Quantity (RQ): 1 lb (0.454 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amphetamine is a mobile liquid with an amine odor. Molecular weight = 135.23; Boiling point = 200−203°C; Flash point ≤100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Amphetamine is used as a pharmaceutical. It is a central nervous system stimulant.

Incompatibilities: Oxidizing materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include dry mouth, metallic taste, loss of appetite, nausea, vomiting, diarrhea, abdominal cramps, headache, chilliness, flushing or pallor, palpitation, restlessness, dizziness, tremor, hyperactive reflexes, talkativeness, tenseness, irritability, weakness, insomnia, fever, confusion. With large doses, irregular heartbeat, pain and difficulty in urination, convulsions, coma, circulatory collapse may occur. This chemical is classified as extremely hazardous. Probable lethal dose in humans is 5−50 mg/kg or 7 drops to 1 teaspoon for a 70-kg (150 lb) person.

Long Term Exposure: Habit-forming drug which affects the central nervous system.

Points of Attack: Central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.[52]

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." Poisonous solids n. o.s. fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid in dry sand, vermiculite, or other absorbent material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Amphetamine*. Washington, DC: Chemical Emergency Preparedness Program

Ampicillin A:1290

Molecular Formula: $C_{16}H_{19}N_3O_4S$

Synonyms: Acillin; Adobacillin; Alpen; Amblosin; Amcill; Amfipen; Aminobenzyl penicillin; D-(-)-α-Aminobenzylpenicillin; D-(-)-α-Aminopenicillin; 6-[D (-)-α-Aminophenylacetamido]penicillanic acid 6; 6-(2-Amino-2-phenylacetamindo)-3,-3-dimethyl-7-oxo-4-thia-1-azabicyclo(3.2.0) heptane-2-carboxylic acid; (Aminophenylmethyl)-penicillin; Amipenix S; Amperil; Ampi-Bol; D-(-)-Ampicillin; D-Ampicillin; Ampicillin A; Ampicillin acid; Ampicillin anhydrate; Ampicillin (USDA); Ampicin; Ampikel; Ampimed; Ampipenin; Amplisom; Amplital; Ampy-penyl; Austrapen; AY-6108; Binotal; Bonapicillin; Britacil; BRL; BRL 1341; Copharcilin; Cymbi; Divercillin; Doktacillin; Grampenil; Guicitrina; Guicitrine; Lifeampil; Marisilan; NSC-528986; Nuvapen; Omnipen; P-50; Penbristol; Penbritin; Penbritin paediatric; Penbritin syrup; Penbrock penicline; Pentrex; Pfizerpen A; Polycillin; Ponecil; Principen; Qidamp; Ro-Ampen; Semicillin; SK-Ampicillin; Synpenin; Tokiocillin; Tolomol; Totacillin; Totalciclina; Totapen; Ultrabion; Ultrabron; Viccillin; Viccillin S; Vicillin; WY-5103

CAS Registry Number: 69-53-4 (anhydrous); 7177-48-2 (trihydrate)

RTECS® Number: XH8350000; HS8425000 (trihydrate)

EC Number: 200-709-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ampicillin in anhydrous form occurs as crystals. Molecular weight = 349.44; Freezing/Melting point = 199−202°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): (*anhydrous*) Health 1, Flammability 0, Reactivity 0; (*trihydrate*) Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an antibiotic.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEELs are available.

Russia[43]: MAC 0.1 mg/m^3 in work-place air, ampicillin.

Harmful Effects and Symptoms

Short Term Exposure: Ampicillin can affect you when breathed in. Exposure can cause skin rash. This may or may not be an allergic reaction, but if hives are present, allergy is likely. Exposure to high levels can cause upset stomach and diarrhea. The LD_{50} for rat is 10 gm/kg and for mouse is 28 mg/kg.[9] Ampicillin can cause hypersensitivity reactions in allergic persons.

Long Term Exposure: Exposure may cause allergy to develop, often accompanied with hives. Once allergy develops, even low future exposures can cause an allergic reaction. Persons having an allergy to penicillin may be more likely to develop an allergic reaction to ampicillin. Exposure can lead to a rare, but sometimes fatal reaction (aplastic anemia) in which blood cell count drops very low. Ampicillin can cause a liver-damaging reaction. Since ampicillin kills many normal germs, new resistant strains can grow after repeated exposure, resulting in a "yeast" or other types of infection.

Points of Attack: Liver, blood cells, skin.

Medical Surveillance: Liver function tests; complete blood count (CBC). Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly at the end of the work shift. Posthazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Ampicillin to potentially exposed workers.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and moisture.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Ampicillin itself does not burn. Poisonous gases are produced in fire, including sulfur oxides and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (February 1989). *Hazardous Substances Fact Sheet: Ampicillin*. Trenton, NJ

Amyl acetates A:1300

Molecular Formula: $C_6H_{12}O_2$ (*n*-); $C_7H_{14}O_2$ (*sec*-); $C_7H_{14}O_2$ (*tert*-); $C_8H_{14}O_2$ (*iso*-)

Common Formula: $CH_3COOCH_2CH_2CH_2CH_3$ (*n*-); $CH_3COOCH(CH_3)CH_2CH_2CH_3$ (*sec*-); $CH_3COOC(CH_3)_2C_2H_5$ (*tert*-); $CH_3COOCH_2CH_2CH(CH_3)CCH_3$ (*iso*-)

Synonyms: *n-isomer:* Acetate d'amyle (French); Acetato de amilo (Spanish); Acetic acid *n*-amyl ester; Acetic acid pentyl ester; Amyazetat (German); *n*-Amyl acetate; Amyl acetate, mixed isomers; Amyl-acetate (*n*-); Amyl acetic acid; Amyl acetic ester; Amyl acetic ether; Banana oil; Birnenoel; Pear oil; Pent acetate; 1-Pentanol acetate; Pentyl acetates; Pentyl ester of acetic acid; *n*-Pentyl ethanoate; Primary amyl acetate

sec-isomer: Acetic acid, 2-pentyl ester; 2-Acetoxypentane; Banana oil; 1-Methylbutyl acetate; 2-Pentanol, acetate; 2-Pentyl acetate

tert-isomer: Acetic acid, isopentyl ester; Amylacetic ester; Banana oil; Isoamyl ethanoate; Isopentyl acetate; Isopentyl alcohol acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl acetate; 3-Methylbutyl ethanoate; Pear oil *iso-isomer:* Acetic acid, isopentyl ester; Amylacetic ester; Isoamyl ethanoate; Isopentyl acetate; Isopentyl alcohol acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl acetate; 3-Methylbutyl ethanoate; Pear oil

CAS Registry Number: 628-63-7 (*n-*); 626-38-0 (*sec-*); 675-16-1 (*tert-*); 123-92-2 (*iso-*); 620-11-1 (*pentyl-*); 624-41-9 (*o-*)

RTECS® Number: AJ1925000 (*n-*); AJ2100000 (*sec-*); NS9800000 (*iso-*)

UN/NA & ERG Number: UN1104/129

EC Number: 211-047-3 [*Annex I Index No.:* 607-130-00-2] (*n-*); 210-946-8 [*Annex I Index No.:* 607-130-00-2] (*sec-*); 204-662-3 [*Annex I Index No.:* 607-130-00-2] (*iso-*); 210-843-8 [*Annex I Index No.:* 607-130-00-2] (*o-*)

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled (*n*-isomer).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*n-*, *sec-*, and *iso*-isomers listed).

European/International Regulations (*n-*; *sec-*; *o-*; *iso*-isomers): Hazard Symbol: None; Risk phrases: R10; R66; Safety phrases: S2; S23; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*n-*; *o-*).

Description: All isomers of amyl acetate are highly flammable, colorless to yellow, watery liquids. The *n-* and *iso*-isomers have a persistent, fruity, banana-like or pear-like odor. The *sec*-isomer has a mild fruity odor. Molecular weight of isomers = 130.21. Hazard Identification (based on NFPA-704 M Rating System): (*sec*-isomer) Health 2, Flammability 3, Reactivity 0.

n-isomer: Boiling point = 121°C; Melting/Freezing point = − 72°C; Specific gravity = 0.876 at 20°C; Liquid surface tension = 0.012 N/m at 30°C; Liquid water interfacial tension = (estimate) 0.05 N/m at 17°C; Relative vapor density (air = 1) = 4.5; Ratio of specific heats of vapor (gas) = 1.1; Latent heat of vaporization = 3.1×10^5 J/kg; Heat of combustion = -310.8×10^5 J/kg; Vapor pressure = 0.93 kPa at 20°C; Flash point = 16−21°C, 25°C (cc); Autoignition temperature = 360°C; Explosive limits: LEL = 1.0%; UEL = 7.5%; Odor threshold = 0.0075−7.3 ppm.

sec-isomer: Boiling point = 121°C; Melting/Freezing point = − 148°C; Critical temperature = 326°C; Critical pressure = 411.6 psia = 28.0 atm = 2.83 MN/m^2; Specific gravity = 0.861−0.866 at 20°C; Liquid surface tension = 28.9 dynes/cm = 0.0289 N/m at 20°C; Liquid water interfacial tension = (estimate) 0.0441 N/m at 20°C; Relative vapor density (air = 1) = 4.5; Ratio of specific heats of vapor (gas) = (estimate)>1−1.1 at 20°C; Latent heat of vaporization = (estimate) = 3.0×10^5 J/kg; Heat of combustion = − 14.402 Btu/lb = − 8000 cal/g = -334.9×10^5 J/kg; Vapor pressure = 7 mmHg at 20°C; Flash point = 32°C; Explosive limits: LEL = 1.1%; UEL = 7.0%; Odor threshold = 0.002 ppm.

tert-isomer: Boiling point = 125°C; Flash point = 26°C; Explosive limits: LEL = 1.0%; UEL = 7.5%; Odor threshold = 0.08 *0.0006 in water.

iso-isomer: Boiling point = 142°C; Melting/Freezing point = − 78.5°C; Critical temperature 326.1°C; Critical pressure = 2.84 MN/m^2; Specific gravity = 0.876 at 15°C; Liquid surface tension = 0.02477 N/m at 20°C; Liquid water interfacial tension = 0.0502 N/m at 15°C; Relative vapor density (air = 1) = 4.5; Ratio of specific heats of vapor (gas) = (estimate)>1−1.1; Latent heat of vaporization = (estimate) = 3.07×10^5 J/kg; Heat of combustion = -334.9×10^5 J/kg; Vapor pressure = 4 mmHg at 20°C; Autoignition temperature = 379°C; Flash point = 25°C; Autoignition temperature = 379°C; Explosive limits: LEL = 1.2% at 100°C; UEL = 7.5%; Odor threshold = 0.015.

They all float on water and have poor (slight to negligible) solubility. Water contact forms a flammable, irritating vapor. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0.

*The range of accepted *odor threshold values* is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

Potential Exposure: Compound Description: (*n*-isomer) Human Data; Natural Product; Primary Irritant; (*sec*-isomer) Human Data. Amyl acetates are used as industrial solvents and in the manufacturing and dry-cleaning industry; making artificial fruit-flavoring agents; cements, coated papers, lacquers; in medications as an inflammatory agent; pet repellents, insecticides, and miticide. Many other uses.

Incompatibilities: Nitrates, strong oxidizers; strong alkalis; strong acids. May soften certain plastics. Forms explosive mixture with air.

Permissible Exposure Limits in Air

OSHA PEL (*628-63-7; 626-38-0*): 100 ppm/525 mg/m^3 TWA.

NIOSH REL (*628-63-7; 626-38-0*): 100 ppm/525 mg/m^3 TWA.

ACGIH TLV®[1] (*628-63-7; 626-38-0; 620-11-1; 625-16-1*): 50 ppm/266 mg/m^3 TWA; 100 ppm/532 mg/m^3 STEL.

NIOSH IDLH: 1000 ppm, *all isomers of amyl acetates.*

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 100 ppm

PAC-3: 1000 ppm

DFG MAK (*628-63-7; 626-38-0; 620-11-1; 625-16-1*): 50 ppm/270 mg/m^3 TWA; Peak Limitation Category I(1). Pregnancy Risk Group D.

Austria: MAK 100 ppm (525 mg/m^3), 1999; Denmark: TWA 100 ppm (525 mg/m^3), 1999; France: VME 100 ppm (530 mg/m^3), 1999; Japan: 100 ppm (530 mg/m^3), 1999;

Norway: TWA 50 ppm (260 mg/m^3), 1999; Poland: MAC (time-weighted average) 250 mg/m^3, MAC (STEL) 500 mg/m^3, 1999; Sweden: TWA 100 ppm (500 mg/m^3), STEL 150 ppm (800 mg/m^3), 1999; Switzerland: MAK-week 100 ppm (500 mg/m^3), 1999; United Kingdom: TWA 50 ppm (270 mg/m^3), STEL 100 ppm (541 mg/m^3), 2000.

sec-isomer

OSHA PEL: 125 ppm/650 mg/m^3 TWA.

NIOSH REL: 125 ppm/650 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/266 mg/m^3 TWA; 100 ppm/532 mg/m^3 STEL.

DFG MAK: 50 ppm/270 mg/m^3 TWA; Peak Limitation Category I(1). Pregnancy Risk Group D.

Australia: TWA 125 ppm (665 mg/m^3), 1993; Austria: MAK 100 ppm (525 mg/m^3), 1999; Belgium: TWA 125 ppm (665 mg/m^3), 1993; Denmark: TWA 100 ppm (525 mg/m^3), 1999; France: VME 125 ppm (670 mg/m^3), 1999; Norway: TWA 50 ppm (260 mg/m^3), 1999; the Philippines: TWA 125 ppm (650 mg/m^3), 1993; Sweden: TWA 100 ppm (500 mg/m^3), STEL 150 ppm (800 mg/m^3), 1999; Switzerland: MAK-week 100 ppm (540 mg/m^3), 1999; Turkey: TWA 100 ppm (525 mg/m^3), 1993; United Kingdom: TWA 50 ppm (270 mg/m^3), STEL 100 ppm (541 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm.

iso-isomer

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 200 ppm

PAC-3: 1000 ppm

DFG MAK: 50 ppm/270 mg/m^3 TWA; Peak Limitation Category I(1). Pregnancy Risk Group D.

Australia: TWA 100 ppm (525 mg/m^3), 1993; Belgium: TWA 100 ppm (532 mg/m^3), 1993; Denmark: TWA 100 ppm (525 mg/m^3), 1999; France: VME 100 ppm (525 mg/m^3), 1999; Japan: 100 ppm (530 mg/m^3), 1999; Norway: TWA 50 ppm (260 mg/m^3), 1999; the Philippines: TWA 100 ppm (525 mg/m^3), 1993; Russia: TWA 100 ppm, 1993; Switzerland: MAK-week 50 ppm (270 mg/m^3), [skin], 1999; United Kingdom: LTEL 100 ppm (525 mg/m^3), STEL 125 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm.

tert-isomer

ACGIH TLV®[1]: 50 ppm/266 mg/m^3 TWA; 100 ppm/532 mg/m^3 STEL

DFG MAK: 50 ppm/270 mg/m^3 TWA; Peak Limitation Category I(1). Pregnancy Risk Group C.

Determination in Air: Use NIOSH Analytical Method #1450 Esters I, #2549 Volatile Organic Compounds[18] (screening).

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.18$ (*n*-isomer); 2.26 (*sec*-isomer).

Routes of Entry: Inhalation, ingestion, eye, and skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Amyl acetates can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, causing burning sensation. Inhalation can irritate the respiratory tract, causing cough and wheezing. Higher exposure can cause headache, drowsiness, weakness, and loss of consciousness.

Long Term Exposure: (*n*-) May cause liver damage. (*sec*-) May cause slight changes in the nervous system (brain wave changes). Prolonged or repeated skin contact to amyl acetates can cause irritation, dryness, and cracking. Although all of these chemicals have not been adequately tested, many similar petroleum-based chemicals can cause brain or other nerve damage. Effects may include reduced memory and concentration, personality changes such as withdrawl and irritability, fatigue, sleep disturbances, reduced coordination, and/or effects on autonomic nerves, and/or nerves to the arms and legs with weakness and sensation of "pins and needles." See also DFG MAK, above, for Pregnancy Risk Groups.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Liver function tests. Positive and borderline individuals showing brain effects, changes in memory, concentration, mood, and sleeping patterns, as well as headaches and fatigue should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *n*-Amyl acetate (CAS: 628-63-7): Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Barricade®™ coated suits; Responder™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Polyvinyl alcohol gloves; Teflon™ gloves, suits, boots. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Wear solvent-resistant protective gloves and clothing to prevent any reasonable probability of skin contact. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear solvent-resistant, splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn.

Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (for *n*-, *sec*-, and *iso*-isomers): *1000 ppm:* CcrFOv* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 500) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection. There are no specific respirator specs for *tert*-amyl acetate.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where amyl acetates may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area, preferably a detached shed. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Amyl acetates require a shipping label of "FLAMMABLE LIQUID." For amyl acetates, the DOT/UN Hazard Class is 3 and the Packing Group is III.[19, 20]

Spill Handling: Avoid contact. Stay upwind. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Establish forced ventilation to keep levels below explosive limit. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are flammable liquids. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions, or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 39−40 (Isoamyl Acetate)

Sax, N. I. (Ed.). (November, December 1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 37−40 (*t*-Amyl Acetate)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: n-Amyl Acetate*. Albany, NY: Bureau of Toxic Substance Assessment.

New Jersey Department of Health and Senor Services. (June 2004). *Hazardous Substances Fact Sheet: n-Amyl Acetate*. Trenton, NJ.

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: sec-Amyl Acetate*. Trenton, NJ.

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Isoamyl Acetate*. Trenton, NJ.

Amyl alcohols A:1310

Molecular Formula: $C_5H_{12}O$

Synonyms: Pentanols

n-isomer: Alcohol *n*-amilico primario (Spanish); Alcohol C-5; Alcool *n*-amyl alcohol; 1-Amyl alcohol; Amyl alcohol; Amyl alcohol, *normal*; Amylique (French); Amylol; *n*-Butyl carbinol; *n*-Pentanol; 1-Pentanol; Pentan-1-ol; Pentanol; Pentanol-1; Pentasol; Pentyl alcohol; *primary-n*-Amyl alcohol; Primary amyl alcohol

sec-isomer: Alcohol *n*-amilico secundario (Spanish); *sec*-Amyl alcohol; Methyl propyl carbinol; 2-Pentanol; Pentanol-2; *sec*-Pentyl alcohol

tert-isomer: Alcohol amilico terciario (Spanish); *tert*-Amyl alcohol; Amylene hydrate; Dimethylethylcarbinol; 2-Methyl butanol-2; 2-Methyl-2-butanol; 3-Methylbutan-3-ol; *tert*-Pentanol; 3-Pentanol; *tert*-Pentyl alcohol

iso-isomer: Alcohol isoamilico primario (Spanish); Alcool isoamylique (French); *iso*-Amylalkohol (German); Diethylcarbinol; Fermentation amyl alcohol; Isoamyl alcohol; Isoamylol; Isobutylcarbinol; Isopentanol; Isopentyl alcohol; 2-Methyl-4-butanol; 3-Methyl butanol; 3-Methylbutan-1-ol; 3-Pentanol; Pentanol-3-ol

CAS Registry Number: 71-41-0 (*n*-isomer); 6032-29-7 (*sec*-isomer); 123-51-3 (*iso-*, *primary*-isomer); 137-32-6 (*active primary*-isomer); 584-02-1 (*iso-*, *sec*-isomer); *(alt.)* 26635-63-2; 75-85-4 (*tert*-isomer); 30899-19-5 (*iso*-isomer); *(alt.)* 94624-12-1; 598-75-4 (*sec-ioamyl*-isomer); 75-84-3 (*neo*-isomer); 30899-19-5 (mixed isomers)

RTECS® Number: SB9800000 (*n*-isomer); SA4900000 (*sec*-isomer); SC0175000 (*tert*-isomer); EL5425000 (*iso-*, *primary*-isomer); SA5075000(*iso-*, *sec*-isomer)

UN/NA & ERG Number: UN1105/129

EC Number: 200-752-1 [*Annex I Index No.:* 603-200-00-1] (*n*-isomer); 227-907-6 (*sec*-isomer); 200-908-9 [*Annex I Index No.:* 603-007-00-2] (*tert*-isomer); 204-633-5 (*iso-*, *primary*-isomer); 209-526-7 (*iso-sec*-isomer); 205-289-9 (*active primary*-isomer)

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*n-*, *sec-*, *iso-*, *primary-*, and *sec*-isomers listed).

European/International Regulations (*all isomers except tert-*): Hazard Symbol: Xn; Risk phrases: R10; R20; R37; Safety phrases: S2; S46; (*tert-; 75-85-4*): Hazard Symbol: F, Xn; Risk phrases: R11; R20; R37/38; Safety phrases: S2; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amyl alcohols (pentanols) have eight isomers. All are flammable, colorless liquids, except the isomer 2,2-dimethyl-1-propanol, which is a crystalline solid. Odors* are described as "acetone-like" and "similar to fuel oil."

n-isomer: CAS 71-41-0: Molecular weight = 88.17; Boiling point = 137.9°C; Melting/Freezing point = − 78.8°C; Critical temperature = 313°C; Specific gravity: 0.818 at 15°C; Liquid surface tension = 0.02560 N/m at 20°C; Liquid water interfacial tension = 0.005 N/m at 20°C; Relative vapor density (air = 1): 3.04; Ratio of specific heats of vapor (gas): 1.06; Latent heat of vaporization = 5.049×10^5 J/kg; Heat of combustion = -376.8×10^5 J/kg; Electrical conductivity = 2.6×10^7 pS/m; Vapor density (air = 1) = 3.0; Vapor pressure = 2.29 mmHg at 20°C. Explosive limits: LEL = 1.2%; UEL = 10.0% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0.

sec-isomer: CAS 6032-29-7: Molecular weight = 88.17; Boiling point = 118°C; Melting/Freezing point = − 78.8°C; Flash point = 34°C; Autoignition temperature = 343°C. Explosive limits: LEL = 1.2%; UEL = 9.0. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 1, Oxidizer. Slightly soluble in water; solubility = 13.5 g/100 mL.

tert-isomer: CAS 75-85-4: Boiling point = 102°C; Melting/Freezing point = − 8°C; Flash point = 19°C; Autoignition temperature = 436°C; Explosive limits: LEL = 1.2%; UEL = 9. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Moderate solubility in water.

iso-, primary-isomer: CAS: 123-51-3*:* Molecular weight = 88.17; Boiling point = 132°C; Melting/Freezing point: − 117°C; Critical temperature: 307°C; Specific gravity: 0.82 at 20°C; Liquid surface tension = 0.0238 N/m at 20°C; Liquid water interfacial tension = 0.005 N/m at 18°C; Relative vapor density (air = 1) = 3.04; Ratio of specific heats of vapor (gas) = (estimate) 1.062; Latent heat of vaporization = 5.016×10^5 J/kg; Heat of combustion = -376.8×10^5 J/kg; Heat of solution = -1.33×10^5 J/kg; Vapor pressure = 28 mmHg at 20°C; Threshold limit = 0.012−10 ppm; Flash point = 43°C (cc); 55°C (oc); Autoignition temperature = 350°C; Explosive limits: LEL = 1.2%; UEL = 9% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Soluble in water; solubility = 2%. Threshold limit = 0.028−0.072 ppm.

iso-sec-isomer: CAS: 6032-29-7: Boiling point = 113−119°C; Melting/Freezing point = − 50°C; Specific gravity (H_2O:1) = 0.812; Flash point = 35°C; Autoignition temperature = 343°C; Explosive limits: LEL = 1.2%; UEL = 9%.

Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0.

*The range of accepted odor threshold values is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

Amyl alcohols are obtained from fused oil which forms during the fermentation of grain, potatoes, or beets for ethyl alcohol. The fused oil is a mixture of amyl alcohol isomers, and the composition is determined somewhat by the sugar source. Slight to moderate solubility in water.

Potential Exposure: Compound Description (*n*-isomer): Mutagen, Human Data; Primary Irritant; (*iso*-, *primary*-): Tumorigen, Human Data; Primary Irritant; (*sec*-, *active primary*-, and other isomers) Primary Irritant. Used as a solvent in organic synthesis and synthetic flavoring, pharmaceuticals, corrosion inhibitors; making plastics and other chemicals; as a flotation agent. The *n*-isomer is used in preparation of oil additives, plasticizers, synthetic lubricants, and as a solvent.

Incompatibilities: Forms an explosive mixture with air. Contact with strong oxidizers and hydrogen trisulfide may cause fire and explosions. Incompatible with strong acids. Violent reaction with alkaline earth metals forming hydrogen, a flammable gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.61 mg/m^3 (*iso*-, *primary*- and *iso*-, *sec*-isomers) at 25°C & 1 atm.

ACGIH TLV®[1]: 100 ppm TWA; 125 ppm STEL (*isoamyl alcohol*, *primary*-).

OSHA PEL: 100 ppm/360 mg/m^3 (*isoamyl alcohol*, *primary- and sec*-).

NIOSH REL: 100 ppm/360 mg/m^3 TWA; 125 ppm/450 mg/m^3 STEL (*isoamyl alcohol*, *primary*- and *sec*-).

AIHA WEEL: 100 ppm TWA (*n-amyl CAS 71-41-0*).

Protective Action Criteria (PAC)

n-isomer

TEEL-0: 20 ppm
PAC-1: 20 ppm
PAC-2: 20 ppm
PAC-3: 35 ppm

pentanol, 2-; (sec-isomer)

TEEL-0: 100 ppm
PAC-1: 100 ppm
PAC-2: 100 ppm
PAC-3: 350 ppm

pentyl alcohol, tert-; (tert-isomer)

TEEL-0: 60 ppm
PAC-1: 100 ppm
PAC-2: 100 ppm
PAC-3: 100 ppm

isoamyl alcohol (primary); (3-methyl-1-butanol)

TEEL-0: 100 ppm
PAC-1: 125 ppm
PAC-2: 125 ppm
PAC-3: 500 ppm

isoamyl alcohol (sec-); (3-pentanol)

TEEL-0: 100 ppm
PAC-1: 125 ppm
PAC-2: 125 ppm
PAC-3: 500 ppm

DFG MAK (*all pentanol isomers*): 20 ppm/73 mg/m^3 TWA; Peak Limitation Category I(4); Pregnancy Risk Group C.

NIOSH IDLH: 500 ppm (*isoamyl alcohol*, *primary*- and *sec*-).

n-isomer

Australia: TWA 100 ppm (530 mg/m^3), 1993; Austria: MAK 100 ppm (525 mg/m^3) (all isomers), 1993; Belgium: TWA 100 ppm (532 mg/m^3), 1993; Denmark: TWA 100 ppm (360 mg/m^3), 1999; Finland: TWA 100 ppm (360 mg/m^3), STEL 150 ppm (540 mg/m^3), 1999; France: VME 100 ppm (530 mg/m^3), STEL 150 ppm (800 mg/m^3), 1993; Hungary: TWA 400 mg/m^3, STEL 800 mg/m^3, 1993; Japan: 100 ppm (530 mg/m^3), 1993; the Philippines: TWA 100 ppm (525 mg/m^3), 1993; Poland: MAC (time-weighted average) 100 mg/m^3; MAC (STEL) 450 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Russia: TWA 100 ppm, STEL 100 mg/m^3, 1993; Switzerland: MAK-week 100 ppm (540 mg/m^3) (all isomers), 1993; Turkey: TWA 100 ppm (525 mg/m^3), 1993; United Kingdom: LTEL 100 ppm (530 mg/m^3), STEL 150 ppm, 1993.

sec-isomer and 584-02-1 iso-, sec-isomer

Denmark: TWA 100 ppm (360 mg/m^3), 1999; Norway: TWA 50 ppm (180 mg/m^3), 1999; Poland: MAC (time-weighted average) 100 mg/m^3; MAC (STEL) 450 mg/m^3, 1993.

iso-, *primary-isomer*

Australia: TWA 100 ppm (360 mg/m^3), STEL 125 ppm, 1993; Austria: MAK 100 ppm (360 mg/m^3), 1999; Belgium: TWA 100 ppm (361 mg/m^3), STEL 125 ppm (452 mg/m^3), 1993; Denmark: TWA 100 ppm (360 mg/m^3), 1999; France: VME 100 ppm (360 mg/m^3), 1999; Japan: 100 ppm (360 mg/m^3), 1999; the Netherlands: MAC-TGG 360 mg/m^3, 2003; the Philippines: TWA 100 ppm (360 mg/m^3), 1993; Russia: TWA 100 ppm, STEL 5 mg/m^3, 1993; Switzerland: MAK-week 100 ppm (360 mg/m^3), KZG-week 200 ppm (720 mg/m^3), 1999; Turkey: TWA 100 ppm (360 mg/m^3), 1993; United Kingdom: TWA 100 ppm (366 mg/m^3), STEL 125 ppm (458 mg/m^3), SEP2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 125 ppm.

Determination in Air: Use NIOSH Analytical Method #1402, #1405.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol–water coefficient: Log K_{ow} = 1.34 (*n*-); 1.42 (*sec*-); 1.15 (*iso*-, *primary*-); 1.35 (*iso*-, *sec*-); 0.9 (*tert*-).

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Passes through the skin; contact contributes significantly to overall exposure. Skin contact can cause skin irritation. Inhalation can irritate the eyes and respiratory system, causing headache, nausea, and vomiting. High exposure can cause dizziness, lightheadedness, confusion, and unconsciousness. Very high exposure can cause death.

Long Term Exposure: Can cause liver damage and blood effects.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Regular medical checkups are recommended, depending on degree of exposure.

First Aid: Skin contact contributes significantly to overall exposure. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. ACGIH and safety equipment suppliers/manufacturers recommend polyvinyl alcohol, polyvinyl chloride, Neoprene™, butyl rubber, nitrile rubber, Neoprene™ + styrene−butadiene rubber (SBR), polyurethane, SBR, and SBR/Neoprene™ as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *500 ppm:* Sa:Cf (APF = 25)† (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

†Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where amyl alcohols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids and hydrogen trifluoride; since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Amyl alcohols require a shipping label of "FLAMMABLE LIQUID." They fall in DOT/UN Hazard Class 3 and Packing Group II or III (*n*-).[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure,

explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 55−56 (*n*-Amyl alcohol)

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Amyl Alcohol*. Trenton, NJ

Amyl nitrate A:1320

Molecular Formula: $C_5H_{11}NO_3$

Common Formula: $C_5H_{11}ONO_2$

Synonyms: *n*-Amyl nitrate; Diesel ignition improver; Nitrate d'amyle (French); Nitrato de amilo (Spanish); Nitric acid, pentyl ester

CAS Registry Number: 1002-16-0

RTECS® Number: QV0600000

UN/NA & ERG Number: UN1112/140

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amyl nitrate is a flammable, colorless liquid with an ether-like odor. Molecular weight = 133.15; Boiling point = 153−157°C; Melting/Freezing point = −123°C; Specific gravity = 1.0 at 20°C; Flash point = 48°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1, Oxidizer. Floats on water; insoluble.

Potential Exposure: Amyl nitrate is used as an ignition additive in diesel fuels.

Incompatibilities: An oxidizer. Contact with reducing agents or other easily oxidizable substances may cause fire and explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 25 ppm
PAC-1: 75 ppm
PAC-2: 500 ppm
PAC-3: 2500 ppm

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Breathing amyl nitrate vapor can cause headaches, dizziness, weakness, and nausea. Higher levels can cause convulsions and death. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness, and a blue color to the skin and lips.

Long Term Exposure: Repeated exposure may cause anemia. After repeated exposure, tolerance develops. If exposure stops suddenly, chest pain and heart attack could occur.

Points of Attack: Blood cells.

Medical Surveillance: Blood tests for methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, flames, and other combustible materials, such as wood, paper, or oil. Outside or detached storage is preferred. Before entering confined space where amyl nitrate may be present, check to make sure that an explosive concentration does not exist. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." The DOT/UN Hazard Class is 3 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate site of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep Amyl Nitrate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with scrubber to remove nitrogen oxides in effluent gases.

Reference

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Amyl Nitrate*. Trenton, NJ

Amyl nitrites A:1330

Molecular Formula: $C_5H_{11}NO_2$

Synonyms: *n-isomer:* 1-Nitropentane

iso-isomer: Nitrous Acid, 3-methylbutyl ester; Isoamyl nitrite; Isopentyl alcohol nitrite; 3-Methylbutanol nitrite; 3-Methylbutyl nitrite; Nitropentane; Nitrous acid, pentyl ester; Pentyl nitrite

CAS Registry Number: 463-04-7 (*n*-); 110-46-3 (*iso*-)

RTECS® Number: RA1140000 (*n*-); NT0187500 (*iso*-)

UN/NA & ERG Number: UN1113/129

EC Number: 207-332-7 [*Annex I Index No.:* 007-020-00-9] (*n*-); 203-770-8 [*Annex I Index No.:* 007-020-00-9] (*iso*-)

Regulatory Authority and Advisory Bodies

European/International Regulations (*n*- and *iso*-isomers): Hazard Symbol: (*n*- and *iso*-isomers) F + , Xn; Risk phrases: R11; R20/22; Safety phrases: S2; S16; S24; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Amyl nitrites are flammable, yellowish liquid with a penetrating, fruity odor. Molecular weight = 117.17; Boiling point = 104°C; Specific gravity (H_2O:1) = 0.8758 at 20°C; Liquid surface tension = (estimate) 0.020 N/m at 20°C; Liquid water interfacial tension = (estimate) 0.040 N/m at 20°C; Relative vapor density (air = 1) = 4; Ratio of specific heats of vapor (gas) = 1.0709; Latent heat of vaporization = 4.94×10^5 J/kg; Heat of combustion = -290×10^5 J/kg; Vapor pressure = (estimate) 27 mmHg; 3.48 kPa at 20°C; Flash point = 3°C (*n*-); 3°C (*iso*-); Autoignition temperature = 209−210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability-, Reactivity 2. Floats on water; very slightly soluble; decomposes.

Potential Exposure: Compound Description: Mutagen Amyl nitrite is used to make pharmaceuticals, perfumes, diazonium compounds, and other chemicals.

Incompatibilities: Forms explosive mixture with air.

Slowly decomposes in light, heat, and on contact with water. A strong oxidizer. Contact with reducing agents and easily oxidizable materials may cause fire and explosions. Reported to be an explosion hazard when exposed to air and light. Keep away from alcohols, antipyrine, alkaline materials; alkaline carbonates; potassium iodide, bromides, and ferrous salts. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) (*iso*-)

TEEL-0: 3 ppm

PAC-1: 7.5 ppm

PAC-2: 60 ppm

PAC-3: 300 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Amyl nitrite can be absorbed through the skin, thereby increasing exposure. Contact can irritate the eyes and skin. A skin allergy can develop. Chronic overexposure can cause blood cell damage and anemia. Exposure can rapidly cause flushing, headaches, dizziness, sharp drop in blood pressure, fast pulse rate, confusion, a blue color to lips and fingernails, and possible fainting and shock.

Long Term Exposure: Chronic overexposure can cause anemia and red blood cell damage. Repeated exposure causes tolerance to develop. If exposure stops suddenly, chest pain and heart attack could occur. May cause skin allergy to develop.

Points of Attack: Blood, skin.

Medical Surveillance: Blood methemoglobin level, complete blood count (CBC), evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where amyl nitrite may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator.[52] Protect from light. Keep under an inert atmosphere. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." The DOT/UN Hazard Class is 3 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep amyl nitrite out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with scrubber to remove nitrogen oxides from the combustion gases.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Amyl Nitrite*. Trenton, NJ

Amyl trichlorosilane A:1340

Molecular Formula: $C_5H_{11}SiCl_3$
Synonyms: Amiltriclorosilano (Spanish); Pentyltrichlorosilane; Pentylsilicon trichloride; Silane, trichloropentyl-; Trichloroamylsilane; Trichloropentylsilane
CAS Registry Number: 107-72-2
RTECS® Number: VV4725000
UN/NA & ERG Number: UN1728/155
EC Number: 203-515-0
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Listed in the TSCA inventory.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Amyl trichlorosilane is a colorless to yellowish liquid with a sharp acrid odor (like hydrochloric acid). Molecular weight = 205.63; Boiling point = 168°C; Specific gravity = 1.137 at 25°C; Liquid surface tension = (estimate) 0.020 N/m at 20°C; Relative vapor density (air = 1) = 7.1; Latent heat of vaporization = 2.02×10^5 J/kg; Heat of combustion = -154×10^5 J/kg; Heat of solution: 4.0×10^5 J/kg; Flash point = 30°C. NFPA 704 M Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Reacts with water.
Potential Exposure: It is used to make silicones.
Incompatibilities: Contact with water forms corrosive and toxic hydrogen chloride fumes. Contact with halogens may cause explosion. Corrodes metals in the presence of moisture.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.2 ppm
PAC-1: **0.60** ppm
PAC-2: **7.3** ppm
PAC-3: **33** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Harmful Effects and Symptoms
Short Term Exposure: A corrosive chemical that can cause severe eye and skin burns. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs, causing coughing, and/or shortness of breath; still higher exposures can cause pulmonary edema, a medical emergency which can be delayed for several hours. This can cause death. The oral LD_{50} for rat is 2340 mg/kg.
Long Term Exposure: Similar corrosive chemicals cause lung damage; bronchitis may develop.
Points of Attack: Lungs, skin.
Medical Surveillance: Lung function tests. Consider lung X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Acid gas*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Amyl trichlorosilane requires a shipping label of "CORROSIVE." The DOT/UN Hazard class is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep amyl trichlorosilane out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.2/1.9

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. *Do not use water or foam.* Use dry chemical, carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Amyl Trichlorosilane*. Trenton, NJ

Aniline A:1350

Molecular Formula: C_6H_5N

Common Formula: $C_6H_3NH_2$

Synonyms: Aminobenzene; Aminophen; Anilina (Spanish); Aniline oil; Anyvim; Arylamine; Benzeneamine; Benzene, amino-; Blue oil; C.I. 76000; Huile d'aniline (French); NCI-C03736; Phenylamine

CAS Registry Number: 62-53-3; 142-04-1 (*hydrochloride*)

RTECS® Number: BW6650000; CY0875000 (hydrochloride)

UN/NA & ERG Number: UN1547/153; UN1548 (hydrochloride)/153

EC Number: 200-539-3 [*Annex I Index No.:* 612-008-00-7]; 205-519-8 (*hydrochloride*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA Gene-Tox Program, Inconclusive: Carcinogenicity-mouse/rat; IARC: Animal, Limited Evidence; Human, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: (*hydrochloride*) Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; IARC: (*hydrochloride*) Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA:

Sufficient evidence from animal studies, inadequate evidence, or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9; Positive/dose response: Cell transform.—BALB/c-3T3; Negative: SHE—clonal assay; *E. coli* polA with S9; Negative: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis.

Banned or Severely Restricted (Restricted in many countries) (UN).[35]

US EPA Gene-Tox Program (*hydrochloride*), Positive: Cell transform.—RLV F344 rat embryo; Positive/dose response: *In vitro* SCE—nonhuman; Positive/limited: Carcinogenicity—mouse/rat; Negative: Sperm morphology—mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U012.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

RCRA Land Ban Waste.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 14.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

California Proposition 65 Chemical: Cancer (includes hydrochloride) 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); Priority Substance List.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Aniline is a clear, colorless, oily liquid that darkens on exposure to light, with a characteristic amine-like odor. Molecular weight = 93.14; 129.60 (hydrochloride); Boiling point = 184.2°C; 245°C (hydrochloride); Melting/Freezing point = −6°C; Specific gravity (H_2O:1) = 1.022; 1.2 (hydrochloride) at 20°C; Liquid surface tension = (estimate) 0.020 N/m at 20°C; Liquid water interfacial tension = (estimate) 0.0058 N/m at 20°C; Liquid surface tension: .0455 N/m at 20°C; Critical pressure = 5.31 MN/m^2; Relative vapor density (air = 1) = 4; Ratio of specific heats of vapor (gas) = 1.0709; Electrical conductivity = 2.4×10^6 pS/m; Latent heat of vaporization = 4.61×10^5 J/kg; Heat of combustion = -348.3×10^5 J/kg; Vapor pressure: 0.6 mmHg at 20°C; <0.076 mmHg (hydrochloride); Flash point = 70°C; 193°C (hydrochloride); NFPA 704 M Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Explosive Limits: LEL = 1.3%; UEL = 11%. Odor threshold = 0.58−10 ppm. Slightly soluble in water; solubility = 3.4 g/100 mL at 20°C; the hydrochloride is more soluble = >100 g/100 mL.

Note: This chemical's odor generally provides inadequate warning of exceeded exposure limits.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant; (hydrochloride) Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Aniline is widely used as an intermediate in the synthesis of dyestuffs. It is also used in the manufacture of rubber accelerators and antioxidants, pharmaceuticals, marking inks; tetryl, optical whitening agents; photographic developers; resins, varnishes, perfumes, shoe polishes, and many organic chemicals.

Incompatibilities: Forms explosive mixture with air. Unless inhibited (usually methanol), aniline is readily able to polymerize. Fires and explosions may result from contact with halogens, strong acids, oxidizers, strong base, organic anhydrides, acetic anhydride, isocyanates, aldehydes, sodium peroxide. Strong reaction with toluene diisocyanate. Reacts with alkali metals and alkali earth metals. Attacks some plastics, rubber and coatings, copper, and copper alloys.

Permissible Exposure Limits in Air

Aniline and homologues

Conversion factor: 1 ppm = 3.81 mg/m^3 at 25°C & 1 atm

OSHA PEL: 5 ppm/19 mg/m^3 TWA [skin].

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/7.6 mg/m^3 TWA [skin]; Confirmed animal carcinogen; BEI: 50 mg/L total *p*-aminophenol in urine at end-of-shift.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)*

Aniline

TEEL-0: 5 ppm

PAC-1: **8** ppm

PAC-2: **12** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/7.7 mg/m^3 [skin] danger of skin sensitization; Peak Limitation Category II(2); Carcinogen Category 4; Pregnancy Risk Group C; BAT: 1 mg/L urine/end-of-shift.

Arab Republic of Egypt: TWA 2 ppm (10 mg/m^3), [skin], 1993; Australia: TWA 2 ppm (10 mg/m^3), [skin], 1993; Austria: MAK 2 ppm (8 mg/m^3), [skin], suspected carcinogen, 1999; Belgium: TWA 2 ppm (7.6 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (4 mg/m^3), [skin], 1999; Finland: TWA 2 ppm (7.6 mg/m^3), STEL 4 ppm, [skin], carcinogen, 1993; France: VME 2 ppm (10 mg/m^3), [skin], carcinogen, 1999; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003; India: TWA 0.2 mg/m^3, [skin], 1993; Japan: 1 ppm (3.8 mg/m^3), [skin], 1993; Norway: TWA 1 ppm (4 mg/m^3), 1999; the Philippines: TWA 5 ppm (19 mg/m^3), [skin], 1993; Poland: MAC (time-weighted average) 5 mg/m^3; MAC (STEL) 20 mg/m^3, 1999; Russia: TWA 1 ppm, STEL 0.1 mg/m^3, [skin], 1993; Sweden: NGV 1 ppm (4 mg/m^3), KTV 2 ppm (8 mg/m^3), [skin], 1999; Switzerland: MAK-week 2 ppm (8 mg/m^3), KZG-week 10 ppm (40 mg/m^3), [skin], 1999; Turkey: TWA 5 ppm (19 mg/m^3), [skin], 1993; United Kingdom: TWA 1 ppm (4 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Mexico: TWA 10 mg/m^3; STEL 5 ppm (20 mg/m^3). Russia[43] set a MAC of 0.05 mg/m^3 in residential air on a momentary basis and 0.03 mg/m^3 in residential air on an average daily basis. The California standard for work-place air is 2 ppm (7.6 mg/m^3) TWA. Several states have set guidelines or standards for aniline in ambient air[60]: 0.4 mg/m^3 (New York), 1.4 μg/m^3 (Massachusetts), 3.0 μg/m^3 (Rhode Island), 23.81 μg/m^3 (Kansas), 50 μg/m^3 (South Carolina), 100 μg/m^3 (North Dakota), 160 μg/m^3 (Virginia), 200 μg/m^3 (Connecticut), 238 μg/m^3 (Nevada), 1000 μg/m^3 (North Carolina).

Determination in Air: Silica adsorption, workup in *n*-propanol, followed by gas chromatography. Use NIOSH Analytical Method 2002 for aromatic amines.[18]

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit in water of 262 μ/mL based on health effects. Russia[43] set a MAC of 0.1 mg/L in water for domestic purposes and 0.0001 mg/L in water for fishery purposes.

Routes of Entry: Inhalation of vapors, percutaneous absorption of liquid and vapor, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact contributes significantly to overall exposure. Direct contact with liquid aniline can cause skin burns, eye irritation, and possible permanent damage. Inhalation can cause irritation of the respiratory tract with wheezing and coughing. High levels can interfere with the blood's ability to carry oxygen. Higher levels can cause difficult breathing, collapse, and death. Symptoms of exposure include grayish blue skin, headache, nausea, sometimes vomiting, dryness of throat, confusion, vertigo, lack of muscle coordination, ringing in the ears, weakness, disorientation, lethargy, drowsiness, and coma. Urinary signs include painful urinating, blood in the urine, the presence of hemoglobin in the urine, and diminished amounts of urine. Aniline is classified as very toxic. Probable oral lethal dose in humans is 50−500 mg/kg for a 150-lb person. The approximate minimum lethal dose for a 150-lb human is 10 g. Serious poisoning may result from ingestion of 0.25 mL.

Long Term Exposure: Chronic exposure can cause anemia, anorexia, weight loss, and skin lesions. Chronic effects may be due to acute damage to the brain, heart, and kidneys. Loss of appetite, dizziness, insomnia, tremors, malignant bladder growths, liver damage, and jaundice. Anemia has been reported. Has been linked to bladder cancer according to a NIOSH study. Signs and symptoms include blood in the urine, other changes in the appearance of the urine, changes in urinary habits, lumps in the groin and lower abdomen, and pain in the lower abdomen or back. Aniline can cross the placental barrier. Because fetal hemoglobin is more easily oxidized to methemoglobin than is adult hemoglobin and is less easily reduced back to normal hemoglobin, methemoglobin theoretically may be at higher levels in fetuses than in exposed mothers.

Points of Attack: Blood, cardiovascular system, liver, kidneys.

Medical Surveillance: Preplacement and periodic physical examinations should be performed on all employees working in aniline exposure areas. These should include a work history to elicit information on all past exposures to aniline, other aromatic amines, and nitro compounds known to cause chemical cyanosis, the clinical history of any occurrence of chemical cyanosis, a personal history to elicit alcohol drinking habits, and general physical examination with particular reference to the cardiovascular system. Persons with impaired cardiovascular status may be at greater risk from the consequences of chemical cyanosis. A preplacement complete blood count and methemoglobin estimation should be performed as baseline levels, also follow-up studies including periodic blood counts and hematocrit. People at special risk include individuals with glucose-6-phosphate-dehydrogenase deficiency and those with liver and kidney disorders, blood diseases, or a history of alcoholism.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Aniline, the simplest aromatic amine, is a prototypical inducer of methemoglobinemia and impaired oxygen transport to tissues. Chemical protective clothing is recommended because aniline vapor and liquid can be dermally absorbed and may contribute to systemic toxicity. Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): butyl rubber gloves, suits, boots; Polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves; Barricade®™ coated suits; Responder™ suits, Trellchem HPS™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 micron>g/cm^2/min): Teflon™ gloves, suits, boots; Viton™ gloves, suits; Saranex™ coated suits. In areas of vapor concentration, the use of respirators alone is not sufficient; skin protection by protective clothing should be provided even though there is no skin contact with liquid aniline. Personal hygiene practices including prompt removal of clothing which has absorbed aniline, thorough showering after work and before changing to street clothes, and clean working clothes daily are essential. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where aniline may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, dry, dark, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Aninline requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and the Packing Group is II.[19, 20] Aniline carries a plus sign (+), indicating that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class. The hydrochloride requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive pressure breathing apparatus and special protective clothing. Remove all ignition sources: no flares, smoking, or flames in hazard area. Do not touch material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with vermiculite, dry sand, earth, or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Fight fire from maximum distance. Dike fire control water for later disposal and do not scatter material. If a leak or spill has not ignited, use water spray to control vapors. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with provision for nitrogen oxides removal from flue gases by scrubber, catalytic or thermal device.[22]

References

US Environmental Protection Agency. (January 20, 1978). *Chemical Hazard Information Profile: Aniline*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 29−31 (1981) and 3, No. 5, 37−40 (1983) and 4, No. 4, 55−59 (1984) (Aniline hydrochloride)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Aniline*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Aniline*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Aniline*. Trenton, NJ

Anisidines A:1360

Molecular Formula: C_7H_9NO

Common Formula: $H_2NC_6H_4OCH_3$

Synonyms: *o-isomer:* Amine, *o*-methoxyphenylamine; *o*-Aminoanisole; 2-Aminoanisole; *o*-Anisidina (Spanish); 2-Anisidine; Anisidine-*o*; *o*-Anisylamine; *o*-Methoxyaniline; 2-Methoxyaniline; 2-Methoxybenzenamine; *o*-Methoxyphenylamine

p-isomer: *p*-Aminoanisole; 4-Aminoanisole; 1-Amino-4-methoxybenzene; *p*-Anisidina (Spanish); 4-Anisidine; Anisidine-*p*; *p*-Methoxyaniline; 4-Methoxyaniline; 4-Methoxybenzenamine; 4-Methoxybenzeneamine

Note: For information on *o*-Anisidine, 5-methyl—120-71-8, see *p*-Cresidine record

CAS Registry Number: 536-90-3 (*m*-isomer); 90-04-0 (*o*-isomer); 104-94-9 (*p*-isomer); 29191-52-4 (mixed isomers) 134-29-2 (hydrochloride)

RTECS® Number: BZ5410000 (*o*-isomer); BZ5450000 (*p*-isomer)

UN/NA & ERG Number: UN2431/153

EC Number: 201-963-1 [*Annex I Index No.:* 612-035-00-4] (*o*-isomer); 203-254-2 [*Annex I Index No.:* 612-112-00-2] (*p*-isomer)

Regulatory Authority and Advisory Bodies

Note: The *o*- and *p*-isomers are the primary concern of federal, state, and local government regulators.

Carcinogenicity: IARC: (*o*-) Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; (*p*-) IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; (hydrochloride, *o*-isomer) NTP: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, (*m*-) Inconclusive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (*o*-isomer).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): CERCLA 1 lb (0.454 kg) (*o*-isomer); 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%. (*o*-isomer).

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0% (*p*-isomer).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as *o*-anisidines.

California Proposition 65 Chemical: Cancer 7/1/87 (includes hydrochloride).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (*o*-isomer); 1% (*p*-isomer).

European/International Regulations (*90-04-0*): Hazard Symbol: T; Risk phrases: R45; R23/24/25; R68; Safety phrases: S53; S45; (*104-94-9*): Hazard Symbol: T + , N; Risk phrases: R26/27/28; R33; R50; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*m-isomer*); 3—Highly water polluting (*o-isomer*); 2—Water polluting (*p-isomer*)

Description: Anisidine exists as *ortho*-, *meta*-, and *para*-isomers. They have characteristic amine (fishy) odors.

o-isomer: A colorless to pink liquid. Solid below 5°C. Molecular weight = 123.17; Boiling point = 224°C; Melting/Freezing point = 5°C; Vapor pressure = <0.1 mmHg at 20°C; Flash point = 118°C (oc); Autoignition temperature = 415°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 1.5%.

m-isomer: Pale yellow liquid. Molecular weight = 123.2; Boiling point = 251°C; Freezing/Melting point = 57.2°C; Vapor pressure = 0.006 mmHg at 20°C.

p-isomer: Reddish-brown solid. Molecular weight = 123.2; Boiling point = 243°C; Freezing/Melting point = 57.2°C; Vapor pressure: 0.4 mmHg at 20°C; Flash point = 122°C; Autoignition temperature = 515°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: (*m-isomer*) Mutagen, (*o*-) Tumorigen, Mutagen, (*p-isomer*) Tumorigen, Drug, Mutagen. Anisidines are used in the manufacture of azo dyes, pharmaceuticals, textile-processing chemicals.

Incompatibilities: Incompatible with strong oxidizers, with risk of fire or explosions. Attacks some coatings and some forms of plastic and rubber.

Permissible Exposure Limits in Air

o- and p-isomers

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin] Potential occupational carcinogen. Reduce exposures to the lowest feasible concentration.

ACGIH TLV®[1]: 0.1 ppm/0.5 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans; BEI established.

Protective Action Criteria (PAC)

o-isomer

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 50 mg/m^3

p-isomers

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Austria: MAK 0.1 ppm (0.5 mg/m^3), [skin], 1993; Belgium: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Denmark: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1999; Finland: TWA 0.5 mg/m^3, STEL 1.5 mg/m^3, [skin], carcinogen, 1993; France: VME 0.1 ppm (0.5 mg/m^3), [skin], carcinogen, 1999; India: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Japan: [skin], 2B carcinogen, 1999; Norway: TWA 0.1 ppm (0.5 mg/m^3), 1999; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-week 0.1 ppm (0.5 mg/m^3), KZG-week 0.2 ppm (1 mg/m^3), [skin], 1999; United Kingdom: TWA 0.1 ppm (0.51 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

p-isomer

OSHA PEL: 0.5 mg/m^3 TWA.

NIOSH REL: 0.5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm TWA [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK: [skin]; DFG Carcinogen Category 3B.

NIOSH IDLH: 50 mg/m^3 (*o*- and *p*-isomers).

Australia: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Austria: MAK 0.1 ppm (0.5 mg/m^3), [skin], 1999; Belgium: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Denmark: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1999; Finland: TWA 0.5 mg/m^3, STEL 1.5 mg/m^3, [skin], carcinogen, 1993; France: VME 0.1 ppm (0.5 mg/m^3), [skin], 1999; India: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; Japan: [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, [skin], 2003; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-week 0.1 ppm (0.5 mg/m^3), KZG-week 0.2 ppm (1 mg/m^3), [skin], 1999; United Kingdom: TWA 0.1 ppm (0.53 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for anisidines in ambient air[60]: 0.02−1.0 μg/m^3 (Rhode Island), 5.0 μg/m^3 (Connecticut and North Dakota), 8.0 μg/m^3 (Virginia), 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 2514, anisidine.[18]

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.93$ (*o*-isomer); [v]; Octanol−water coefficient: Log $K_{ow} = 1.18$ (*m*-isomer); Octanol−water coefficient: Log $K_{ow} = 0.95$ [v] (*p*-isomer).

Routes of Entry: Inhalation, ingestion, skin, eye, mucous membrane absorption.

Harmful Effects and Symptoms

Short Term Exposure: These chemicals can be absorbed through the skin, eyes, or mucous membranes, thereby increasing exposure. Contact with anisidines can irritate the eyes, skin, and respiratory tract; can cause a burning sensation and skin rash. Inhalation of *p*-anisidine can cause shortness of breath and coughing. Exposure can interfere with the blood's ability to carry hemoglobin (methemoglobinemia). This can cause headache, dizziness, cyanosis of the skin and lips. Higher levels can cause difficult breathing, collapse, and death.

Long Term Exposure: *o*-Anisidine is a probable carcinogen in humans (IARC: Group 2B, limited human evidence). Related aromatic amines are carcinogens, and *p*-anisidine may be carcinogenic as well. Repeated exposure to these isomers may cause anemia, skin allergy, lung irritation and bronchitis, and nerve and kidney damage.

Points of Attack: Blood, kidneys, liver, cardiovascular system, central nervous system.

Medical Surveillance: *o-anisidine*: Evaluation by a qualified allergist, test for blood hemoglobin, complete blood count (CBC), and reticulocyte count. Consider nerve conduction studies. *p-Anisidine*: lung function tests, evaluation by a qualified allergist, kidney function tests, complete blood count (CBC), methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention

immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (*o*-anisidine) or dust-proof (*p*-anisidine) chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 500) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area. Protect against sunlight and strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Anisidines require a shipping label of "POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: *Liquid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Cover with sand and soda ash (9:1). After mixing, collect material in the most convenient and safe manner and deposit in sealed containers. Keep *o*-anisidine out of confined spaces, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in combustible solvent (alcohols, benzene, etc.) and spray solution into furnace equipped with afterburner and scrubber, or burn spill residue on sand and soda ash absorbent in a furnace.

References

National Cancer Institute. (1978). *Biossay of o-Ansidine Hydrochloride for Possible Carcinogenicity*, Technical Report Series No. 89. Bethesda, MD

National Cancer Institute. (1978). *Biossay of p-Anisidine Hydrochloride for Possible Carcinogenicity*, Technical Report Series No. 116. Bethesda, MD

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 34−36

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: p-Anisidine*. Trenton, NJ

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: o-Anisidine*. Trenton, NJ

Anisole A:1370

Molecular Formula: C_7H_8O
Common Formula: $C_6H_5OCH_3$
Synonyms: Benzene, methoxy; Ether, methyl phenyl; Methoxybenzene; Methyl phenyl ether; Metil fenil eter (Spanish); Phenyl methyl ether
CAS Registry Number: 100-66-3
RTECS® Number: BZ8050000
UN/NA & ERG Number: UN2222/128
EC Number: 202-876-1
Regulatory Authority and Advisory Bodies
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Anisole is a colorless to yellowish liquid with an agreeable, aromatic, spicy-sweet odor. Molecular weight = 108.15; Boiling point = 154°C; Freezing/Melting point = −37.3°C; Vapor pressure = 3.1 mmHg at 25°C; Flash point = 51.6°C (oc); Autoignition temperature = 475°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.
Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Anisole is used as a solvent, a flavoring, vermicide, making perfumes, and in organic synthesis.
Incompatibilities: Oxidizers, strong acids.
Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.1 ppm TWA (A4) [skin]
Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 12.5 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 400 mg/m^3
Russia: STEL 10 mg/m^3, 1993
Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/L in water bodies used for domestic purposes.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.1.
Routes of Entry: Inhalation, absorbed through the skin, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: A skin irritant since it degreases the skin; prolonged skin contact can cause drying and cracking. It irritates the eyes and respiratory tract if exposure occurs.[57] Exposure can cause dizziness, lightheadedness, and unconsciousness. It is moderately toxic by ingestion.[44] The oral LD_{50} for rat is 3700 mg/kg and for mouse is 2800 mg/kg.[9]
Long Term Exposure: Skin problems, dryness, cracking.
Points of Attack: Eyes, skin, respiratory system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away

from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where anisole may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated, fireproof area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Anisole requires a shipping label of "FLAMMABLE LIQUID." Anisole falls in Hazard Class 3, Packing Group III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate spill or leak area. Absorb spilled liquid in sand or inert absorbent and put in sealed containers and remove for disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Anisole.* Trenton NJ

Anthracene A:1380

Molecular Formula: $C_{14}H_{10}$

Synonyms: Anthracen (German); Anthracene oil; Anthracene polycyclic aromatic compound; Anthracin; Antraceno (Spanish); Green oil; Paranaphthalene; Sterilite hop defoliant; Tetra olive N2G

CAS Registry Number: 120-12-7; 906-80-5 (anthracene oil)

RTECS® Number: CA9350000

UN/NA & ERG Number: UN2713 (acridine)/153; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-371-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Negative: Cell transform.—BALB/c-3T3; SHE—clonal assay; Negative: Cell transform.—mouse embryo; Negative: *In vitro* cytogenetics—nonhuman; *E. coli* polA with S9; Negative: Histidine reversion—Ames test; *In vivo* SCE—nonhuman; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast; Negative: *In vitro* UDS in rat liver; *S. cerevisiae*—homozygosis; Inconclusive: Carcinogenicity—mouse/rat; Inconclusive: Cell transform.—RLV F344 rat embryo; Inconclusive: Host-mediated assay; Mammalian micronucleus; Inconclusive: *E. coli* polA without S9; *In vitro* SCE—nonhuman.

Banned or Severely Restricted (UN) (in cosmetic products in the EU).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Set (EPA)[6] (Kansas)[61] (Mexico).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total Toxic Organics, 40CFR423, Priority Pollutants, as polynuclear aromatic hydrocarbons (PAH)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8100 (200); 8270 (10).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg), 40CFR 372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

California Proposition 65 Chemical: (*coke oven emissions*) Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Anthracene is colorless to pale yellow crystalline solid with a bluish fluorescence. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 178.24; Boiling point = 340°C; Freezing/Melting point = 216.5°C; Specific gravity (H_2O:1) = 1.24; Vapor pressure = 0.99 mmHg at 145°C; Flash point = 121°C; Autoignition temperature = 540°C. Explosive limits: LEL = 0.6%.[17] NFPA 704 M Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. It is used as an intermediate in dyestuffs (alizarin), insecticides, and wood preservatives; making synthetic fibers, anthraquinone, and other chemicals. May be present in coke oven emissions, diesel fuel, and coal tar pitch volatiles.

Incompatibilities: Finely dispersed powder forms explosive mixture in air. Contact with strong oxidizers, chromic acid, or calcium hypochlorite may cause violent reactions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 500 mg/m^3

No occupational limits have been established for anthracene. However this chemical may be present as *coke oven emissions* and *coal tar pitch volatiles*.

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

DFG MAK: Carcinogen Category 1.

NIOSH IDLH: 80 mg/m^3.

See also entry for coal tar pitch volatiles.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: Anthracene falls in the "polynuclear aromatic hydrocarbon" category of priority toxic pollutants as defined by EPA.[6] The EPA has considered setting criteria in the range from 0.097 to 9.7 ng/L for the protection of human health from polynuclear aromatic hydrocarbons. In addition, Kansas has set forth a guideline for anthracene in drinking water[61] of 0.029 μg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.2$.[d, icsc]

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Anthracene can affect you when breathed in. Skin contact can cause irritation or a skin allergy which is greatly aggravated by sunlight on contaminated skin. Breathing irritates the nose, throat, and bronchial tubes. Eye contact or "fume" exposure can cause irritation and burns.

Long Term Exposure: Repeated skin contact can cause thickening, pigment changes, and growths. Anthracene may cause mutations. Handle with extreme caution. The carcinogenic status of anthracene is a bit confusing: Animal negative[9] compares with ACGIH[1] and DFG[3] categorization of coal tar volatiles as proven carcinogens. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies. The Lewis/Sax reference below states that it is a mutagen and questionable carcinogen.

Points of Attack: Skin, respiratory system, bladder, liver, kidneys, as PAH.

Medical Surveillance: Evaluation by a qualified allergist. NIOSH lists the following tests: complete blood count; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria.[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Antidotes and Special Procedures:* Sun screens for ultraviolet light may help prevent skin allergic reactions. These may need frequent re-applications if you are sweating. Ultraviolet-screening sunglasses can help with eye allergic reactions. Consult your doctor or pharmacist in selecting these.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Anthracene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), chromic acid, and calcium hypochlorite, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Anthracene is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The "Acridine" standard may be used for this chemical. The required label is "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.[22]

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 6, 18−43

US EPA. (April 1975). *Identification of Organic Compounds in Effluents from Industrial Sources*, EPA-560/3-75-002

Eller, P. M., & Cassinelli, M. E. (Eds.). *NIOSH Manual of Analytical Methods* (NMAM®) (4th ed.), 2nd Supplement

National Institute for Occupational Safety and Health. (1998), DHHS (NIOSH), Publication No. 98-119, Cincinnati, OH

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Anthracene*. Trenton, NJ

Anthraquinone A:1390

Molecular Formula: C14H8O2

Synonyms: 9,10-Anthracenedione; Anthradione; 9,10-Anthraquinone; Antraquinona (Spanish); 9,10-Dioxoanthracene

CAS Registry Number: 84-65-1
RTECS® Number: CB4725000
UN/NA & ERG Number: UN3143 (dyes, solid, toxic, n.o.s. [or] dye intermediates, solid, toxic, n.o.s.)/151
EC Number: 201-549-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

TSCA 40CFR704.30; 40CFR716.120(a) List of substances; 40CFR712.30(m); 40CFR799.500 Testing Requirements. Export notification required by §12(b).

California Proposition 65 Chemical: Cancer 9/28/07.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Anthraquinone is a combustible, light yellow to green crystalline solid. Molecular weight = 208.23; Boiling point = 380°C; Melting/Freezing point = 286°C (sublimes); Flash point = 185°C (cc). NFPA 704 M Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Very slightly soluble in water; solubility = <13 mg/L at 22°C.

Potential Exposure: Anthraquinone is an important starting material for vat dye manufacture. Also used in making organics and used as a bird repellent in seeds.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 100 mg/m^3
PAC-3: 500 mg/m^3
Russia[43]: MAC 5 mg/m^3 work-place air.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.39 (measured), 2.7 (calculated).

Routes of Entry: Through the skin, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Can be absorbed through the skin, thereby increasing exposure. Eye or skin contact can cause irritation. An allergen, may cause skin irritation and sensitization. Severe poisoning, may cause seizures and coma.

Long Term Exposure: May cause skin allergy, with itching and rash. It may be mutagenic.

Points of Attack: Skin, lungs.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical can be classified by the hazardous materials description and proper shipping name as: "Dyes, solid, toxic, n.o.s. or dye intermediates, solid, toxic, n.o.s." It requires labeling of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered

material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Anthraquinone*. Trenton NJ

Antimony A:1400

Molecular Formula: Sb

Synonyms: Amspec antimony; Antimonio (Spanish); Antimony black; Antimony powder; Antimony, regulus; Atomergic antimony; C.I. 77050; Silver GLO 33BP; Silver GLO 3KBP; Silver GLO BP; Stibium; thermoguard CPA

CAS Registry Number: 7440-36-0 (metal)

RTECS® Number: CC4025000

UN/NA & ERG Number: UN2871 (powder)/170; UN1549/157 (inorganic compounds, n.o.s.); UN3141/157 (inorganic liquid compounds, n.o.s.)

EC Number: 231-146-5

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standards Set (EPA)[6, 32] (Kansas)[61] (Mexico).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Priority Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA Land Ban Waste.

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 6010 (300); 7040 (2000); 7041 (30).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 5000 lb (2270 kg) *only if the diameter of pieces of solid metal has a diameter equal to or greater than 0.004 in.*, 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as antimony, elemental; National Pollutant Release Inventory.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony is a silvery-white, lustrous, hard, brittle metal, scale-like crystals, or dark gray lustrous powder. Molecular weight = 121.75; Specific gravity (H_2O:1) = 6.68 at 25°C; Boiling point = 1635°C; Freezing/Melting point = 630°C. Hazard Identification (based on NFPA-704 M Rating System): [powder] Health 2, Flammability 2, Reactivity 0. Insoluble in water and organic solvents.

Potential Exposure: Compound Description: Tumorigen; Human Data. Exposure to antimony may occur during mining, smelting, or refining; alloy and abrasive manufacture; and typesetting in printing. Antimony is widely used in the production of alloys, imparting increased hardness, mechanical strength, corrosion resistance, and a low coefficient of friction. Some of the important alloys are Babbitt, pewter, white metal, Britannia metal, and bearing metal (which are used in bearing shells), printing-type metal, storage battery plates, cable sheathing, solder, ornamental castings, and ammunition. Pure antimony compounds are used as abrasives, pigments, flame-proofing compounds, plasticizers, and catalysts in organic synthesis; they are also used in the manufacture of tartar emetic, paints, lacquers, glass, pottery, enamels, glazes, pharmaceuticals, pyrotechnics, matches, and explosives. In addition, they are used in dyeing, for blueing steel, and in coloring aluminum pewter and zinc. A highly toxic gas, stibine, may be released from the metal under certain conditions.

Incompatibilities: Finely dispersed powder forms explosive mixture in air. Strong oxidizers; strong acids [especially halogenated acids], produce a violent reaction, and deadly stibine gas (antimony hydride). Heat forms stibine gas.

Mixtures with nitrates or halogenated compounds may cause combustion. Forms an explosive mixture with chloric and perchloric acid.

Note: Stibine is formed when antimony is exposed to nascent (freshly formed) hydrogen.[NIOSH]

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.
OSHA PEL: 0.5 mg[Sb]/m^3 TWA.
NIOSH REL: 0.5 mg[Sb]/m^3 TWA.
NIOSH IDLH: 50 mg[Sb]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 50 mg/m^3

Antimony and inorganic compounds, excluding stibine

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

Arab Republic of Egypt: TWA 0.5 mg/m^3, 1993; Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1993; France: VME 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg [Sb]/m^3; MAC-TGG 0.5 mg/m^3, 2003; Japan: 0.1 mg/m^3, 2B carcinogen, 1999; Norway: TWA 0.5 mg[Sb]/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Russia:; TWA 0.2 mg/m^3, STEL 0.5 mg/m^3, 1993; Sweden: NGV 0.5 mg/m^3, 1999; Switzerland: MAK-week 0.5 mg/m^3, 1999; Turkey: TWA 0.5 mg/m^3, 1993; United Nations: TWA 0.5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg[Sb]/m^3. Several states have set guidelines or standards for antimony in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 1.19 μg/m^3 (Kansas) to 1.2 μg/m^3 (Pennsylvania) to 5 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 10 μg/m^3 (Connecticut) to 12 μg/m^3 (Nevada) to 40 μg/m^3 (Rhode Island).

Determination in Air: OSHA Analytical Methods ID-125G, ID121. See also NIOSH Analytical Method #8005 (elements in blood and tissue).

Permissible Concentration in Water: To protect freshwater aquatic life—on an acute basis 9000 μg/L and on a chronic basis, 1600 μg/L. *To protect saltwater aquatic life:* no criterion due to insufficient data. *To protect human health:* 146 μg/L. EPA has also suggested an ambient limit of 7 μg/L[32] based on health effects. Mexico has set an Ecological Criteria guideline of 0.1 mg/L. Russia[43] set a MAC of 0.05 mg/L of antimony dust in water used for domestic purposes. In addition, Kansas has set a guideline for antimony in drinking water[61] of 143 μg/L.

Determination in Water: Digestion followed by atomic absorption. See EPA Methods 204.1 and 204.2.

Routes of Entry: Inhalation of dust or fume, skin, and/or eye contact.

Harmful Effects and Symptoms

Local: Antimony and its compounds are generally regarded as primary skin irritants. Lesions generally appear on exposed, moist areas of the body, but rarely on the face. The dust and fumes are also irritants to the eyes, nose, and throat, and may be associated with gingivitis, anemia, and ulceration of the nasal septum and larynx. Antimony trioxide causes a dermatitis known as "antimony spots." This form of dermatitis results in intense itching followed by skin eruptions. A diffuse erythema may occur, but usually the early lesions are small erythematous papules. They may enlarge, however, and become pustular. Lesions occur in hot weather and are due to dust accumulating on exposed areas that are moist due to sweating. Neither evidence of eczematous reaction is present, nor an allergic mechanism. *Systemic:* Systemic intoxication is uncommon from occupational exposure. However, miners of antimony may encounter dust containing free silica; cases of pneumoconiosis in miners have been termed "silico-antimoniosis." Antimony pneumoconiosis, *per se*, appears to be a benign process. Antimony metal dust and fumes are absorbed from the lungs into the blood stream. Principal organs attacked include certain enzyme systems (protein and carbohydrate metabolism), heart, lungs, and the mucous membrane of the respiratory tract. Symptoms of acute oral poisoning include violent irritation of the nose, mouth, stomach, and intestines, vomiting, bloody stools, slow shallow respiration, pulmonary congestion, coma, and sometimes death due to circulatory or respiratory failure. Chronic oral poisoning presents symptoms of dry throat, nausea, headache, sleeplessness, loss of appetite, and dizziness. Liver and kidney degenerative changes are late manifestations. Antimony compounds are generally less toxic than antimony. Antimony trisulfide, however, has been reported to cause myocardial changes in humans and experimental animals. Antimony trichloride and pentachloride are highly toxic and can irritate and corrode the skin. Antimony fluoride is extremely toxic, particularly to pulmonary tissue and skin.

Short Term Exposure: Eye and skin contact can cause irritation and itchy skin rash. Inhalation can cause respiratory tract irritation with wheezing and shortness of breath. Exposure can cause headache, nausea, abdominal pain, and loss of sleep.

Antimony poisoning can be delayed from 30 min to 2 h following ingestion. Symptoms include nausea, vomiting, dehydration and thirst, difficulty in swallowing, rapid pulse, cyanosis, watery stool and cramps, collapse, and shock. See also above.

Long Term Exposure: Repeated exposure can cause ulcers and sores of the nose to develop, damage to the kidneys, liver, and heart, lung effects (abnormal chest X-ray). See also above.

Points of Attack: Respiratory system, cardiovascular system, skin, eyes, and lungs.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic

X-ray, sputum cytology, urine (chemical/metabolite), urine (chemical/metabolite) pre- and postshift, urinalysis (routine), complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including antimony. Although BAS is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: A combination of protective clothing, barrier creams, gloves, and personal hygiene will protect the skin. Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide washing facilities, emergency showers and eyewash. Eating should not be permitted in exposed areas.

Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, halogens, strong acids, and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Contact with acids forms deadly stibine gas. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: Antimony powder requires a shipping label of "POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 6.1 and Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Antimony dust can present a moderate hazard when exposed to flame. Self-contained breathing apparatus may be required when antimony is exposed to extreme temperatures in a fire. Use dry chemical appropriate for metal fires, water spray, fog, or standard foam extinguishers. Toxic fumes are produced in fire, including deadly stibine gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a

secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is an option to disposal which should be considered for scrap antimony and spent catalysts containing antimony. Dissolve spilled material in minimum amount of concentrated HCl. Add water, until white precipitate appears. Then acidify to dissolve again. Saturate with H_2S. Filter, wash, and dry the precipitate and return to supplier.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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US Environmental Protection Agency. (February 1976). *Literature Study of Selected Potential Environmental Contaminants: Antimony and its Compounds*, Report No. EPA-560/2-76-002. Washington, DC: Office of Toxic Substances

National Institute for Occupational Safety and Health. (August 1979). *Environmental Exposure to Airborne Contaminants in the Antimony Industry*, NIOSH Publication No. 79-140. Cincinnati, OH

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol II: Antimony*, Report EPA-600-/1-77-022. Research Triangle Park, NC, pp. 15−29

US Environmental Protection Agency. (April 30, 1980). *Antimony: Health and Environmental Effects Profile No. 10*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 68−69

National Institute for Occupational Safety and Health. (September 28, 1978). *Criteria for a Recommended Standard: Occupational Exposure to Antimony*. Washington, DC

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony*. Trenton, NJ

Antimony lactate A:1410

Molecular Formula: $C_9H_{15}O_9Sb$
Common Formula: $Sb(OCOCHOHCH_3)_3$
Synonyms: Antimony (3 +) salt (3:1); 2-Hydroxypropanoic acid trainhydride with antimonic acid; 2-Hydroxy-, trianhydride with antimonic acid; Lactic acid, antimony salt; Propanic acid, 2-hydroxy-
CAS Registry Number: 58164-88-8
RTECS® Number: CC5455000
UN/NA & ERG Number: UN1550/151
EC Number: 261-148-1

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as antimony compounds, n.o.s.; National Pollutant Release Inventory as antimony compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony lactate is a noncombustible, tan solid. Molecular weight = 388.98. Soluble in water. Antimony lactate may be contaminated with arsenic or other toxic substances.

Potential Exposure: Antimony lactate is used in fabric dyeing.

Incompatibilities: Contact with strong oxidizers (chlorates, permanganates, peroxides, and nitrates) may cause a violent reaction. Contact with acids can produce deadly stibine gas.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

No Teel available.

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

NIOSH IDLH: 50 mg[Sb]/m^3.

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia[43] set a MAC of 0.3 mg/m^3 in work-place air.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Antimony lactate can affect you when breathed and by passing through skin. Exposure can irritate the eyes, nose, throat, and skin. Very high levels could cause Antimony poisoning, with symptoms of nausea headaches, abdominal pain, trouble breathing, and death. See also antimony [7440-36-0]. Antimony lactate may be contaminated with arsenic or other toxic substances.

Long Term Exposure: Repeated exposure can cause abnormal chest X-ray and damage the heart and liver. Prolonged or repeated skin contact can cause sores and ulcers.

Points of Attack: Skin, lungs, heart, liver.

Medical Surveillance: EKG, liver function tests, urine tests for antimony. Also test for arsenic if contamination is suspected. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure and at the end of the work shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of this antimony compound to potentially exposed workers.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* \100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly-closed containers in a cool, well-ventilated area away from heat, acids, and oxidizers.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony lactate itself does not burn. Poisonous gases are produced in fire, including deadly stibine gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Antimony*. Lactate, Trenton, NJ

Antimony pentachloride A:1420

Molecular Formula: Cl_5Sb
Common Formula: $SbCl_5$
Synonyms: Antimonic chloride; Antimonpentachlorid (German); Antimony(V) chloride; Antimony perchloride; Atomergic antimony pentachloride; Butter of antimony; Pentachloroantimony; Pentacloruro de antimonio (Spanish); Perchlorure d'antimoine (French); Tentachlorure d'antimoine (French)
CAS Registry Number: 7647-18-9
RTECS® Number: CC5075000
UN/NA & ERG Number: UN1730 (liquid)/157; UN1731 (solutions)/157
EC Number: 231-601-8 [*Annex I Index No.:* 051-002-00-3]
Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants; Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352) (as antimony).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

SUPERFUND/CERCLA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1000 lb (454 kg); 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory as antimony compounds.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R34-R51/53; Safety phrases: S1/2; S26; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony pentachloride is a noncombustible, colorless to reddish-yellow oily liquid with an offensive odor. Molecular weight = 299.05; Boiling point = 77°C (decomposes); Freezing/Melting point = 3°C; Specific gravity (H_2O:1) = 2.354 at 20°C; Liquid surface tension (estimate) = 0.015 N/m at 20°C; Latent heat of vaporization = 1.60×10^5 J/kg; Heat of solution = -4.925×10^5 J/kg; Vapor pressure: 0.84 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): (*solid or liquid*) Health 3, Flammability 0, Reactivity 1. Decomposes on contact with water.

Potential Exposure: It is used in dyeing, coloring metals, and in many organic chemical reactions as a catalyst.

Incompatibilities: Decomposes on contact with heat, acids, alkalis, ammonia, water, or other forms of moisture producing fumes of hydrogen chloride and antimony. Decomposes above 77°C forming chlorine and antimony trichloride. Attacks many metals in the presence of moisture forming explosive hydrogen gas. Reacts with air forming corrosive vapors.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.
OSHA PEL: 0.5 mg[Sb]/m^3 TWA.
NIOSH REL: 0.5 mg[Sb]/m^3 TWA.
NIOSH IDLH: 50 mg[Sb]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 1.23 mg/m^3
PAC-1: 3.68 mg/m^3
PAC-2: 6.14 mg/m^3
PAC-3: 123 mg/m^3
DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia[43] set a MAC of 0.3 mg/m^3 in work-place air.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Skin absorption, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Antimony pentachloride is a corrosive chemical; can affect you when breathed in and by passing through your skin. Exposure can cause sore throat, rash, poor appetite, abdominal pain, loss of sleep, and irritate the lungs. Higher levels can cause pulmonary edema, a medical emergency that can be delayed for several hours, irregular heartbeat which can cause death. High or repeated exposure may damage the liver, kidneys, and the heart muscle. If used near acid, a deadly stibine gas can be formed. Antimony may contain arsenic. It is a corrosive chemical. Contact can burn the skin or eyes. The oral LD_{50} for rat is 1115 mg/kg.[9]

Long Term Exposure: Repeated contact can cause ulcers or sores in the nose, kidney, liver, and heart damage.
Points of Attack: Kidneys, liver, heart, respiratory system.
Medical Surveillance: EKG, liver, and kidney function tests. Consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Antimony pentachloride must be stored to avoid contact with organic or combustible materials (such as wood, paper, and oil) since violent reactions occur. See incompatibilities. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.
Shipping: This chemical requires a shipping label of "CORROSIVE." The DOT/UN Hazard Class is 8, the Packing Group is II (liquid) and III (solutions). [19, 20]
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony pentachloride itself does not burn. Poisonous gases are produced in fire, including chlorine and hydrogen chloride. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Encapsulate and transfer to an approve landfill. If chemically treated and neutralized, the chemical is amenable to biological treatment at municipal sewage treatment plant. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony Pentachloride*. Trenton, NJ

Antimony pentafluoride A:1430

Molecular Formula: F_5Sb

Common Formula: SbF_5

Synonyms: Antimony fluoride; Antimony(5 +) fluoride; Antimony(V) fluoride; Antimony(5 +) pentafluoride; Antimony(V) pentafluoride; Atochem antimony pentafluoride; Atomergic antimony pentafluoride; Pentafluoroantimony; Pentafluoruro de antimonio (Spanish)

CAS Registry Number: 7783-70-2

RTECS® Number: CC5800000

UN/NA & ERG Number: UN1732/157

EC Number: 232-021-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

CERCLA/SARA Section 304 Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as antimony(V)pentafluoride; National Pollutant Release Inventory, as antimony compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony pentafluoride is a noncombustible, oily, colorless liquid with a pungent odor. Molecular weight = 216.75; Boiling point = 143°C; Melting/Freezing point = 8.3°C; Specific gravity: 2.340 at 30°C; Liquid surface tension = (estimate) 0.020 N/m at 20°C; Latent heat of vaporization = (estimate) 1.8×10^5 J/kg; Vapor pressure = 1.33 kPa at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: It is used as a catalyst in chemical reactions or as a source of fluorine (fluorinating reagent) in fluorination reactions.

Incompatibilities: Water and other forms of moisture forms hydrofluoric acid, combustible organic and siliceous materials, phosphorus, and phosphate materials. Attacks glass, ceramic, lead, and copper in the presence of moisture.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

NIOSH IDLH: 50 mg[Sb]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.89 mg/m^3

PAC-1: 0.89 mg/m^3

PAC-2: 2.7 mg/m^3

PAC-3: 89 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

*As fluoride*s

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA

2.5 mg(F)/m^3, 1993; Austria: MAK 0.5 mg(Sb)/m^3, 1993; Austria: MAK 2.5 mg(F)/m^3, 1999; Belgium: TWA 0.5 mg (Sb)/m^3, 1993; Belgium: TWA 2.5 mg(F)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Finland: TWA 0.5 mg (Sb)/m^3, 1993; Finland: TWA 2.5 mg(F)/m^3, 1993; France: VME 0.5 mg(Sb)/m^3, 1993; France: VME 2.5 mg(F)/m^3, 1999; Hungary STEL 0.5 mg(Sb)/m^3, 1993; Hungary: TWA 1 mg(F)/m^3, STEL 2 mg(F)/m^3, 1993; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.6 mg(F)/m^3, 1999; the Philippines: TWA 0.5 mg(Sb)/m^3, 1993; the Philippines: TWA 2.5 mg(F)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3, 1993; Poland: MAC (time-weighted average) 1 mg(HF)/m^3; MAC (STEL) 3 mg (HF)/m^3, 1999; Russia: STEL 0.3 mg/m^3, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2.5 mg (F)/m^3; United Kingdom: TWA 0.5 mg(Sb)/m^3; TWA 2.5 mg(F)/m^3, 2000.

Note: the OSHA PEL for fluorides (measured as fluorine) is 2.5 mg/m^3 TWA for an 8-h work shift.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Severe health hazard. May be fatal if inhaled or absorbed through the skin. The compound is corrosive and irritating to eyes, skin, and lungs. Contact with eyes or skin causes severe burns. Ingestion causes vomiting and severe burns of mouth and throat. Overexposure by any route can cause bloody stools, slow pulse, low blood pressure, coma, convulsions, and cardiac arrest. The probable oral lethal dose of 5−50 mg/kg or between 7 drops and a teaspoonful for a 150-lb person (antimony salts).

Long Term Exposure: Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system.

Medical Surveillance: EKG, liver, and kidney function tests. Consider lung function tests and chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

NIOSH: *(fluorides) 12.5 mg/m*^{3}: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m*^{3}*:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m*^{3}*:* Sa:Cf (APF = 25) *† (any supplied-air respirator operated in a continuous-flow mode) or P*† *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 mg/m*$^{3:}$ HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m*^{3}*:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF^{+} (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent. Exposure to 500 mg/m^3 (IDLH) is immediately dangerous to life and health.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Antimony pentafluoride must be stored to avoid contact with phosphorus, phosphates, siliceous, and combustible or organic materials since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat. Outside or detached storage is preferred.

Shipping: Antimony pentafluoride requires a shipping label of "CORROSIVE/POISONOUS/TOXIC MATERIALS." The DOT/UN Hazard Class is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For *large spills*, dike far ahead. Absorb spills with noncombustible absorbent material, such as vermiculite, dry sand, earth, etc., and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Approach fire from upwind; avoid hazardous vapors and toxic decomposition products. Do not use water or foam on fire or on adjacent fires; extinguish with dry chemicals or carbon dioxide. Water spray may be used to reduce vapors. Poisonous gases are produced in fire, including hydrogen fluoride and antimony fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Antimony Pentafluoride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony Pentafluoride*. Trenton, NJ

Antimony potassium tartrate A:1440

Molecular Formula: $C_4H_4KO_7Sb$

Synonyms: Antimonate (2-), bis μ-2,3-dihydroxybutanedioata(4-)-01,02: 03,04di-,dipotassium, trihydrate, stereoisomer; Antimonyl potassium tartrate; Emetique (French); ENT 50,434; Potassium antimonyl-δ-tartrate; Potassium antimonyl tartrate; Potassium antimony tartrate; Tartar emetic; Tartaric acid, antimony potassium salt; Tartarized antimony; Tartrated antimony; Tartrato de antimonio y potasio (Spanish); Tastox

CAS Registry Number: 28300-74-5

RTECS$^{®}$ Number: CC6825000

UN/NA & ERG Number: UN155/151

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (as antimony compounds).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Antimony potassium tartrate is an odorless, colorless, crystalline material, or white powder with a sweetish, metallic taste. Molecular weight = 635.88; Specific gravity (H_2O:1) = 2.6. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solution is slightly acidic.

Potential Exposure: It is used in medicine, in textile and leather dyeing, as an insecticide.

Incompatibilities: Solution will react with alkaline materials.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

NIOSH IDLH: 50 mg[Sb]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1.37 mg/m^3

PAC-1: 4.11 mg/m^3

PAC-2: 6.86 mg/m^3

PAC-3: 137 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 mg/m^3.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Skin absorption, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Antimony potassium tartrate can affect you when breathed in and by passing through your skin. Eye and skin contact can cause irritation and skin rash. Exposure can cause poor appetite, abdominal pain, nausea, headaches, sore throat, and irritation of air passages, with cough. Higher levels can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may make the heartbeat irregular or stop. High or repeated exposure may damage the liver or heart muscle.

Long Term Exposure: Prolonged or repeated contact can cause ulcers or sores in the nose, kidney, liver, and heart damage.

Points of Attack: Skin, eyes, respiratory system, cardiovascular system, kidneys, liver.

Medical Surveillance: EKG. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Antimony potassium tartrate requires a shipping label of “POISONOUS/TOXIC MATERIALS.” The Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony potassium tartrate itself does not burn. Poisonous gases are produced in fire, including potassium oxide and antimony. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 33−35

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony Potassium Tartrate*. Trenton, NJ

Antimony tribromide A:1450

Molecular Formula: Br_3Sb

Common Formula: $SbBr_3$

Synonyms: Antimonous bromide; Antimony(3 +) bromide; Antimony(III) bromide; Stibine, tribromo-; Tribromo stibine; Tribromuro de antimonio (Spanish)

CAS Registry Number: 7789-61-9

RTECS® Number: CC4400000

UN/NA & ERG Number: UN1549 (antimony compounds n.o.s.)/157

EC Number: 232-179-8

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic

Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (as antimony compounds).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony tribromide is a nonflammable, colorless to yellow crystalline solid. Molecular weight = 361.51. Boiling point = 288°C at 749 mmHg; Freezing/Melting point = 96.6°C; Specific gravity = 4.148 at 23°C; Critical temperature = 904.5°C; Critical pressure = 5.67 MN/m^2; Heat of Vaporization = 53.2 kJ/mol at 560°C; Vapor pressure = <0.075 mmHg at 23°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water, forms an acid.

Potential Exposure: It is used to make antimony salts, in dyeing, and analytical chemistry.

Incompatibilities: Contact with water or light can cause decomposition, potassium, sodium, and bases. Heat forms toxic bromides. Contact with water form an acid, liberates hydrogen bromide and antimony trioxide.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

NIOSH IDLH: 50 mg[Sb]/m^3.

No TEEL available.

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 mg/m^3.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Harmful Effects and Symptoms

Short Term Exposure: Antimony tribromide can affect you when breathed and by passing though skin. Exposure can cause sore throat, skin rash, poor appetite, irritation of the air passages with cough. Higher exposures can cause pulmonary edema, a medical emergency, that can be delayed for several hours. This can cause death. This chemical can cause irregular heartbeat; this can cause death. High or repeated exposure may damage the liver and the heart muscle. Antimony tribromide is a corrosive chemical and contact can burn the skin and eyes, with burns and possible permanent damage. If used near acid, a deadly stibine gas can be released.

Long Term Exposure: Repeated exposure can cause liver, heart muscle damage, headaches, loss of appetite, dry throat, and sleep disturbance. Corrosive substances, such as antimony tribromide, have the potential for causing lung damage.

Points of Attack: Skin, eyes, respiratory system, cardiovascular system.

Medical Surveillance: EKG, liver function tests, urine tests for antimony, lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Antimony Tribromide must be stored to avoid contact with potassium, sodium, and bases (such as sodium hydroxide, potassium hydroxide, and ammonium hydroxide) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony tribromide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Encapsulate and bury at an approved chemical landfill. Unacceptable for disposal at sewage treatment plants. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 42−43 (1983) and 8, No. 5, 56−59 (January 1987)

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Antimony Tribromide*. Trenton, NJ

Antimony trichloride A:1460

Molecular Formula: Cl_3Sb

Common Formula: $SbCl_3$

Synonyms: Antimoine (trichlorure d') (French); Antimonius chloride; Antimony butter; Antimony(III) chloride; Butter of antimony; Chlorid antimonity; C.I. 77056; Stibine, trichloro-; Trichloro stibine; Trichlorostibine; Trichlorure d' antimoine (French); Tricloruro de antimonio (Spanish)

CAS Registry Number: 10025-91-9

RTECS® Number: CC4900000

UN/NA & ERG Number: UN1733 (solid or liquid)/157

EC Number: 233-047-2 [*Annex I Index No.:* 051-001-00-8]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: B subtilis rec assay.

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority

Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as antimony(III) trichloride; National Pollutant Release Inventory (as antimony compounds).

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R34; Safety phrases: S1/2; S26; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Antimony trichloride is a noncombustible, clear, colorless, crystalline solid with an acrid, pungent odor. Molecular weight = 228.10; Boiling point = 223.3°C; Freezing/Melting point = 73°C; Specific gravity (H_2O:1) = 3.14 at 20°C; Heat of solution = -1.6×10^5 J/kg; Heat of fusion = 13.3 cal/g; Vapor pressure = 0.119 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2. Soluble in water; solubility = 10%[d]; reaction.

Potential Exposure: It is used to make antimony salts and drugs, to fireproof textiles, and as a catalyst in many organic reactions, as a reagent for chloral, aromatic hydrocarbons, vitamin A, and for drug identification.

Incompatibilities: Decomposes in water, forming hydrochloric acid and antimony oxychloride. Reacts violently with strong bases; ammonia, alkali metals; aluminum, potassium, sodium. Forms explosive mixture with perchloric acid when hot. Reacts with air forming hydrochloric acid. Attacks metals in the presence of moisture, forming explosive hydrogen gas.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

NIOSH IDLH: 50 mg[Sb]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.937 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 93.7 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA 0.5 mg(Sb)/m^3, 1993; Austria: MAK 0.5 mg(Sb)/m^3, 1993; Belgium: TWA 0.5 mg(Sb)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; Finland: TWA 0.5 mg(Sb)/m^3, 1993; France: VME 0.5 mg(Sb)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.5 mg (Sb)/m^3, 1999; the Philippines: TWA 0.5 mg(Sb)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3; MAC (STEL) 1.5 mg(Sb)/m^3, 1999; Russia: STEL 0.3 mg/m^3, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Sweden: NGV 0.5 mg(Sb)/m^3, 1999; Switzerland: MAK-week 0.5 mg(Sb)/m^3, 1999; Turkey: TWA 0.5 mg (Sb)/m^3, 1993; United Kingdom: TWA 0.5 mg(Sb)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg[Sb]/m^3.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Antimony trichloride can affect you when inhaled. Exposure can cause sore throat, skin rash, poor appetite, and irritation of the air passages, with cough. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Higher exposures can also cause irregular heartbeat; this can cause death. High or repeated exposure may damage the liver and the heart muscle. Antimony trichloride is a corrosive chemical and contact can burn the skin and eyes, with possible permanent damage. If used near acid, a deadly gas (stibine) can be released. The oral LD_{50} for rat is 525 mg/kg.[9]

Long Term Exposure: May cause mutations. May damage the developing fetus. Repeated exposure can cause liver, heart muscle damage, headaches, loss of appetite, dry throat, and sleep disturbance. Corrosive substances, such as antimony trichloride, have the potential for causing lung damage.

Points of Attack: Cardiovascular system, reproductive system, liver, heart, and lungs.

Medical Surveillance: EKG, liver function tests, urine test for antimony, lung function tests including chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers under nitrogen in a cool, well-ventilated area away from water or moisture, heat and incompatible substances, such as strong bases, aluminum, potassium, and sodium.

Shipping: This chemical requires a shipping label of "CORROSIVE MATERIAL." (solid) (liquid) The Hazard Class is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony trichloride itself does not burn. Poisonous gases are produced in fire, including chlorine and antimony. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 73−74. New York: Van Nostrand Reinhold Co.

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Antimony Trichloride*. Trenton, NJ

Antimony trifluoride A:1470

Molecular Formula: F_3Sb

Synonyms: Antimoine fluorure (French); Antimonous fluoride; Antimony(III) fluoride (1:3); Stibine, trifluoro-; Trifluoroantimony; Trifluoroantimony, stibine, trifluoro-; Trifluorostibine; Trifluoruro de antimonio (Spanish)

CAS Registry Number: 7783-56-4

RTECS® Number: CC5150000

UN/NA & ERG Number: UN1549 (antimony compounds n.o.s.)/157

EC Number: 232-009-2 [*Annex I Index No.:* 051-004-00-4]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.).

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

CERCLA Section 304 Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (as antimony compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: S23/24/25; R51/53; Safety phrases: S1/2; S7; S26; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Antimony trifluoride is a noncombustible, odorless, white to gray crystalline solid. Molecular weight = 178.75; Specific gravity = 4.38 at 21°C (solid); Boiling point = 376°C; Freezing/Melting point = 292°C; Vapor pressure = 3 mmHg at 17°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: It is used in dyeing, to make porcelain and pottery, and as a fluorinating agent.

Incompatibilities: Hot perchloric acid.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.734 mg/m^3

PAC-1: 0.734 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 73.4 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006).

NIOSH IDLH: 50 mg[Sb]/m^3.

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 mg/m^3.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Harmful Effects and Symptoms

Short Term Exposure: Antimony trifluoride can affect you when breathed in and by passing through your skin. Exposure can cause sore throat, skin rash, poor appetite, and irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Antimony trifluoride can cause irregular heartbeat; this can cause death. High or repeated exposure may damage the liver and the heart muscle. Antimony trifluoride is a corrosive chemical and contact can burn the skin and eyes, causing damage. If used near acid, a deadly gas (Stibine) can be released. The oral LD_{50} for mouse is 804 mg/kg.[9]

Long Term Exposure: Repeated contact can cause ulcers and sores of the nose. Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system.

Medical Surveillance: EKG, liver, and kidney function tests. Consider lung function tests and chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or

authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

NIOSH: (fluorides) 12.5 mg/m^3: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3*: Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or*† *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* HieF$^+$ (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 250 mg/m^3: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF$^+$ (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent. Exposure to 500 mg/m^3 (IDLH) is immediately dangerous to life and health.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony trifluoride itself does not burn. Poisonous gases are produced in fire, including fluorides and antimony. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 2, No. 8, 34−36 (1981) and 3, No. 5, 40−42. New York: Van Nostrand Reinhold Co.

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony Trifluoride*. Trenton, NJ

Antimony trioxide A:1480

Molecular Formula: Sb_3O_3

Synonyms: Antimonous oxide; Antimony peroxide; Antimony sesquioxide; Antimony, white; Cystic prefil F; Diantimony trioxide; Exitelite; Fireshield H; Fireshield HPM; Fireshield L; Flowers of antimony; NCI-C55152; Nihon kagaku sangyo antimony trifluoride; Octoguard FR-10; Octoguard FR-15; Petcat R-9; Senarmontite; STCC 4966905; Trioxido de antimonio (Spanish); Ultrafine II; UN9201; Valentinite; Weisspiessglanz (German); White antimony

CAS Registry Number: 1309-64-4; 1327-33-9

RTECS® Number: CC5650000

UN/NA & ERG Number: UN1549 (antimony compounds n.o.s.)/157

EC Number: 215-175-0 [*Annex I Index No.:* 051-005-00-X] (*1309-64-4*); 215-474-6 (1327-33-9)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1989; ACGIH (A2) Suspected Human Carcinogen.

US EPA Gene-Tox Program, Positive: B subtilis rec assay.

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds).

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as antimony compounds, n.o.s.

Safe Drinking Water Act: MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

CERCLA/SARA Section 304 Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as antimony trioxide; National Pollutant Release Inventory (as antimony compounds).

European/International Regulations (*1309-64-4*): Hazard Symbol: Xn; Risk phrases: R40; Safety phrases: S2; S22; S36/37; European/International Regulations (*1327-33-9*): not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Water polluting (*antimony(III) oxide*).

Description: Antimony trioxide is a noncombustible, odorless, white crystalline powder. Molecular weight = 291.50; Boiling point = (sublimes) 1545°C; Freezing/Melting point = 655°C; Specific gravity (H_2O:1): 5.2 at 25°C (solid); Heat of fusion = 46.3 cal/g; Vapor pressure = 0.98 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 1.4×10^{-4} g/100 mL at 30°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Reproductive Effector, Primary Irritant. It is used in flame-proofing, pigments and ceramics, to stain iron and copper, to decolorize glass, industrial chemical, dye, pigment, and printing ink.

Incompatibilities: Strong oxidizers, strong acids, halogenated acids or bases, chlorinated rubber, bromine trifluoride. Reduction with hydrogen forms toxic antimony hydride.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Sb]/m^3 TWA.

NIOSH REL: 0.5 mg[Sb]/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg[Sb]/m^3 TWA; Suspected Human Carcinogen; (production) keep worker exposure to a minimum.

Protective Action Criteria (PAC)

1309-64-4

TEEL-0: 0.599 mg/m^3
PAC-1: 0.599 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 59.9 mg/m^3
DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Group 3A (2005).

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: STEL 0.5 ppm; TWA 0.5 mg(Sb)/m^3, 1993; Austria: carcinogen, 1999; Belgium: STEL 0.5 ppm; TWA 0.5 mg(Sb)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; Finland: TWA 0.5 mg(Sb)/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Hungary: STEL 0.5 mg (Sb)/m^3, 1993; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.5 mg(Sb)/m^3, 1999; the Philippines: TWA 0.5 mg(Sb)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3, 1993; Russia: STEL 1 mg/m^3, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Sweden: NGV 0.5 mg(Sb)/m^3, 1999; Switzerland: TWA 0.1 mg/m^3, Carcinogen 1993; Switzerland: MAK-week 0.1 mg(Sb)/m^3, carcinogen, 1999; Turkey: TWA 0.5 mg (Sb)/m^3, 1993; United Kingdom: TWA 0.5 mg(Sb)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Harmful Effects and Symptoms

Short Term Exposure: Antimony trioxide can affect you when breathed in. Exposure can cause sore throat, rash, poor appetite, and irritation of the airways, with cough. High or repeated exposure may damage the liver and the heart muscle. If used near acid, a deadly stibine gas can be released.

Long Term Exposure: There is an association between Antimony trioxide in smelting processes and increased lung cancer. There is some evidence that this chemical may damage the developing fetus and cause miscarriage. Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, kidneys, liver, reproductive system.

Medical Surveillance: Complete blood count (CBC), urine test for antimony, EKG, liver, and kidney function tests. Consider lung function tests and chest X-ray. Depending on the degree of exposure, periodic medical checkups are advisable.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72−216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, strong oxidizers, acids. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS."

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use any agent suitable for surrounding fires. Poisonous gases are produced in fire, including toxic Sb fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 74–76

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: Antimony Trioxide*. Trenton, NJ

Antimycin A A:1490

Molecular Formula: $C_{28}H_4N_2O_9$ (Antimycin A); $C_{28}H_{40}N_2O_9$ (Antimycin A_1); $C_{26}H_{36}N_2O_9$ (Antimycin A_3); $C_{25}H_{34}N_2O_9$ (Antimycin A_4)

Synonyms: Antimicina A (Spanish); Antimycin A; Antipiricullin; Dihyrosamidin; Fintrol; Isovaleric acid 8-ester with 3-formamido-*N*-(7-hexyl-8-hydroxy-4,9-dimethyl-2,6-dioxo-1,5-dioxonan-3-yl)salicylamide isovaleric acid 8 ester; Virosin

CAS Registry Number: 1397-94-0 (A-); 11118-72-2 (Antimycin/Fintrol); 518-75-2 (Antimycin/Citrinin); 642-15-9 (A_1-Dimidin); 522-70-3 (A_3-); 27220-59-3 (A_4-)

Note: Both A_1 CAS numbers are found in RTECS, with the same chemical formula, although EPA regulates only CAS number 1397-94-0 (Antimycin A-)

RTECS® Number: CD0350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 208-257-2 (CAS 518-75-2)

Regulatory Authority and Advisory Bodies

518-75-2 (Antimycin/Citrinin)

IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).[7]

Reportable Quantity (RQ): 1 lb (0.454 kg).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*Antimycin A*-).

Description: Antimycin (A_3 $C_{26}H_{36}N_2O_9$) and (Antimycin A_1) $C_{28}H_{40}N_2O_9$ are crystalline solids. Molecular weight = 512.8 (A); 520.64 (A_3-); 506.6 (A_4-); Freezing/Melting point = 170–175°C; 149–150°C (A_1); 174–175°C (A_3). They are complex 9-membered (2 oxygens and 7 carbons) ring derivatives with complex side chains. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Specific uses for antimycin A were not found, however, antimycin A_1 and antimycin A_3 are reported to be antibiotic substances produced by streptomyces for use as a fungicide, possible insecticide, and miticide. Registered as a pesticide in the United States.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) *Antimycin A; 1397-94-0*

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1.8 mg/m^3

PAC-3: 12.5 mg/m^3

Routes of Entry: Ingestion, intramuscular.

Harmful Effects and Symptoms

Short Term Exposure: Subcutaneous, intravenous, and intraperitoneal route poisons. Moderately toxic by ingestion and intramuscular routes. The oral LD_{50} for rat is 28 mg/kg.[9]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention

immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: This material is not listed in the DOT list of materials for Performance-Oriented Packaging Standards.[19] However, 1397-94-0 (antimycin A-) may fit DOT number 2811 (toxic solids, organic, n.o.s.) which requires a shipping label of “POISONOUS/TOXIC MATERIALS.” This DOT number is in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources (Nonspecific—Pesticide, solid, n.o.s.). Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: (Nonspecific—Pesticide, solid, n.o.s.). *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Antimycin A*. Washington, DC: Chemical Emergency Preparedness Program

ANTU A:1500

Molecular Formula: $C_{11}H_{10}N_2S$

Synonyms: α-Naphthyl thiourea; α-Naphtyl thiouree (French); Alrato; Anturat; Bantu; Chemical 109; Dirax; Kill kantz; Krysid; Krysid PI; α-Naftiltiourea (Spanish); α-Naphthothiourea; α-Naphthylthiocarbamide; 1-Naphthylthioharnstoff (German); α-Naphthylthiourea; *N*-(1-Naphthyl)-2-thiourea; 1-(1-Naphthyl)-2-thiourea; 1-Naphthylthiourea; 1-Naphthyl-thiouree (French); Naphtox; Rattrack; Rat-TU; Smeesana; Thiourea, 1-Naphthalenyl-; Urea,1-(1-naphthyl)-2-thio-

CAS Registry Number: 86-88-4

RTECS® Number: YT9275000

UN/NA & ERG Number: UN1651/153

EC Number: 201-706-3 [*Annex I Index No.:* 006-008-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; Inconclusive: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA Hazardous Waste Number (RCRA No.): P072.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

CERCLA/SARA Section 304 Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (as 1-naphthyl thiourea).

WGK (German Aquatic Hazard Class): No value assigned.

Description: ANTU is a noncombustible, white crystalline solid or gray powder. Odorless. Molecular weight = 202.29; Boiling point = (decomposes) 457°C; Freezing/Melting point = 198°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. ANTU or its formulations are used as a rodenticide.

Incompatibilities: Strong oxidizers, silver nitrate.

Permissible Exposure Limits in Air

OSHA PEL: 0.3 mg/m^3 TWA.

NIOSH REL: 0.3 mg/m^3 TWA.

ACGIH TLV®[1]: 0.03 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 100 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.3 mg/m^3

PAC-1: 0.9 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: 0.3 mg/m^3 inhalable aerosol; Peak Limitations Category 11(2).

Australia: TWA 0.3 mg/m^3, 1993; Austria: MAK 0.3 mg/m^3, 1999; Belgium: TWA 0.3 mg/m^3, 1993; Denmark: TWA 0.3 mg/m^3, 1999; Finland: TWA 0.3 mg/m^3, STEL 0.9 mg/m^3, 1999; France: VME 0.3 mg/m^3, carcinogen, 1999; the Netherlands: MAC-TGG 0.3 mg/m^3, 2003; the Philippines: TWA 0.3 mg/m^3, 1993; Switzerland: MAK-week 0.3 mg/m^3, KZG-week 1.5 mg/m^3, 1999; Turkey: TWA 0.3 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea. New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for ANTU in ambient air[60] ranging from 3 μg/m^3 (North Dakota) to 5 μg/m^3 (Virginia) to 6 μg/m^3 (Connecticut) to 7 μg/m^3 (Nevada).

Determination in Air: Collection on a filter and analysis by gas–liquid chromatography. Use NIOSH Analytical Method 5276.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.66$.

Routes of Entry: Inhalation, ingestion, and skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous. Symptoms include seizures and dermal irritation. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ingestion may cause vomiting, shortness of breath, and bluish discoloration of the skin. ANTU is moderately toxic: probable oral lethal dose (human) 0.5–5 mg/kg, or between 1 oz and 1 pint (or 1 lb) for a 150-lb person. The LD_{50} for oral rat is 6 mg/kg.[9] Chronic sublethal exposure may cause antithyroid activity. Can produce hyperglycemia of 3 times normal in 3 h.

Long Term Exposure: May cause chronic dermatitis, increased production of white blood cells. A suspected carcinogen and a possible mutagen.

Group Points of Attack: Respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. People with chronic respiratory disease or liver disease may be especially at risk. Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *3 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *7.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *15 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or

GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and silver nitrate. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Naphthylthiourea requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid inhalation and skin contact; wear proper respiratory protection and protective clothing. Do not touch spilled material, stay upwind, keep out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: ANTU may burn but will not ignite readily. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Poisonous gases are produced in fire, including nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a furnace equipped with an alkaline scrubber.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 83−86

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: ANTU*. Washington, DC: Chemical Emergency Preparedness Program

Argon A:1510

Molecular Formula: Ar

Synonyms: Argon-40; Argon, cryogenic; Liquid argon; R-740

CAS Registry Number: 7440-37-1

RTECS® Number: CF2300000

UN/NA & ERG Number: UN1006 (compressed gas)/121; UN1951 [argon, refrigerated liquid (cryogenic liquid)]/120

EC Number: 231-147-0

Regulatory Authority and Advisory Bodies

Most regulatory authorities and advisory organizations (such as ACGIH) list argon as a "simple asphyxiant" or "asphyxiant." (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: With the symbol A, argon is a nonflammable gas; one of the elements in the inert gas category. It is colorless. Molecular weight = 39.95; Boiling point = − 186°C; Freezing/Melting point = − 192°C; Vapor density (air = 1) = 1.66. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 3.5% at 20°C.

Potential Exposure: Argon is used in metal fabrication and steel making, as an inert gas shield in arc welding, as an inert atmosphere in electric lamps, as a blanketing agent in metals refining (especially titanium and zirconium).

Permissible Exposure Limits in Air

An asphyxiant at less than 18% oxygen by volume.

OSHA: (shipyards and construction) simple asphyxiant, inert gas, and vapor.

ACGIH: simple asphyxiant with no specified numerical TLV.

Protective Action Criteria (PAC)

TEEL-0: 65,000 ppm
PAC-1: 65,000 ppm
PAC-2: 230,000 ppm
PAC-3: 400,000 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: asphyxiant, 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant.

Routes of Entry: Inhalation and possibly skin contact with liquid argon.

Harmful Effects and Symptoms

Short Term Exposure: The gas is a simple asphyxiant as noted above. Contact with the liquid can cause frostbite. High levels or concentrations in the air can replace oxygen, resulting in headache, unconsciousness, or death.

First Aid: If contact with liquid argon occurs, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with warm water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Where exposure to cold equipment, vapors, or liquids may occur, employees should be equipped with special clothing designed to prevent the freezing of body tissues. Avoid skin contact with liquid argon. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear splash-proof chemical goggles where exposure to liquid argon can occur.

Respirator Selection: Color Code—Green: General storage may be used. Exposure to argon is dangerous because it can cause a deficiency of oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Storage areas should be well-ventilated. Protect vessels which contain argon from physical damage.

Shipping: Argon must be labeled "NONFLAMMABLE, NONPOISONOUS GAS." It falls in Hazard Class 2.2 and has no designated Packing Group.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If sources of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air and allow cylinder to empty. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Argon is nonflammable and indeed can act as an extinguishing agent itself. Therefore, use extinguishing agents suited for surrounding fires. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 36−37

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Argon*. Trenton, NJ

Arsenic (inorganic arsenic compounds) A:1520

Molecular Formula: As

Synonyms: Accuspin ASX-10 Spin-On Dopant; Arsen (German); Arsenic-75; Arsenicals; Arsenic black; Arsenic, metallic; Arsenico (Spanish); Arsenic, solid; AS-120; AS-217; Butter of arsenic; Colloidal arsenic; Grey arsenic; Metallic arsenic; Realgar; Ruby arsenic

Note: The above synonyms are for metallic arsenic. Other inorganic synonyms vary depending on the specific As compound. The term "inorganic arsenic" does not include arsine.

CAS Registry Number: 7440-38-2

RTECS® Number: CG0525000

UN/NA & ERG Number: UN1558 (metal)/152; UN1562/152 (dust)

EC Number: 231-148-6 [*Annex I Index No.:* 033-001-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen [CFR 1910.1018, inorganic compounds (except arsine)].

OSHA, 29CFR1910 Specifically Regulated Chemicals [See (CFR1910.1018) Inorganic compounds (except arsine)].

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries).[13, 35]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L.

RCRA “D Series Waste” Number, D004, Chronic Toxicity Reference Level, 0.05 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.4; Nonwastewater (mg/L), 5.0 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List Suggested Methods (PQL μg/L): total dust 6010 (500), 7060 (10), 7061 (20).

Safe Drinking Water Act: 47FR9352 Regulated Chemical: MCL, 0.05 mg/L (Section 141.11) applies only to community water systems.

Note: Effective January 2006 the MCL will be 0.01 mg/L.

Reportable Quantity (RQ): 1 lb (0.454 kg), no reporting required, if diameter of metal is equal to or exceeds 0.004 in.

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/25; R53; Safety phrases: S1/2; S20/21; S28; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Elemental arsenic, As, occurs to a limited extent in nature as a steel-gray, amorphous metalloid. Molecular weight = 74.9216. Boiling point = 613°C (sublimes); Freezing/Melting point = 814°C at 36 atm; 817°C at 28 atm; Critical temperature = 803°C; Critical pressure = 34.6 MN/m^2; Specific gravity (H_2O:1) = 5.727 at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0; (*arsenic compounds*) Health 4, Flammability 0, Reactivity 0. Insoluble in water. Arsenic in this entry includes the element and any of its inorganic compounds *excluding* arsine. Arsenic trioxide (As_2O_3), the principal form in which the element is used, is frequently designated as arsenic, white arsenic, or arsenous oxide. Arsenic is present as an impurity in many other metal ores and is generally produced as arsenic trioxide as a by-product in the smelting of these ores, particularly copper. Most other arsenic compounds are produced from the trioxide.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Arsenic compounds have a variety of uses. Arsenic and its compounds are used as an alloy additive, in electronic devices, in veterinary medicines, in agriculture as insecticides, herbicides, larvicides, and pesticides. Some arsenic compounds are used in pigment production; the manufacture of glass as a bronzing or decolorizing agent; the manufacture of opal glass and enamels, textile printing; tanning, taxidermy, antifouling paints; to control sludge formation in lubricating oils. Metallic arsenic is used as an alloying agent for heavy metals and in solders, medicines, herbicides. EPA has estimated that more than 6 million people living within 12 miles of major sources of copper, zinc, and lead smelters may be exposed to 10 times the average US atmospheric levels of arsenic. The agency says that 40,000 people living near some copper smelters may be exposed to 100 times the national atmospheric average.

Incompatibilities: Incompatible with strong acids; strong oxidizers; peroxides, bromine azide, bromine pentafluoride, bromine trifluoride; cesium acetylene carbide, chromium trioxide; nitrogen trichloride, silver nitrate. Can react vigorously with strong oxidizers (chlorine, dichromate, permanganate). Forms highly toxic fumes on contact with acids or active metals (iron, aluminum, zinc). Hydrogen gas can react with inorganic arsenic to form highly toxic arsine gas.

Permissible Exposure Limits in Air

Arsenic, and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. Limit exposure to lowest feasible level.

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA.

Arsenic, inorganic and organic compounds

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.01 mg/m^3

PAC-1: 0.35 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: See Regulatory Authority and Advisory Bodies for US EPA levels. *To protect freshwater aquatic life:* total recoverable trivalent inorganic arsenic never to exceed 440 μg/L. *To protect saltwater aquatic life:* 508 μg/L on an acute basis. *To protect human health:* preferably zero. A value of 0.02 μg/L corresponds to a human health risk of 1 in 100,000. Allowable arsenic levels in drinking water have also been set by Russia[43] at 0.05 mg/L and in water for fishery purposes of 0.05 mg/L also. Maine (drinking water)[61] of 0.05 mg/L. Mexico 0.5 mg/L (reduce human exposure to a minimum).

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It has also been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate, an alternative is atomic absorption, another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, through the skin, and ingestion of dust and fumes.

Harmful Effects and Symptoms

Local: Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect, but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of the skin, eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles. Arsenic has been cited as a cause of skin cancer, but the incidence is low. *Systemic:* The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within 0.5−4 h following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 h. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop. Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms—cough, chest pain, dyspnea, giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries. Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss, nausea, and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and paresthesias of "glove and sticking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis. Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms. *First Phase:* The worker complains of weakness, loss of appetite; some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea. *Second Phase:* The worker complains of conjunctivitis, and a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passages. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common. *Third Phase:* The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur. Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These finding, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence of pneumoconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both erythropoiesis and myelopoiesis. Evidence is now available incriminating arsenic compounds as a cause of lung cancer as well as skin cancer. Skin cancer in humans is causally associated with exposure to inorganic arsenic compounds in drugs, drinking water, and the occupational environment. The risk of lung cancer was increased 4−12 times in certain smelter workers who inhaled high levels of arsenic trioxide. However, the influence of other constituents of the working environment cannot be excluded in these studies. Case reports have suggested an association between exposure to arsenic compounds and blood dyscrasias and liver tumors.

Short Term Exposure: Skin contact can cause irritation, itching, burning sensation, and rash. Eye contact can cause irritation and burns. Inhalation can cause irritation of the respiratory tract. High exposure can cause poor appetite, nausea, vomiting, and muscle cramps. High exposure can cause nerve damage with numbness, “pins and needles” sensation, weakness of the arms and legs.

Long Term Exposure: Arsenic is a carcinogen, causes skin, lung, and lymphatic cancer, possible reproductive hazard (a teratogen in animals). Can cause an ulcer of the “bone” dividing the inner nose. It can cause hoarseness, sore eyes, nerve damage, thickening of the skin with patch areas of darkening and loss of pigment, liver damage and stomach problems. Small doses can accumulate in the body.

Points of Attack: Liver, kidneys, skin, lungs, lymphatic system.

Medical Surveillance: Before first exposure and every 6−12 months thereafter, OSHA 1910.1018 requires employers to provide (for persons exposed to 0.005 mg/m^3 of arsenic) a medical history and exam which shall include chest X-ray, exam of the nose, skin, and nails, sputum cytology examination, test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). Levels should not be greater than 100 μg/g creatinine in the urine. Exam of the nervous system. After suspected overexposure, repeat these tests and consider complete blood count (CBC) and liver function tests. Also examine skin periodically for abnormal growths. Skin cancer from arsenic can easily be cured when detected early. Employees have a legal right to testing information under OSHA 1910.20.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). Oral *penicillamine (not penicillin)* has been used as a follow-up treatment or used instead of BAL for milder poisoning, with mixed success. Side effects may occur with such treatment and it is never a substitute for controlling exposure. Treatment can only be done under strict medical care.

Personal Protective Methods: Workers should be trained in personal hygiene and sanitation, the use of personal protective equipment, and early recognition of symptoms of absorption, skin contact irritation, and sensitivity. With the exception of arsine and arsenic trichloride, the compounds of arsenic do not have odor or warning qualities. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof chemical goggles and face shield when working with powder or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, “*Inorganic Arsenic*.”

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Workers should be permitted to leave the work area every 2 h to wash their faces and obtain clean respirators.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Arsenic must be stored in a cool, dry place away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric) since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The shipping label required for solid arsenic and inorganic compounds is "POISONOUS/TOXIC MATERIALS" (UN1558). These materials fall in Hazard Class 6.1 and Packing Group II for solid arsenic and I for solid arsenic compounds.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with dry lime or soda ash and collect powdered material in a safe manner and deposit in sealed containers. Alternatively, if the spill is a solid, place in suitable container without raising dust. Use a high efficiency particulate absolute (HEPA) filter vacuum (*not* a standard shop vac) or wet method to reduce dust during cleanups. *Do not dry sweep.* If the spill is a liquid, cover with an absorbent and sweep into a suitable container. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Arsenic metal is noncombustible, however arsenic dust can be flammable when exposed to heat or flame. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including arsine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Elemental arsenic wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic pentaselenide-wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic trichloride: hydrolyze to arsenic trioxide utilizing scrubbers for hydrogen chloride abatement. The trioxide may then be placed in long-term storage. Arsenic trioxide: long-term storage in large shiftproof and weatherproof silos. This compound may also be dissolved, precipitated as the sulfide, and returned to the suppliers. Arsenic-containing sewage may be decontaminated by pyrolusite treatment.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

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National Institute for Occupational Safety and Health. (1975). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Arsenic* (revised), NIOSH Document No. 75-149. Washington, DC

US Environmental Protection Agency. (1979). *Arsenic: Ambient Water Quality Criteria*. Washington, DC

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New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Arsenic*. Trenton, NJ

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Arsenic*. Albany, NY: Bureau of Toxic Substance Assessment

US Public Health Service. (November 1987). *Toxicological Profile for Arsenic*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

Arsenic acid A:1530

Molecular Formula: AsH_3O_4 (ortho-); $AsHO_3$ (meta-)

Synonyms: Acido arsenico (Spanish); Arsenate; *o*-Arsenic acid; Arsenic pentoxide; Orthoarsenic acid (*o*-isomer); Scorch®; Zotox®

CAS Registry Number: 1327-52-2; 7778-39-4 (*ortho-*) (These two CAS number are specifically regulated by the US EPA, New Jersey, California, and others); 10102-53-1 (*meta-*)

RTECS® Number: CG0700000

UN/NA & ERG Number: UN1554 (solid)/154; UN1553 (liquid)/154

EC Number: 231-901-9 (*ortho-*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen (CFR 1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds).

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries).[13, 35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number P010.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as arsenic acid [CAS 7778-39-4].

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Arsenic acid is an odorless, noncombustible, white semi-transparent crystalline material or in a commercial grade that is a pale yellow syrup-like liquid. Molecular weight = 141.95; Boiling Point = (loses water) 160°C; Melting/Freezing point = 36°C; Specific gravity (H_2O:1) = 2.2 at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. It converts to As_2O_5 (arsenic pentoxide) when heated above 300°C. See also arsenic pentoxide.

Potential Exposure: It is used as a wood treatment, drying agent, soil sterilant, and to make other arsenates. It has been used as a cotton defoliant.

Incompatibilities: Incompatible with sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides, oxidizers, epichlorohydrin, vinyl acetate, amides. Avoid contact with chemically active metals. Corrodes brass, mild steel, and galvanized steel. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

Arsenic, and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)

7778-39-4

TEEL-0: 0.0189 mg/m^3

PAC-1: 0.4 mg/m^3

PAC-2: 3 mg/m^3

PAC-3: 9.5 mg/m^3

TEEL: CAS 1327-52-2 deleted in Ver. 26 September 2010

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United

Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: *To protect freshwater aquatic life:* total recoverable trivalent inorganic arsenic never to exceed 440 μg/L. *To protect saltwater aquatic life:* 508 μg/L on an acute basis. *To protect human health:* preferably zero. A value of 0.02 μg/L corresponds to a human health risk of 1 in 100,000. EPA has established a maximum arsenic level of 0.05 mg/L. This does not address carcinogenicity and is under review. Russia[43] has set MAC values for inorganic arsenic compounds in water for domestic purposes at 0.05 mg/L and in water bodies for fishery purposes of 0.5 mg/L also.

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It has also been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate, an alternative is atomic absorption, another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact can cause irritation, itching, burning sensation, and rash. Eye contact can cause irritation and burns. Inhalation can cause irritation of the respiratory tract. High exposure can cause poor appetite, nausea, vomiting, and muscle cramps. High exposure can cause nerve damage with numbness, "pins and needles" sensation, weakness of the arms and legs. The oral LD_{50} for rat is 48 mg/kg.[9] Ingestion of 130 mg of arsenic may be fatal to humans. Smaller doses may become fatal since arsenic accumulates in the body.

Long Term Exposure: Arsenic acid is a mutagen that may cause changes to genetic material and an animal teratogen. Can cause an ulcer of the "bone" dividing the inner nose. It can cause disturbed sleep, thickening of the skin with patch areas of darkening and loss of pigment, or the development of white lines in the nails.

Points of Attack: Liver, kidneys, skin, lungs, nervous system, lymphatic system.

Medical Surveillance: Examination of the nose, skin, eyes, nails, and nervous system. Test for urine arsenic. At NIOSH recommended exposure limits, urine arsenic should not be greater than 50−100 μg/L of urine. See also entry for "Arsenic."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where arsenic acid is handled, used, or stored. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full face-piece respiratory. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic.*"

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH* *conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Arsenic acid must be stored to avoid contact with heat and chemically active metals (such as potassium, sodium, magnesium, and zinc) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Arsenic acid requires a shipping label of “POISONOUS/TOXIC MATERIALS.” The Hazard Class is 6.1 and the Shipping Group is II for solid and I for the liquid form.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Neutralize spilled material with crushed limestone, soda ash, or lime. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area and wash spill site after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Arsenic acid itself does not burn. Poisonous gases are produced in fire, including arsine and oxides of arsenic. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 56−59

New Jersey Department of Health and Senior Services. (April 1996). *Hazardous Substances Fact Sheet: Arsenic Acid*. Trenton, NJ

Arsenic pentoxide A:1540

Molecular Formula: As_2O_5

Synonyms: Anhydride arsenique (French); Arsenic acid anhydride; Arsenic anhydride; Arsenic oxide; Arsenic(V) oxide; Arsenic pentaoxide; Diarsenic pentoxide; Fotox; Peroxido de arsenico (Spanish)

CAS Registry Number: 1303-28-2; *(alt.)* 12044-50-7

RTECS$^®$ Number: CG2275000

UN/NA & ERG Number: UN1559/151

EC Number: 215-116-9 [*Annex I Index No.:* 033-004-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen (CFR 1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds).

US EPA Gene-Tox Program, Positive: B subtilis rec assay.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries).[13, 35]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number P011.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer (oxides of arsenic are also developmental/reproductive toxins) 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Arsenic pentoxide is an odorless white lumpy solid or powder and nonflammable. It may be shipped as a concentrated water solution. Molecular weight = 229.84; Specific gravity (H_2O:1) = 4.32 at 25°C; 5.73[NIOSH] Boiling point = 499.8°C; Freezing/Melting point = 315°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Highly soluble in water; solubility = 66 g/100 mL.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Arsenic pentoxide is used in production of metal arsenates, as an herbicide, defoliant on cotton, as a chemical intermediate, as an ingredient in wood preservatives, and in glass. Other possible uses are as an insecticide and soil sterilant.

Incompatibilities: Decomposes above 315°C, forming oxygen and arsenic trioxide fumes. Arsenic pentoxide is an oxidizer; reacts violently with bromine pentafluoride and reducing agents. The solution in water is a weak acid. Incompatible with acids, strong alkalis, halogens, rubidium carbide, zinc. Corrosive to metals in the presence of moisture. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

Arsenic, and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0153 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.7 mg/m^3

PAC-3: 7.7 mg/m^3

DFG TRK: DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/ L in urine/end-of-shift; Carcinogen Category 1.

NIOSH IDLH: 5 mg[As]/m^3.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: *To protect freshwater aquatic life:* total recoverable trivalent inorganic arsenic never to exceed 440 μg/L. *To protect saltwater aquatic life:* 508 μg/L on an acute basis. *To protect human health:* preferably zero. A value of 0.02 μg/L corresponds to a human health risk of 1 in 100,000. EPA has established a maximum arsenic level of 0.05 mg/L. This does not address carcinogenicity and is under review. Russia[43] has set MAC values for inorganic arsenic compounds in water for domestic purposes at 0.05 mg/L and in water bodies for fishery purposes of 0.5 mg/L also.

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It has also been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate, an alternative is atomic absorption, another is inductively coupled plasma (ICP) optical emission spectrometry. Octanol−water coefficient: Log K_{ow} = (estimated) 0.68.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: It is irritating to eyes, nose, and respiratory system. This chemical can be absorbed through the skin, thereby increasing exposure. Skin contact can cause irritation, burning, itching, and a rash. Symptoms usually appear 0.5−1 h after ingestion, but may be delayed. Symptoms include a sweetish, metallic taste and garlicky odor of breath, difficulty in swallowing, abdominal pain, vomiting and diarrhea, dehydration, feeble heart beat, dizziness and headache, and eventually coma, sometimes convulsions, general paralysis, and death. The oral LD_{50} for rat is 8 mg/kg.[9] This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and a teaspoonful for a 150-lb person.

Long Term Exposure: Arsenic pentoxide is a carcinogen in humans. It has been shown to cause skin cancer. May damage the male reproductive glands. Chronic exposure may cause nerve damage to the extremities, alter cellular composition of the blood, and cause structural changes in blood components. Repeated exposure can cause an ulcer in the "bone" dividing the inner nose. Long-term skin contact can cause thickened skin and pigmentation changes. Some persons develop white lines in the finger nails.

Points of Attack: Liver, kidneys, skin, respiratory system, lymphatic system.

Medical Surveillance: See entry under "Arsenic and Inorganic compounds."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Reduce contact to lowest possible level. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full face-piece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wash thoroughly immediately after exposure to arsenic pentoxide and at the end of the work shift. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry, well-ventilated area away from metals, acids, and other incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Arsenic pentoxide requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1, the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material. Neutralize spilled material with crushed limestone, soda ash, or lime. Absorb small liquid spills with sand or other noncombustible absorbent material and place into containers for later disposal. For *large spills*, dike far ahead of spill for later disposal. Ventilate area and wash spill site after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: As_2O_5 may burn but does not readily ignite. Poisonous gases, including arsenic trioxide fumes, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S.[22] If needed, seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548−8730 (24-h response line). Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 59−61 (1982) and 8, No. 3, 45−55

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Arsenic Pentoxide*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Arsenic Pentoxide*. Trenton, NJ

Arsenic trioxide A:1550

Molecular Formula: As_2O_3

Synonyms: Acide arsenieux (French); Anhydride arsenieux (French); Arsenic blanc (French); Arsenic(III) oxide; Arsenic sesquioxide; Arsenicum album; Arsenigen saure (German); Arsenious acid; Arsenious oxide; Arsenious trioxide; Arsenite; Arsenolite; Arsenous acid; Arsenous acid anhydride; Arsenous anhydride; Arsenous oxide; Arsenous oxide anhydride; Arsodent; Claudetite; Crude arsenic; Diarsenic trioxide; Spinrite arsenic; Trioxido de arsenico (Spanish); White arsenic

CAS Registry Number: 1327-53-3

RTECS® Number: CG3325000

UN/NA & ERG Number: UN1561/151

EC Number: 215-481-4 [*Annex I Index No.* 033-003-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen (CFR 1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds).

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018).

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries).[13, 35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L.

RCRA, 40CFR261, Appendix 8, Hazardous Constituents, waste number P 012.

RCRA Land Ban Waste.

Safe Drinking Water Act: 47FR9352 Regulated chemical: MCL, 0.05 mg/L (Section 141.11) applies only to community water systems.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Arsenic trioxide is a noncombustible, odorless, white powder or colorless crystalline solid. Molecular weight = 197.84; Boiling point = 460−465°C; Freezing/Melting point = 312°C (sublimes at 193°C). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Arsenic trioxide, a primary raw material for other arsenic compounds, is used in manufacture of pesticides, glass, industrial chemicals, and drugs. It is an intermediate for insecticides, herbicides, and fungicides. The material is used as a wood and tanning preservative and a decoloring and refining agent in glass manufacture. It is also used in pharmaceuticals and in the purification of synthetic gas.

Incompatibilities: Sodium chlorate, sodium hydroxide, sulfuric acid, fluorine, chlorine trifluoride, chromic oxide, aluminum chloride, phosphorus pentoxide, hydrogen fluoride, oxygen difluoride, tannic acid, infusion cinchona and other vegetable astringent infusions and decoctions, iron in solution. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3

Protective Action Criteria (PAC)*

TEEL-0: 0.0132 mg/m^3

PAC-1: 0.4 mg/m^3

PAC-2: **3** mg/m^3

PAC-3: **9.1** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) and ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Australia: carcinogen, 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Denmark: TWA 0.05 mg(As)/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, carcinogen, 1999; Japan: carcinogen, 1999; Norway: TWA 0.01 mg(As)/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, carcinogen, 1993; Poland: TWA 0.01 mg(As)/m^3, 1999; Sweden: TWA 0.03 mg(As)/m^3, carcinogen, 1999; Switzerland: MAK-week 0.1 mg(As)/m^3, carcinogen, 1999; United Kingdom: TWA 0.1 mg(As)/m^3, carcinogen, SEP2000; United Kingdom: TWA 0.1 mg(Se)/m^3, SEP2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed human carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.0002^3 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: To protect freshwater aquatic life: total recoverable trivalent inorganic arsenic never to exceed 440 μg/L. To protect saltwater aquatic life: 508 μg/L on an acute basis. To protect human health: preferably zero. A value of 0.02 μg/L corresponds to a human health risk of 1 in 100,000. EPA has established a maximum arsenic level of 0.05 mg/L. This does not address carcinogenicity and is under review. Russia[43] has set MAC values for inorganic arsenic compounds in water for domestic purposes at 0.05 mg/L and in water bodies for fishery purposes of 0.5 mg/L also.

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact can cause burning, itching, and rash. Inhalation can cause respiratory irritation. Eye contact can cause irritation and possible permanent damage. High exposures can cause an abnormal EKG. Symptoms of acute poisoning may take from half-an-hour to several hours after ingestion to appear. They may include sweetish metallic taste; garlicky odor of breath and feces; constriction in throat and difficulty in swallowing; burning and colicky pains in esophagus, stomach and bowel; vomiting and profuse painful diarrhea (stools are watery initially, later becoming bloody); dehydration with intense thirst and muscular cramps; bluing of skin; feeble pulse and cold extremities; vertigo, frontal headache; stupor, delirium and mania (these symptoms may occur without concurrent or preceding gastric symptoms); fainting, coma, convulsions, general paralysis; and then possible death. This material is considered super toxic; probable oral lethal dose (human) is less than 5 mg/kg, i.e., a taste (less than 7 drops) for a 70-kg (150 lb) person. Material causes acute gastrointestinal and central nervous system symptoms.

Long Term Exposure: Arsenic trioxide is a human carcinogen; causes skin and liver cancer. Renal and hepatic damage have been observed. Chronic exposure to material has led to nasal septum perforation, dermatological symptoms (lesions, necrosis, etc.) and an increase in the incidence of lung and lymphatic cancers. Appreciable exposure to respiratory irritant promoters, such as metal oxide fumes, elicits a carcinogenic response from arsenic trioxide. Repeated or high exposure can cause nerve damage with "pins and needles" sensation, burning, numbness, and weakness in the extremities. Exposure can cause skin allergy to develop.

Points of Attack: Skin, liver, kidneys, lungs, lymphatic system.

Medical Surveillance: See entry under "Arsenic and Inorganic Arsenic Compounds."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with large amounts of soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to physician: For severe poisoning, BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where Arsenic Trioxide is handled, used, or stored. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full face-piece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wash thoroughly immediately after exposure to Arsenic trioxide and at the end of the work shift. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic.*"

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry well-ventilated area away from contact with incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear full protective clothing including gloves and eye protection. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be

properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Avoid breathing dusts and fumes from burning materials. Keep upwind. Wear self-contained breathing apparatus. Extinguish fire using agent suitable for type of surrounding fire (material itself does not burn or burns with difficulty). Use water in flooding quantities as fog. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S.[22] If needed, seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report,* 3, No. 5, 50−58

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Arsenous Oxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Arsenic Trioxide*. Trenton, NJ

Arsenic trisulfide A:1560

Molecular Formula: As_2S_3

Synonyms: Arsenic sesquisulfide; Arsenic sulfide; Arsenic sulfide yellow; Arsenic tersulfide; Arsenic yellow; Arsenous sulfide; Auripigment; C.I. 77086; C.I. Pigment yellow; Diarsenic trisulfide; King's gold; King's yellow; Orpiment; STCC 4923222; Trisulfuro de arsenico (Spanish); Yellow arsenic sulfide

CAS Registry Number: 1303-33-9

RTECS® Number: CG2638000

UN/NA & ERG Number: UN1557/152

EC Number: 215-117-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen (CFR 1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018).

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries).[13, 35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Safe Drinking Water Act: 47FR9352 Regulated chemical: MCL, 0.05 mg/L (Section 141.11) applies only to community water systems.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Arsenic trisulfide is a noncombustible, odorless, yellow or orange powder or red needles (changes to a different "red" form at 170°C). Molecular weight = 246.04; Specific gravity: 3.43 at 20°C; Boiling point = 707°C; Freezing/Melting point = 300−327°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Arsenic trisulfide is used in the manufacture of glass, oil cloth, linoleum, electrical semi-conductors, fireworks, and used as a pigment.

Incompatibilities: Avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and potassium nitrate mixed with sulfur, since violent reactions occur. Water contact forms hydrogen sulfide.

Incompatible with acids, halogens. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3.

No TEEL available.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.0002^3 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects of exposure to arsenic through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of arsenic estimated to result in additional lifetime cancer risks ranging from no additional risk to an additional risk of 1 in 100,000 are presented in the Criterion Formulation section of this document. The EPA is considering setting criteria at an interim target risk level in the range of 10^{-5}, 10^{-6}, or 10^{-7} with corresponding criteria of 0.02, 0.002, and 0.0002 μg/L, respectively.[6]

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation of dust, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Arsenic trisulfide can affect you when breathed in and may enter the body thought the skin. Arsenic trisulfide is a carcinogen; handle with extreme caution. Contact can cause burning, itching, thickened skin, rash, and color changes. Exposure can irritate the nose and throat and may cause an ulcer or hole in the inner nose. High or repeated exposures can cause disturbed sleep, "pins and needles," and numbness and weakness of arms and legs. High or repeated exposure can cause poor appetite, nausea, vomiting, diarrhea, and death.

Long Term Exposure: Arsenic trisulfide is a carcinogen in humans; it has been shown to cause skin, liver, and lung cancer. It may be a teratogen, causing reproductive damage, such as reduced fertility and interference with the menstrual cycle. May cause liver damage and lower the red blood cell count. Repeated skin contact can cause thickened skin and pigmentation changes. Some persons develop white lines on the fingernails. High or repeated exposure can cause nerve damage with burning, "pins and needles" sensation and weakness of the extremities.

Points of Attack: Skin, respiratory system, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: examination of the nose, skin, eyes, nails, and nervous system. Complete blood count (CBC). Examination of the nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a workday). At NIOSH recommended exposure levels, urine arsenic should not be greater than 50−100 μg/L of urine. After suspected overexposure, repeat these tests. Also examine your skin periodically for abnormal growths. Skin cancer from arsenic is easily cured with early detection.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Avoid skin contact with arsenic trisulfide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operations. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Eye protection is included in the recommended respiratory protection. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic.*"

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Avoid contact with the incompatible materials cited above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Arsenic sulfide requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep water and acids away from spilled Arsenic trisulfide. Collect powdered materials using a vacuum equipped with a high-efficiency particulate filter (do not use a standard shop vacuum) or wet cleaning methods and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Arsenic trisulfide may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases and fumes are produced in a fire, including hydrogen sulfide, arsine, sulfur oxides, and arsenic fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Arsenic Trisulfide*. Trenton, NJ

Arsenous trichloride A:1570

Molecular Formula: $AsCl_3$

Synonyms: Arsenic butter; Arsenic chloride; Arsenic(III) chloride; Arsenic trichloride; Arsenous chloride; Arsenous trichloride; Butter of arsenic; Caustic arsenic chloride; Chlorure d'arsenic (French); Fuming liquid arsenic; Trichloroarsine; Trichlorure d'arsenic (French); Tricloruro de arsenico (Spanish)

CAS Registry Number: 7784-34-1

RTECS$^{®}$ Number: CG1750000

UN/NA & ERG Number: UN1560/157

EC Number: 232-059-5

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration); *Theft hazard* 2.2 (≥30% concentration).

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NTP: Known to be a human carcinogen; EPA: Human Carcinogen; OSHA: Carcinogen (CFR 1910.1018, inorganic compounds).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds).

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries)[13, 35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Section 112(r), accidental Release Prevention/Flammable Substances (Section 68.130), TQ = 15,000 lb (5825 kg).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals.

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L.

RCRA, 40CFR261, Appendix 8, Hazardous Constituents, waste number not listed

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (228 kg).

Reportable Quantity (RQ): EHS 1 lb (0.454 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

WGK (German Aquatic Hazard Class) severe hazard to water: (estimate) 3.

Description: Arsenous trichloride is a noncombustible, colorless or pale yellow oily, fuming liquid. The odor is described as pungent and acrid. Molecular weight = 181.27; Boiling point = 130.2°C; Freezing/Melting point = − 16°C; Specific gravity = 2.156 at 25°C; Latent heat of vaporization = 49.06 cal/g; Heat of solution = (estimate) -0.42×10^5 J/kg; Vapor pressure = 8.4 mmHg. Decomposes in water, forming hydrogen chloride.

Potential Exposure: Compound Description: Mutagen. Arsenic chloride is used in the ceramics industry, in the synthesis of chlorine-containing arsenicals, as a chemical intermediate for arsenic insecticides, pharmaceuticals, and has been used in chemical warfare agents.

Incompatibilities: Contact with sodium, potassium, or powdered aluminum may cause a violent reaction. It is decomposed in water, forming arsenic hydroxide and hydrogen chloride. Exposure to light forms toxic gas. Violent reaction with anhydrous ammonia, strong acids, strong oxidizers, and halogens. Incompatible with alkali metals; active metals, such as arsenic, iron, aluminum, zinc. Corrodes metals in the presence of moisture and forms flammable and explosive hydrogen gas.

Permissible Exposure Limits in Air

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0242 ppm

PAC-1: 0.2 ppm

PAC-2: 1.35 ppm

PAC-3: 12.1 ppm

DOT ERG 2008: Inhalation Hazard Zone B

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.0002^3 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of

Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: See the entry under "Arsenic and Inorganic Compounds."

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause burns, possibly causing permanent damage. Exposure to vapors causes spasm of eyelids, tearing, pain, and reddening. Exposure above the occupational exposure limits can cause death. In acute exposures, it is extremely toxic and caustic, owing not only to the poisonous nature of arsenic, but also to the release of hydrochloric acid in the presence of water. Exposure to the skin causes local irritation and blisters. Inhalation or ingestion causes hemorrhagic gastroenteritis resulting in loss of fluids and electrolytes, collapse, shock, and death. The fatal human dose is 70−180 mg depending on the weight of the victim. Symptoms usually appear 30 min to 1 h after ingestion. Symptoms include a sweetish metallic taste, garlicky odor on the breath and stools, constriction in throat, difficulty in swallowing, abdominal pain, vomiting, diarrhea, bluing of the skin, weak pulse, dizziness, headaches, coma, and convulsions.

Long Term Exposure: Chronic poisoning can lead to peripheral disturbed sleep, skin conditions, liver damage. Arsenic and certain arsenic compounds have been implicated in the induction of skin and lung cancer. Based on several related arsenic compounds, arsenic trichloride may be a mutagen and teratogen.

Points of Attack: Liver, kidneys, skin, lungs, reproductive system.

Medical Surveillance: See entry under "Arsenic and Inorganic Compounds."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where arsenous trichloride is handled, used, or stored. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full face-piece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Arsenous trichloride, $AsCl_3$, should be stored in tightly closed containers in a cool, well-ventilated area away from heat, water, and any possible contact with active metals or other incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Inhalation Hazard Zone B: $AsCl_3$ should be labeled "POISONOUS/TOXIC MATERIALS."[19] It falls in Hazard Class 6.1 and Shipping Group I.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into sealed containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Arsenous trichloride is not flammable so agents must be used which are suitable for surrounding fire. Poisonous gases are produced in fire, including arsine and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S.[22] If needed, seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Arsenous Trichloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Arsenic Trichloride*. Trenton, NJ

Arsine (Agent SA, WMD) A:1580

Molecular Formula: AsH_3

Synonyms: Arsenic anhydride; Arsenic trihydride; Arseniuretted hydrogen; Arsenous hydride; Arsenwasserstoff (German); Arsina (Spanish); Hydrogen arsenide; SA (military designation)

CAS Registry Number: 7784-42-1

RTECS® Number: CG6475000

UN/NA & ERG Number: UN2188/119

EC Number: 232-066-3 [*Annex I Index No.* 033-006-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration); *Theft hazard* 15 (≥0.67% concentration).

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

Banned or Severely Restricted (UN).[35]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45.4 kg).

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants; 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 1000 lb (454 kg).

Clean Water Act: 40CFR401.15 Toxic Pollutant.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds).

California Proposition 65 Chemical: Cancer 2/27/87.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Arsine (SA) is an extremely flammable, colorless, liquefied compressed gas with a slight garlic-like odor. SA is nonirritating, produces no immediate symptoms, and odor is not an adequate indicator of arsine's (SA) presence, so persons exposed to hazardous levels may be unaware of its presence. The established PEL is 10 times lower than the concentration at which people begin to smell SA (odor threshold of 0.5 ppm and above)[NIOSH]. Molecular weight = 77.95. Boiling point = − 62°C; Freezing/Melting point = − 117.2°C; Relative vapor density (air = 1) = 2.69; Vapor pressure = 14.9 atm at 21.1°C; >760 mmHg at 20°C[NIOSH]; Flash point = flammable gas. Explosive Limits: LEL = 5.1%; UEL = 78%. NFPA 704 M Hazard Identification (based on NFPA-704M Rating System): Health 4, Flammability 4, Reactivity 2. It has an odor threshold of <1.0 ppm, but the odor cannot be relied on. Decomposes at 300°C. Solubility in water = 20% at 20°C.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Human Data. Arsine is used in making electronic and semiconductor components, in organic syntheses, and in making lead−acid storage batteries. Arsine may be generated by side reactions or unexpectedly; e.g., it may be generated in metal pickling operations, metal drossing operations, or when inorganic arsenic compounds contact sources of nascent hydrogen. It has been known to occur as an impurity in acetylene. Most occupational exposure occurs in chemical, smelting, and refining industries. It has been used as a poison gas. Cases of exposure have come from workers dealing with zinc, tin, cadmium, galvanized coated aluminum, and silicon and steel metals. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. SA is used as a military poison gas (blood agent). It forms cyanide in the body.

Incompatibilities: SA reacts with strong oxidizers, nitric acid, causing an explosion hazard. Thermally unstable; shock, friction, and concussion sensitive; can explosively decompose. Can explode on contact with warm, dry air. Violent reaction with acids, halogens, mixtures of potassium and ammonia. Decomposes to metallic arsenic (fumes) on exposure to light, moisture, or upon decomposition from heat or ignition.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.19 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.05 ppm/0.2 mg/m^3 TWA.

NIOSH REL: 0.002 mg/m^3 [15 min.] Ceiling level, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.005 ppm/0.01mg/m^3 TWA.

NIOSH IDLH: 3 ppm, Potential occupational carcinogen.

Protective Action Criteria (PAC) SA*

TEEL-0: 0.005 ppm

PAC-1: 0.025 ppm

PAC-2: **0.17** ppm

PAC-3: **0.50** ppm

*AEGLs (Acute Emergency Guideline Levels) and ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: Inappropriate

ERPG-2: 0.5 ppm

ERPG-3: 1.5 ppm

Arab Republic of Egypt: TWA 0.05 ppm (0.2 mg/m^3), 1993; Australia: TWA 0.05 ppm (0.2 mg/m^3), 1993; Austria: MAK 0.05 ppm (0.2 mg/m^3), 1999; Denmark: TWA 0.01 ppm (0.03 mg/m^3), 1999; France: VME 0.05 ppm (0.2 mg/m^3), VLE 0.2 ppm (0.8 mg/m^3), 1999; Hungary: TWA 0.05 mg/m^3, STEL 0.1 mg/m^3, [skin], 1993; Japan: 0.01 ppm (0.032 mg/m^3), 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; Norway: TWA 0.003 ppm (0.01 mg/m^3), 1999; the Philippines: TWA 0.05 ppm (0.5 mg/m^3), 1993; Poland: MAC (time-weighted average) 0.2 mg/m^3; MAC (STEL) 0.6 mg/m^3, 1999; Russia: TWA 0.05 ppm, STEL 0.1 mg/m^3, 1993; Sweden: NGV 0.02 ppm (0.05 mg/m^3), 1999; Switzerland: MAK-week 0.05 ppm (0.16 mg/m^3), KZG-week 0.25 ppm, 1999; Thailand: TWA 0.05 ppm (0.2 mg/m^3), 1993; Turkey: TWA 0.05 ppm (0.2 mg/m^3), 1993; United Kingdom: TWA 0.05 ppm (0.16 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 ppm. Several states have set guidelines or standards for arsine in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 1.0 μg/m^3 (Connecticut) to 2.0 μg/m^3 (Florida and North Dakota) to 3.3. μg/m^3 (Virginia) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 6001, OSHA Analytical Method ID-105, ID-125G.

Permissible Concentration in Water: No criteria set, but EPA[32] cites the same limits as earlier proposed for arsenic by EPA of 50 μg/L based on health effects and 10 μg/L based on ecological effects.

Determination in Water: Since arsine is a gas, water pollution is unlikely to be a problem. Still, warn pollution control authorities just in case. Octanol—water coefficient: Log K_{ow} = (estimated) 0.68.

Routes of Entry: Inhalation of gas, ingestion, skin contact.

Harmful Effects and Symptoms

Arsine is an extremely toxic gas that can be fatal if inhaled in sufficient quantities. Acute poisoning is marked by a triad of main effects caused by massive intravascular hemolysis of the circulating red cells. Early effects may occur within an hour or two and are commonly characterized by general malaise, apprehension, giddiness, headache, shivering, thirst, and abdominal pain with vomiting. In severe acute cases the vomitus may be blood stained and diarrhea ensues as with inorganic arsenical poisoning. Pulmonary edema has occurred in severe acute poisoning. Invariably, the first sign observed in arsine poisoning is hemoglobinuria, appearing with discoloration of the urine up to port wine hue (first to the triad). Jaundice (second of triad) sets in on the second or third day and may be intense, coloring the entire body surface a deep bronze hue. Coincident with these effects is a severe hemolytic-type anemia. Severe renal damage may occur with oliguria or complete suppression of urinary function (third of triad), leading to uremia and death. Severe hepatic damage may also occur, along with cardiac damage and EKG changes. Where death does not occur, recovery is prolonged. In cases where the amount of inhaled arsine is insufficient to produce acute effects, or where small quantities are inhaled over prolonged periods, the hemoglobin liberated by the destruction of red cells may be degraded by the reticuloendothelial system and the iron moiety taken up by the liver, without producing permanent damage. Some hemoglobin may be excreted unchanged by the kidneys. The only symptoms noted may be general tiredness, pallor, breathlessness on exertion, and palpitations as would be expected with severe secondary anemia.

Short Term Exposure: Inhaling arsine can irritate the lungs, causing shortness of breath and coughing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposure can cause hemolysis (destruction of red blood cells), causing anemia with headache, weakness, nausea, vomiting, and abdominal pain. Acute kidney failure may follow; this can cause death. High concentrations of arsine gas will cause damage to the eyes; however, many experts agree that before this occurs systemic effects can be expected. Skin or eye contact with compressed gas can cause frostbite.

Long Term Exposure: Arsine is carcinogenic to humans and should be treated as a teratogen. Repeated exposure may damage the nerves, causing weakness, "pins and needles" sensation, and weakness in the limbs with loss of coordination. May cause kidney, liver, and heart damage.

Points of Attack: Blood, kidneys, liver, lungs.

Medical Surveillance: NIOSH lists the following tests: liver function tests, pulmonary function tests, reticulocyte count, urine (chemical/metabolite) hemoglobin, urinalysis (routine), white blood cell count/differential. In preemployment physical examinations, special attention should be given to past or present kidney disease, liver disease, and anemia. Periodic physical examinations should include tests to determine arsenic levels in the blood and urine, complete blood count (CBC) with reticulocyte count, kidney and liver function tests, urine hemoglobin, examination of the nervous system, and chest X-ray (following acute exposure). Since arsine gas is a by-product of certain production processes, workers should be trained to recognize the symptoms of exposure and to use appropriate personal protective equipment.

First Aid: If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. *Dimercaprol* treatment is indicated and blood transfusions may be necessary. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention immediately. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination*:* Since arsine is a gas, you do not have to decontaminate victims or yourself. If you do not have the equipment and training, do not enter the hot zone to rescue and treat victims. And, be aware that arsine may be trapped in the victim's clothing.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. In most cases, arsine poisoning cannot be anticipated except through knowledge of the production processes. Where arsine is suspected in concentration above the acceptable standard, the worker should be supplied with a supplied air full-face respirator or a self-contained positive pressure-respirator with full face-piece. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. Prevent possible skin freezing from direct liquid contact.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. At any concentrations above the NIOSH REL, or where* *there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Arsine must be stored to avoid contact with incompatible materials including oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Outside, detached storage is preferred. Arsine decomposes and deposits Arsenic on exposure to light and moisture. Sources of ignition, such as smoking and open flames, are prohibited where arsine is handled, used, or stored. Metal containers involving the transfer of arsine should be grounded and bonded.

Shipping: Arsine requires a shipping label of "POISON GAS, FLAMMABLE GAS." The Hazard Class 2.3 and the Packing Group is unlisted.[19, 20] It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: No flares, smoking, or flames in area. Use water spray to reduce vapors. Isolate area until arsine gas has dispersed. Stay upwind; keep out of low areas. Ventilate area of leak to disperse the gas if it can be done without placing personnel at risk. Wear positive pressure breathing apparatus and full protective clothing. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stop the flow of gas if it can be done safely, with undue risk. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Use large amounts of water to disperse vapors; contain runoff. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

SA, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)

Day	1.3/2.0
Night	3.4/5.5

Large Spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)

Day	5.7/9.2
Night	7.0 + /11.0 +

Arsine (for SA see above)

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)

Day	0.7/1.1
Night	2.5/4.1

Large Spills (From a large package or from many small packages)

First: Isolate in all directions(feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)

Day	4.4/7.0
Night	7.0 + /11.0 +

Fire Extinguishing: Containers may explode when heated. Containers may rocket. In case of fire, *do not put out the fire.* Arsine is so bad that the fire is safer than the unburned arsine. If you cannot shut off the flow of gas do not do anything else—let the fire burn out. Poisonous gases, including arsenic and nitrogen oxides, are produced in fire. In the unlikely situation where there is a tank of arsine adjacent to a fire, cool the tank with large amounts of water, but first evacuate the area—if the tank ruptures from heating, arsine could kill. Again, arsine gives off toxic gases in a fire or when heated, but these are not as bad as the arsine itself. You can use a water spray to "knock down" the toxic gases coming from an arsine fire. This chemical is a highly flammable gas. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Approach fire from upwind. Fight fire from protected location or maximum possible distance. Let small fires burn out, if possible. Use water spray or foam extinguishers. For massive fire in cargo area use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Cool containers that are exposed to flames with water from the side until well after fire is out. See isolation distances above if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Arsine may be disposed of by controlled burning. When possible, cylinders should be sealed and returned to suppliers.[22] Seek guidance from regulatory agencies as to proper disposal. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Arsine*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Arsine*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Arsine*. Trenton, NJ

Asbestos A:1590

Molecular Formula: $ONa_2Fe_2O_{33}FeO_8SiO_2H_2O$ (Crocidolite); $H_4O_4Si \cdot \tfrac{1}{2}H_2O \cdot 3/2Mg$ (Chrysotile)

Synonyms: Amianthus; Amosite; Amphibole; Asbest (German); Asbesto (Spanish); Asbestose (German); Asbestos fiber; Ascarite; Chrysotile (AKA white asbestos); Crocidolite (AKA brown asbestos, blue asbestos); Fiberous grunerite; Krokydolith (German); Mysorite; NCI-C08991; Serpentine; Tremolite

Note: Asbestos is a generic name for various hydrated mineral silicates.

CAS Registry Number: 1332-21-4 (no specified type); 77536-66-4 (Actinolite); 12172-73-5 (Amosite); 77536-67-5 (Anthophyllite); 17068-78-9 (OSHA); 12001-29-5; *(alt.)* 12426-98-1; 61076-97-9 (Chrysotile); 12001-28-4; *(alt.)*: 132207-33-1 (Crocidolite); 77536-68-6 *(alt.)* 14567-73-8 (Tremolite); 81133-20-2 (Ascarite)

RTECS® Number: CI6475000 (No Spec type); CI6476000 (Actinolite); CI6477000 (Amosite); CI6478000 (Anthophyllite); CI6478500 (Chrysotile); CI6479000 (Crocidolite); CI6560000 (Tremolite)

UN/NA & ERG Number: UN2212 [blue asbestos (crocidolite) or brown asbestos (amosite, mysorite)]/171; UN2590 [white asbestos (chrysotile, actinolite, anthophyllite, tremolite)]/171

E Number: 650-013-00-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987; NTP: Known to be a human carcinogen; EPA: Human Carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; TRP reversion; NCI: Carcinogenesis Studies (Chrysotile) (feed); equivocal evidence: rat NCI: Carcinogenesis Studies (feed); no evidence: hamster; NTP: Carcinogenesis Studies (Chrysotile) (feed): some evidence: rat; NCI: Carcinogenesis Studies (Crocidolite) (feed); no evidence: rat.

Banned or Severely Restricted (several countries) (UN).[13, 35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA)[6] (Kansas, Minnesota)[61] (Mexico).

OSHA 29CFR1910 OSHA Specifically Regulated Substances. (See CFR1910.1001).

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants; §63.74 List of high-risk pollutants, weighting factor: 100.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; §307 Priority Pollutants; §313 Priority Chemicals.

Safe Drinking Water Act: 40CFR141.62, MCL, 7 million fibers/L (longer than 10 μm); 40CFR141.51, MCLG, 7 million fibers/L (longer than 10 μm); 47FR9352 regulated chemical; 40CFR141.23, inorganic chemical sampling and analytical requirements; 40CFR141.32, public notification requirements.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

California Proposition 65 Chemical: Cancer.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1; National Pollutant Release Inventory (NPRI); CEPA Schedule I, Toxic Substances (atmospheric releases from mines and mills).

TSCA 40CFR716.120.c6 (asbestiform minerals).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as Asbestos: Actinolite 77536-66-4; Anthophyllite 77536-67-5; Amosite 12172-73-5; Crocidolite 12001-28-4; Tremolite 77536-68-6).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids; Freezing/Melting point = 600°C (Decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water. Asbestos is a generic term that applies to a number of naturally occurring, hydrated mineral silicates incombustible in air and separable into filaments. The most widely used in industry in the United States is chrysotile, a fibrous form of serpentine. Other types include amosite, crocidolite, tremolite, anthophyllite, and actinolite.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Natural Product. Most asbestos is used in the construction industry. Much of it is firmly bonded, i.e., the asbestos is "locked in" in such products as floor tiles, asbestos cements, and roofing felts, and shingles; while the remaining 8% is friable or in powder forms present in insulation materials, asbestos cement powders, and acoustical products. As expected, these latter materials generate more airborne fibers than the firmly bonded products. The asbestos used in nonconstruction industries is utilized in such products as textiles, friction material including brake linings and clutch facings, paper, paints, plastics, roof coatings, floor tiles, and miscellaneous other products. Significant quantities of asbestos fibers appear in rivers and streams draining from areas where asbestos-rock outcroppings are found. Some of these outcroppings are being mined. Asbestos fibers have been found in a number of drinking water supplies, but the health implications of ingesting asbestos are not fully documented. Emissions of asbestos fibers into water and air are known to result from mining and processing of some minerals. Exposure to asbestos fibers may occur throughout urban environments perhaps resulting from asbestos from brake linings and the flaking of sprayed asbestos insulation material. In recent years, much effort has been put into removal of asbestos insulation, particularly from schools and other public buildings where worn or exposed asbestos causes public exposure.

Incompatibilities: None.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 asbestos fiber (>5 μm long)/cc; 1 f/cc/30 min excursion; carcinogen. [0.1 fiber (longer than 5 μm and having a length-to-diameter ratio of at least 3 to 1) per cubic centimeter of air (0.1 fiber/cm^3), as determined by the membrane filter method at approximately 400 × magnification with phase-contrast illumination. No worker should be exposed in excess of 1 fiber/cm^3 (excursion limit) as averaged over a sampling period of 30 min; Cancer and Lung Disease Hazard].

NIOSH REL: 0.1 f/cc (fibers>5-μm long)/400 L; carcinogen. [NIOSH considers asbestos to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible concentration. For asbestos fibers >5 μm in length: 1×10^5 fibers/m^3/0.1 fiber/cm^3 as determined by a 400-L air sample collected over 100 min (see NIOSH Analytical Method #7400)].

ACGIH TLV®[1]: (all forms) 0.1 f/cc TWA; Confirmed Human Carcinogen.

European OEL: 0.1 asbestos fibers/cc (2003).

Protective Action Criteria (PAC)

No specified type

TEEL-0: 0.005 mg/m^3
PAC-1: 0.05 mg/m^3
PAC-2: 0.06 mg/m^3
PAC-3: 0.3 mg/m^3

Anthophyllite

TEEL-0: 0.005 mg/m^3
PAC-1: 0.05 mg/m^3
PAC-2: 250 mg/m^3
PAC-3: 250 mg/m^3

Ascarite

TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 0.5 mg/m^3
PAC-3: 2.5 mg/m^3

Crocidolite

TEEL-0: 0.005 mg/m^3
PAC-1: 0.05 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 250 mg/m^3

Chrysotile

TEEL-0: 0.005 mg/m^3
PAC-1: 0.05 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 250 mg/m^3

DFG MAK: Carcinogen Category 1, Confirmed Human carcinogen, (2004).

Austria: carcinogen, 1999; France: VME 0.3 fiber/mL, carcinogen, 1999; Norway: TWA 0.1 fiber/cm^3, 1999; Switzerland: MAK-week 0.25 fiber/mL, carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for asbestos in ambient air[60] ranging from zero (Massachusetts, Nevada, North Carolina, North Dakota, South Carolina) to 0.001 μg/m^3 (Connecticut) to 0.005 μg/m^3 (Pennsylvania) to 0.005 μg/m^3 (Nevada) to 2.0 μg/m^3 (Virginia) to 5.0 μg/m^3 (New York).

Determination in Air: NIOSH Analytical Method #9002, asbestos (bulk) by PLM, #7402, by PCM #7402, by TEM (Transmission Electron Microscopy), OSHA Analytical Methods ID-160, asbestos in Air, and ID-191, Polarized Light Microscopy of asbestos. NIOSH Analytical Method #9000, asbestos, chrysotile by XRD.

Permissible Concentration in Water: To protect freshwater and saltwater aquatic life: no criteria have been established due to insufficient data. *To protect human health:* preferably zero. A lifetime cancer risk of 1 in 100,000 corresponds to concentrations of 300,000 fibers/L.[6] A maximum level in drinking water of 7 million fibers/L has been proposed by EPA.[62] In addition, Kansas and Minnesota have set guidelines for asbestos in drinking water.[61] Mexico drinking water ecological criteria is 3000 mg/L.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: There is no known acute health effects. Persons who develop serious and fatal diseases later in life may feel fine at the time of exposure.

Long Term Exposure: Asbestosis (chronic exposure): dyspnea (breathing difficulty), interstitial fibrosis, restricted pulmonary function, finger clubbing, irritation of eyes (Potential occupational carcinogen). Available studies provided conclusive evidence that exposure to asbestos fibers causes cancer and asbestosis in humans. Lung cancers and asbestosis have occurred following exposure to chrysotile, crocidolite, amosite, and anthophyllite. Mesotheliomas, lung and gastrointestinal cancers have been shown to be excessive in occupationally exposed persons, while mesotheliomas have developed also in individuals living in the neighborhood of asbestos factories and near crocidolite deposits, and in persons living with asbestos workers. Asbestosis has been identified among persons living near anthophyllite deposits. Likewise, all commercial forms of asbestos are carcinogenic in rats, producing lung carcinomas and mesotheliomas following their inhalation and mesotheliomas after intrapleural (i.p.) injection. Mesotheliomas and lung cancers were induced following even 1-day exposure by inhalation. The size and shape of the fibers are important factors; fibers less than 0.5 μm in diameter are most active in producing tumors. Other fibers of a similar size including glass fibers can also produce mesotheliomas following intrapleural or i.p. injection. There are data that show that the lower the exposure, the lower the risk of developing cancer. Excessive cancer risks have been demonstrated at all fiber concentrations studied to date. Evaluation of all available human data provides no evidence for a threshold or for a "safe" level of asbestos exposure.

Points of Attack: Respiratory system, eyes, lungs [cancer site].

Medical Surveillance: OSHA mandates the following: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); NIOSH lists the following tests: chest X-ray, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), radiography, sputum cytology, tuberculin skin test. Medical surveillance is required, except where a variance from the medical requirements of this proposed standard have been granted, for all workers who are exposed to asbestos as part of their work environment. For the purposes of this requirement the term "exposed to asbestos" will be interpreted as referring to TWA exposures above 1 fiber/c or peak exposures above 5 fibers/c. The major objective of such surveillance will be to ensure proper medical management of individuals who show evidence of reaction to past dust exposures, either due to excessive exposures or unusual susceptibility. Medical management may range from recommendations as to job placement, improved work practices, cessation of smoking, to specific therapy for asbestos-related disease or its complications. Medical surveillance cannot be a guide to adequacy of current controls when environmental data and medical examinations only cover recent work experience because of the prolonged latent period required for the development of asbestosis and neoplasms. Required components of a medical surveillance program include periodic measurements of pulmonary function [forced vital capacity (FVC) and forced expiratory volume for one second (FEV_1)], and periodic chest X-ray (postero-anterior 14 × 17 in.). Additional medical requirement components include a history to describe smoking habits and details on past exposures to asbestos and other dusts and to determine presence or absence of pulmonary, cardiovascular, and gastrointestinal symptoms, and a physical examination, with special attention to pulmonary rales, clubbing of fingers, and other signs related to cardiopulmonary systems. Chest X-rays and pulmonary function tests should be performed at least every 2 years in all employees exposed to asbestos. Such tests should be made annually in individuals: (a) who have a history of 10 or more years of employment involving exposure to asbestos or (b) who show X-ray findings (such as small opacities, pleural plaques, pleural thickening, or pleural calcification) which suggest or indicate pneumoconiosis or other reactions to asbestos or (c) who have changes in pulmonary function which indicate restrictive or obstructive lung disease. Preplacement medical examinations and medical examinations on the termination of employment of asbestos-exposed workers are also required.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water.

Personal Protective Methods: Prevent skin contact and any barrier that will prevent contamination from the fiber. Use of respirators can be decided on the basis of TWA or peak concentration. When the limits of exposure to asbestos dust cannot be met by limiting the concentration in the workplace, the employer must utilize a program of respiratory protection and furnishing of protective clothing to protect every worker exposed. *Protective clothing*: (1) The employer shall provide each employee subject to exposure in a variance area with coveralls or similar full body protective clothing and hat, which shall be worn during the working hours in areas where there is exposure to asbestos dust. Nondisposable clothing should be placed in plastic bags for laundering or decontamination. (2) The employer shall provide for maintaining and laundering of the solid protective clothing, which shall be stored, transported and disposed of in-sealed nonreusable containers marked "Asbestos—Contaminated Clothing" in easy-to-read letters. (3) Protective clothing shall be vacuumed before removal. Clothes shall not be cleaned by blowing dust from the clothing or shaking. (4) If laundering is to be done by a private contractor, the employer shall inform the contractor of the potentially harmful effects of exposure to asbestos dust and of safe practices required in the laundering of the asbestos-soiled work clothes. (5) Resin-impregnated paper or similar protective clothing can be substituted for fabric-type of clothing. (6) It is recommended that in tightly contaminated operations (such as insulation and textiles) provisions be made for separate change rooms.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with asbestos workers *must* be, by law, trained in its proper handling and storage. Asbestos should be stored wet with special surfactants and water. Keep asbestos in closed, impermeable, sealed containers. Protect against physical damage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The label requirement for asbestos is "CLASS 9." The Hazard Class is 9 and the Packing Group is II for UN2212 [Blue asbestos (crocidolite)] or Brown asbestos (amosite, mysorite)] and III for NA2212 and UN2590 [White asbestos (chrysotile, actinolite, anthophyllite, tremolite)].[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Proper procedures for repair or removal of the material must be followed by trained personnel. Strict hygiene is required; keep dust under control. Wear a protective equipment, use a wet mop, or special high efficiency HEPA vacuum to clean area. Do not use common shop vacuum cleaner. *Note:* Avoid blowing, sweeping or dry brushing, and dry mopping, all of which may raise dust levels. Do not shovel. For storing asbestos wastes, use heavy-gauge impervious plastic bags. For final disposal contact your local environmental authority. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Asbestos itself does not burn. Care should be taken to contain asbestos materials disturbed in a fire. Becomes powder-like and loses its hazardous properties when heated above 1200°C. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Asbestos may be recovered from waste asbestos slurries as an alternative to disposal. Landfilling is an option[22] for disposal if carefully controlled.

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Asphalt and fumes A:1600

Synonyms: Asfalto (Spanish); Asphaltum; Bitumen fume; Judean pitch; Mineral pitch; Petroleum asphalt; Petroleum bitumen; Pitch; Road asphalt; Road tar; Roofing asphalt
CAS Registry Number: 8052-42-4
RTECS® Number: CI9900000
UN/NA & ERG Number: UN1999 [Tars, liquid (including road asphalt and oils, bitumen, and cut backs)]/130
EC Number: 232-490-9
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 2B (*extracts of steam and air refined*); Group 3 (*steam refined, cracking residue, and air-refined*) 1987; NTP: Carcinogenesis studies; selected, October 2000.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
California Proposition 65 Chemical: (*if present as coke oven emissions*) Cancer 2/27/87.
WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Asphalt fumes are flammable when hot and may contain hydrogen sulfide and human carcinogen, such as benzo(a)pyrene and dibenz(a,h)anthracene. Fumes generated during the production or application of asphalt (a dark-brown to black cement-like substance manufactured by the vacuum distillation of crude petroleum oil). Molecular weight = variable 1000−2600; Boiling point = >300°C; Freezing/Melting point = 55−175°C; Flash point ≤10−225°C (as a general rule, the more liquid the type of asphalt, the lower the flashpoint; cutback <10°C; typical asphalt 225°C); Autoignition = >400°C. Hazard Identification (based on NFPA-704 M Rating System) (typical asphalt): Health 0, Flammability 1, Reactivity 0. However, *asphalt cutback* has a flammability rating of 3. Insoluble in water. Hazard Identification (based on NFPA-704 M Rating System): *roofer's flux and straight run residue*: Health 0, Flammability 1, Reactivity 0.

Asphalt fumes have been defined by NIOSH as the nimbose effusion of small, solid particles created by condensation from the vapor state after volatilization of asphalt. In addition to particles, a cloud of fume may contain materials still in the vapor state. The major constituent groups of asphalt are asphaltenes, resins, and oils made up of saturated and unsaturated hydrocarbons. The asphaltenes have molecular weights in the range of 1000−2600, those of the resins fall in the range of 370−500, and those of the oils is in the range of 290−630. Asphalt has often been confused with tar because the two are similar in appearance and have sometimes been used interchangeably as construction materials. Tars are, however, produced by destructive distillation of coal, oil or wood, whereas asphalt is a residue from fractional distillation or crude oil. The amounts of benzo(a) pyrene found in fumes collected from two different plants that prepared hot mix asphalt ranged from 3 to 22 ng/m^3; this is approximately 0.03% of the amount in coke oven emissions and 0.01% of that emitted from coal-burning home furnaces.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Occupational exposure to asphalt fumes can occur during the transport, storage, production, handling, or use of asphalt. The composition of the asphalt that is produced is dependent on the refining process applied to the crude oil, the source of the crude oil, and the penetration grade (viscosity) and other physical characteristics of the asphalt required by the consumer. The process for production of asphalt is essentially a closed-system distillation. Refinery workers are therefore potentially exposed to the fumes during loading of the asphalt for transport from the refinery during routine maintenance, such as leaning of the asphalt storage tanks, or during accidental spills. Most asphalt is used out of doors, in paving, and roofing. The workers' exposure to the fumes is dependent on environmental conditions, work practices, and other factors. These exposures are stated to be generally intermittent and at low concentrations. Workers are potentially exposed also to skin and eye contacts with hot, cut-back, or emulsified asphalts. Spray application of cut-back or emulsified asphalts may involve respiratory exposure also.

Incompatibilities: None reported. *Note:* Asphalt becomes molten at about 93°C.

Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 5 mg/m^3 15-min Ceiling concentration; NIOSH considers asphalt fumes to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible concentration. See Pocket guide, Appendix A.
ACGIH TLV®[1]: 0.5 mg/m^3 not to be exceeded at any time; not classifiable as a human carcinogen [asphalt (bitumen) fume(8052-42-)] *as benzene-soluble aerosol*; BEI issued (1999).
Protective Action Criteria (PAC) *asphalt; bitumen 8052-42-4*
TEEL-0: 0.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3
Petroleum asphalt
TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 125 mg/m^3
DFG MAK: [skin] Carcinogen Category 2, *as bitumen, vapor and aerosol*.
Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Norway: TWA 5 mg/m^3, 1999; Poland: TWA 5 mg/m^3 (fume), STEL 15 mg/m^3 (fume), 1999; United Kingdom

LTEL 5 mg/m^3, STEL 10 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Not classifiable as a human carcinogen.

Occupational exposure to asphalt fumes is defined as exposure in the workplace at a concentration of one-half or more of the recommended occupational exposure limit. If exposure to other chemicals also occurs, as is the case when asphalt is mixed with a solvent, emulsified, or used concurrently with other materials, such as tar or pitch, provisions of any applicable standard for the other chemicals shall also be followed. Occupational exposure to asphalt fumes shall be controlled so that employees are not exposed to the airborne particulates at a concentration greater than 5 mg/m^3 (measured as total particulates) of air, determined during any 15-min period (NIOSH Ceiling Concentration). Several states have set guidelines or standards for asphalt fumes in ambient air[60]: 50 μg/m^3 (North Dakota), 80 μg/m^3 (Virginia), 100 μg/m^3 (Connecticut), 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 5042 "Benzene-soluble fraction and total particulate (asphalt fume)." The total particulate portion of this method is based on NIOSH Analytical Method 0500. Other methods applicable to asphalt fume are NIOSH Analytical Method #5800, Polycyclic Aromatic Compounds (PAC), and NIOSH Analytical Method #2550, Benzothiazole in Asphalt Fume.

Routes of Entry: Inhalation of dusts and fumes. Skin exposure can cause thermal burns from hot asphalt.

Harmful Effects and Symptoms

Short Term Exposure: The principal adverse effects on health from exposure to asphalt fumes are irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract. Hot asphalt can cause burns of the skin and release vapors that irritate the eyes, throat, and possible bronchial tubes and lungs.

Long Term Exposure: In animals, there is evidence that asphalt left on the skin for long periods of time may result in local carcinomas, but there have been no reports of such effects of human skin that can be attributed to asphalt alone.

Points of Attack: Skin, respiratory system. Cancer site in animals: skin.

Medical Surveillance: Lung function tests. Details of recommended preplacement and periodic physical examinations and record keeping have been set forth by NIOSH in the Criteria Document cited below.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Employees shall wear appropriate protective clothing, including gloves, suits, boots, face shields (8-in. minimum), or other clothing as needed, to prevent eye and/or skin contact with asphalt. NIOSH recommends thermally insulated gloves if working with hot asphalt, long-sleeve shirts, long-cuffless trousers, and metal-toed shoes. All protective clothing should be clean and available each day, and put on prior to the work shift.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter, ck-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Engineering controls shall be used when needed to keep concentrations of asphalt fumes below the recommended exposure limit. The only conditions under which compliance with the recommended exposure limit may be achieved by the use of respirators are (a) during the time required to install or test the necessary engineering controls; (b) for operations, such as nonroutine maintenance or repair activities, causing brief exposure at concentrations above the environmental limit; (c) during emergencies when concentrations of asphalt fumes may exceed the environmental limit. When a respirator is permitted above, it shall be selected from a list of respirators approved by NIOSH. See the Criteria Document cited below.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Asphalt is normally shipped solid in steel drums. Fumes are encountered only in asphalt melting operations. Wherever lighter or liquid forms of asphalt are used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Tars, liquid, including road asphalt and oils, bitumen, and cut-backs require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group III. The Hazard Class is 3 and the Packing Group III[19, 20] for asphalt at or above its flashpoint.

Spill Handling: Spilled asphalt is allowed to cool and solidify whereupon it is recovered, melted, and used if clean. Ventilate area of spill or leak. Absorb liquid asphalt with sand or other noncombustible absorbent material and place in containers for disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The lighter, more liquid forms are flammable (especially cutback). The heavier, more solid forms may give off flammable gas when heated. Poisonous gases are produced in fire, including hydrogen sulfide. For heavy forms of asphalt, use dry chemical, carbon dioxide, or foam extinguishers. For light forms, use dry chemical, fog, or water mist. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Asphalt solids may be landfilled.[22]

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New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Asphalt Fumes*. Trenton, NJ

Atrazine A:1610

Molecular Formula: $C_8H_{14}ClN_5$

Synonyms: A361; Aatram; Aatrex; Aatrex 4L; Aatrex 80W; Aatrex herbicide; Aatrex Nine-O; Actinite PK; 2-Aethylamino-4-chlor-6-isopropylamino-1,3,5-triazin (German); AI3-28244; Aktikon; Aktikon PK; Aktinit A; Aktinit PK; Argezin; Atazinax; Atranex; Atrasine; Atratol; Atratol A; Atrazin; Atrazin 80; Atrazina (Spanish); Atred; Atrex; Candex; Cekuzina-T; 2-Chloro-4-ethylamineisopropylamine-*s*-triazine; 1-Chloro-3-ethylamino-5-isopropylamino-*s*-triazine; 1-Chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine; 2-Chloro-4-ethylamino-6-isopropylamino-*s*-triazine; 2-Chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine; 2-Chloro-4-ethylamono-6-isopropylamino-; 6-Chloro-*N*-ethyl-*N*-isopropyl-1,3,5-triazinediyl-2,4-diamine; 6-Chloro-*N*-ethyl-*N′*-(1-methylethyl)-1,3,5-triazine-2,4-diamine; 2-Chloro-4-(2-propylamino)-6-ethylamino-*s*-triazine; Chromozin; Crisatrina; Crisazine; Cyazin; EPA pesticide chemical code 080803; 2-Ethylamino-4-isopropylamino-6-chloro-*s*-triazine; Farmco atrizine; Fenamin; Fenamine; Fenatrol; G30027; Geigy 30,027; Gesaprim; Gesaprim 50; Gesaprim 500L; Gesoprim; Griffex; Hungazin; Hungazin PK; Inakor; New chlorea; NSC 163046; Oleogesaprim; Penatrol; Plant extract, Corn grown in atrizine-treated soil; Primatol; Primatol A; Primaze; Radazin; Radizine; Residox; Shell Atrazine herbicide; Strazine; Triazine A 1294; *s*-Triazine, 2-chloro-4-(ethylamino)-6-(isopropylamino)-; 1,3,5-Triazine-2,4-diamine,6-chloro-*N*-ethyl-*N′*-(1-methylethyl)-; *s*-Triazine, zeazin; Tripart Atrazine 50 SC; Vectal; Vectal SC; Weedex; Weedex A; Wonuk; Zeapos; Zeazin; Zeazin 50; Zeazine

CAS Registry Number: 1912-24-9; *(alt.)* 11121-31-6; *(alt.)* 12040-45-8; *(alt.)* 12797-72-7; *(alt.)* 39400-72-1; *(alt.)* 69771-31-9; *(alt.)* 93616-39-8

RTECS$^{®}$ Number: XY5600000

UN/NA & ERG Number: UN2753/151

EC Number: 217-617-8 [*Annex I Index No.:* 613-068-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Gene-Tox Program, Positive: *Aspergillus*-reversion; *S. cerevisiae* gene conversion; Negative: *N. crassa-aneuploidy*; Inconclusive: *D. melanogaster*-whole sex chrom. loss; Inconclusive: *D. melanogaster*-nondisjunction; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-8894.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Set (EPA) (Canada).

Safe Drinking Water Act: 40CFR141.61(c)5, MCL, 0.003 mg/L; 40CFR141.50(b)7, MCGL 0.003 mg/L; 40CFR142.62, Variances and Exceptions from the MCLs; 40CFR9352 Regulated Chemical; 40CFR141.24, Requirements for Sampling and Analytical Testing; 40CFR 141.32 Public Notification Requirements.

FIFRA 40CFR180.102-1147 tolerances on raw agricultural commodities.

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases R43; R48/22; R50/53; Safety phrases: S2; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Atrazine is a white, odorless, crystalline solid or powder which is often mixed with a flammable liquid. Molecular weight = 215.72; Boiling point = decomposes; Freezing/Melting point = 175−177°C; Specific gravity (H_2O:1) = 1.19; Vapor pressure = 2.9×10^{-7}. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water; solubility 0.003%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Atrazine is an herbicide and plant growth regulator used for season-long-weed control in corn, sorghum, and certain other crops.

Incompatibilities: Strong oxidizers, acids.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

NO TEEL available.

DFG MAK: 2 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(8) (2004).

Australia: TWA 5 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 0.2 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Switzerland: MAK-week 2 mg/m^3, 1999; United Kingdom LTEL 10 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards[60] for atrazine in ambient air ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use OSHA versatile sampler-2; Reagent; Gas chromatography/Electron capture detection; NIOSH #5602.

Permissible Concentration in Water: A maximum level (MCL and MCGL) in drinking water of 0.003 mg/L has been set by EPA.[62] The Canadian Drinking Water IMAC is 0.06 mg/L. A suggested no-adverse-effect-level in drinking water has been calculated by NAS/NRC as 0.15 mg/L. An acceptable daily intake (ADI) of 0.0215 mg/kg/day has been calculated for atrazine.[46] A limit of 0.5 mg/L of atrazine has been specified by Russia[43] in water bodies used for domestic purposes. Also, several states have set guidelines for atrazine in drinking water[61] ranging from 0.093 μg/L (Massachusetts) to 15 μg/L (California) to 25 μg/L (New York) to 43 μg/L (Maine) to 150 μg/L (Kansas).

Determination in Water: Analysis of atrazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen−phosphorus-containing pesticides in water samples. In this method, approximately 1:1 sample is extracted with methylene chloride. The extract is concentrated, and the compounds are separated using capillary column GC. Measurement is made using a nitrogen phosphorus detector. The method detection limit has not been determined for this compound, but it is estimated that the detection limits for the method analytes are in the range of 0.1 2 μg/L. Fish Tox: 88.31816000 ppb MATC (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 2.3.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Atrazine is possibly carcinogenic to humans (IARC: 2B). There is inadequate evidence to confirm carcinogenicity of atrazine in humans. However, there is the increased risk for tumors known to be associated with hormonal factors. These have been observed in both animals and human beings, and are consistent with the known effects of atrazine on the hypothalamic pituitary gonadal axis.

Short Term Exposure: Contact may cause skin and severe eye irritation.

Long Term Exposure: Atrazine may be a carcinogen in humans since it has been shown to cause mammary and uterine cancers in animals. There is limited evidence that atrazine may damage the developing fetus. Atrazine may cause skin allergy. Human Tox: 3.00000 ppb (HIGH).

Human Tox Type: MCL.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver.

Medical Surveillance: Evaluation by a qualified allergist. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or milk and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (for liquid) or dust-proof (for powders or dust) chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Should be stored in tightly closed containers away from strong acids.

Shipping: Triazine pesticides, solid, toxic, n.o.s. require a shipping label of “POISONOUS/TOXIC MATERIALS.” Triazines fall in Hazard Class 6.1 and Packing Group I to III.[19, 20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect spilled dry material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing atrazine in vermiculite, dry sand, earth, or similar material. Treatment technologies which will remove atrazine from water include activated carbon adsorption, ion exchange, reverse osmosis, ozone oxidation, and ultraviolet irradiation. Conventional treatment methods have been found to be ineffective for the removal of atrazine from drinking water. Limited data suggest that aeration would not be effective in atrazine removal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index $K_{oc} = 100$.

Fire Extinguishing: Extinguish fire using an agent suitable for the type of surrounding fire; atrazine itself does not burn. Poisonous gases are produced in fire, including hydrogen chloride and nitrogen oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atrazine is hydrolyzed by either acid or base.[22] The hydroxy compounds are generally herbicidally inactive, but their complete environmental effects are uncertain. However, the method appears suitable for limited use and quantities of triazine. Atrazine underwent >99% decomposition when burned in a polyethylene bag, and combustion with a hydrocarbon fuel would appear to be a generally suitable method for small quantities. Combustion of larger quantities would probably require the use of a caustic wet scrubber to remove nitrogen oxides and HCl from the product gases.[22]

References

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Atrazine*. Trenton, NJ

US Environmental Protection Agency. (September 1987). *Health Advisory: Atrazine*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Auramine A:1620

Molecular Formula: $C_{17}H_{21}N_3$

Common Formula: $(CH_3)_2N{-}C_6H_4CNH{-}C_6H_4{-}N(CH_3)_2$; $(CH_3)_2{-}N{-}C_6H_4{-}(C{=\!=}NH){-}C_6H_4{-}N{-}(CH_3)_2 \cdot H_2O$

Synonyms: Apyonine auramarine base; Auramina (Spanish); Auramine; Auramine base; Auramine N base; Auramine OAF; Auramine O base; Auramine SS; Basic yellow 2; Baso yellow 124; Benzeneamine, 4,4′-cabonimidoylbis(N-dimethyl-); Brilliant oil yellow; 4,4′-Carbonimidoylbis(*N*,*N*-dimethylbenzenamine); C.I. 41000B; C.I. basic yellow 2, free base; C.I. Solvent yellow 34; 4,4′-Dimethylaminobenzophenonimide; Fat Yellow A; Glauramine; 4,4-(Imidocarbonyl)bis (*N*,*N*-dimethylaniline); Tetramethyldiaminodiphenylacetimine; Waxoline yellow O; Yellow pyoctanine

CAS Registry Number: 492-80-8 (technical grade); 2465-27-2 (*hydrochloride*)

RTECS® Number: BY3500000; BY3675000 (hydrochloride salt)

UN/NA & ERG Number: UN3143 (dyes, solid, toxic, n.o.s. [or] dye intermediates, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 207-762-5 [*Annex I Index No.:* 612-096-00-7]; 219-567-2 (*hydrochloride*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Sufficient Evidence, *carcinogenic to humans*, Group 1; *Technical grade*: Human Possibly Carcinogenic, *possibly carcinogenic to humans*, Group 2B, 1998.

Banned or Severely Restricted (Italy, Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U014 (as C.I. Solvent Yellow 34).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg).

California Proposition 65 Chemical: Cancer.

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

European/International Regulations (*492-80-8 and salts*): Hazard Symbol: Xn, N; Risk phrases: R22; R36; R40; R51/53; Safety phrases: S2; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Auramine is a yellow crystalline powder or flaky material. Molecular weight = 267.4; Freezing/Melting point = 136°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0; (*hydrochloride*) Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Auramine is used industrially as a dye or dye intermediate for coloring textiles, paper, and leather. Also used as an antiseptic (a powerful antiseptic in ear and nose surgery and in treatment of gonorrhea) and fungicide. Human exposure to auramine occurs principally through skin absorption or inhalation of vapors. Low-level dermal exposure to the consumer may occur but would be limited to any migration of auramine from fabric, leather, or paper goods.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

2465-27-2

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 60 mg/m^3

Technical grade and hydrochloride

DFG MAK: [skin] Carcinogen Category 2

No numerical occupational exposure limits (OELs) have been established. However auramine may be a carcinogen; there may be no safe level of exposure. This chemical can be absorbed through the skin, thereby increasing the potential for exposure. Zero in New York, North Dakota[60] in ambient air.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes, and may cause damage. Skin absorption may result in dermatitis and burns, nausea, and vomiting.

Long Term Exposure: Commercial auramine is carcinogenic in mice and rats after oral administration, producing liver tumors; after subcutaneous injection in rats, producing local sarcomas. The manufacture of auramine (which also involves exposure to other chemicals) has been shown in one study to be causally associated with an increase in bladder cancer. The actual carcinogenic compound(s) has not been specified precisely.

Points of Attack: Liver, bladder.

Medical Surveillance: Monthly urinalysis. Physical examination every 6 months focused on bladder.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with auramine you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Auramine *per se* is not on the DOT list.[19] It is used as a dye intermediate, pesticide, and as an antiseptic; it is an environmental hazard and a carcinogen. Dyes, solid, toxic, n.o.s. or dye intermediates, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover with sand and soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use water, carbon dioxide, powdered agents, or alcohol foam on auramine fires. Poisonous gases are produced in fire, including nitrogen oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incinerate in furnace with afterburner and scrubber.[24]

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 37−38

New Jersey Department of Health and Senior Services. (February 2004). *Hazardous Substances Fact Sheet: Auramine*. Trenton, NJ

Azathioprine A:1630

Molecular Formula: $C_9H_7N_2O_2S$

Synonyms: Azanin azatioprin; Azothioprine; BW 57-322; Ccucol; Imuran; Imurek; Imurel; 6-(1′-Methyl-4′-nitro-5′-imidazolyl)-mercaptopurine; Methylnitroimidazolylmercaptopurine; 6-(1-Methyl-*p*-nitro-5-imidazolyl)-thiopurine; 6-(1-Methyl-4-nitroimidazol-5-ylthio)purine; 6-(Methyl-*p*-nitro-5-imidazolyl)-thiopurine; 6-[(1-Methyl-4-nitro-1H-imidazol-5-yl)thio]-1H-purine; 6-[(1-Methyl-4-nitroimidazol-5-yl)thio]purine; NCI-C03474; NSC-39084; Rorasul

CAS Registry Number: 446-86-6

RTECS® Number: UO8925000

UN/NA & ERG Number: UN2811/154

EC Number: 207-175-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998; NTP 11th Report on Carcinogens, Known to be a Human Carcinogen; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Azathioprine is a complex heterocyclic compound which forms pale yellow crystals. Molecular weight = 277.3; Freezing/Melting point = 243−244°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0.

Potential Exposure: Azathioprine is an immunosuppressive agent, generally used in combination with a corticosteroid to prevent rejection following renal homotransplantations. It also is used following transplantation of other organs. Other uses of azathioprine include the treatment of a variety of presumed autoimmune diseases, including rheumatoid arthritis; ankylosing spondylitis; systemic lupus erythematosus; dermatonyositis, periarteritis nodosa, scleroderma, refractory thombocytopenic purpura; autoimmune hemolytic anemia; chronic active liver disease; regional enteritis; ulcerative colitis; various autoimmune diseases of the eye; acute and chronic glomerulonephritis; the nephritic syndrome; Wegener's granulomatosis; and multiple sclerosis.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Human exposure to azathioprine occurs because of its widespread use, since the 1970s, to prevent rejection following organ transplantation and to treat a variety of autoimmune diseases. Azathioprine is readily absorbed from the gut and is known to cross the human placenta.

Harmful Effects and Symptoms

There is sufficient evidence that azathioprine is carcinogenic in humans. Two large prospective studies of kidney transplant patients (receiving azathioprine and prednisone almost routinely) showed that these patients experienced increased incidences of non-Hodgkin's lymphomas, cancer of the skin, hepatobiliary carcinoma, and other tumors. Patients treated with azathioprine, but not transplant recipients, showed an increased incidence of the same cancers as patients with transplants, but to a lesser extent. Mice receiving azathioprine by intraperitoneal, subcutaneous, or intramuscular injection had suggestive evidence of induced lymph system neoplasms. Rats given azathioprine orally had suggestive evidence of induced ear cancers. Results of the animal studies provide limited evidence of carcinogenicity. Among reported symptoms of azathioprine exposure are bone-marrow depression, especially leukopenia[52]; toxic hepatitis and jaundice, stomatitis, dermatitis, hair loss; fever; anorexia, vomiting, and diarrhea. It is a developmental toxicant and suspected toxicant of the following systems: cardiovascular or blood, respiratory, gastrointestinal, liver, kidney, musculo-skeletal.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate with water or normal saline immediately for at least 20−30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere.[52] A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: It will require a label of "POISONOUS/TOXIC MATERIALS" and falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Seal the accumulated wastes in vapor-tight plastic bags for eventual disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 36−37

Azinphos-ethyl A:1640

Molecular Formula: $C_{12}H_{16}N_3O_3PS_2$

Synonyms: Athyl-gusathion; Azinos; Azinphos-aethyl (German); Bay 16225; Bayer 16259; Benzotriazine derivative of an ethyl dithiophosphate; Cotnion-ethyl; Crysthion; Crysthyon; *O*,*O*-Diethyl *S*-(4-oxo-3H-1,2,3-bezotriazine-3-yl)methyl] dithiophosphate; *O*,*O*-Diethyl-*S*-(4-oxobezotriazin-3-methyl)-dithiophosphat (German); *O*,*O*-Diethyl *S*-(4-oxobezotriazino-3-methyl) phosphorodithioate; *O*,*O*-Diethyl-*S*-[(4-oxo-3H-1,2,3-bezotriazin-3-yl)-methyl]-dithiophosphat (German); *O*,*O*-Diethylphosphorodithioate ester with 3-(mercaptomethyl)-1,2,3-benzotriazin-4(3H)-one; *S*-(3,4-Dihydro-4-oxo-1,2,3-benzotriazin-3-ylmethyl) *O*,*O*-diethyl phosphorodithioate; 3,4-Dihydro-4-oxo-3-benzotriazinylmethyl *O*,*O*-diethyl phosphorodithioate; ENT 22,014; Ethyl azinphos; Ethyl guthion; Etil azinfos (Spanish); Etiltriazotion; Gusathion A; Gusathion A insecticide; Gusathion ethyl; Guthion ethyl; Guthion insecticide; R 1513

CAS Registry Number: 2642-71-9

RTECS® Number: TD8400000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 220-147-6 [*Annex I Index No.:* 015-056-00-1]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (UN).[35]

Very Toxic Substance (World Bank).[15]

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T +, N; Risk phrases R24; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Azinphos-ethyl is a colorless crystalline substance; Freezing/Melting point = 53°C. Molecular weight = 345.4. Boiling point = 111°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: It is a nonsystemic organophosphate insecticide and miticide with good ovicidal properties and long persistence. It is not registered for use in the United States. Among other crops, it is used on cotton, citrus, vegetables, potatoes, tobacco, rice, and cereals to control caterpillars, beetles, aphids, spiders, and many other insects.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.9 mg/m^3

PAC-3: 150 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: The symptoms are similar to parathion. Nausea is often the first symptom followed by vomiting, abdominal cramps, diarrhea, and excessive salivation. Also common in inhalation exposure are headache, giddiness, vertigo and weakness, nasal discharge, and a sensation of tightness in the chest. Other symptoms include blurring or dimness of vision; tearing, eye muscle spasm, and pain; pinpoint pupils, loss of muscle coordination; slurring of speech; muscle twitching (especially tongue and eyelids); difficulty in breathing; excessive secretions of mucous in mouth, nose, and respiratory tract; convulsions and coma. It is an extremely potent systemic toxicant via ingestion, inhalation, and skin contact. It may cause death or permanent injury after very short exposure to small quantities. The oral LD_{50} for rat is 7 mg/kg.[9] A cholinesterase inhibitor. Like similar organic phosphorus poisons, guthion-ethyl may act as an irreversible inhibitor of the enzyme cholinesterase. This enzyme allows the accumulation of large amounts of acetylcholine. Death can be caused when a critical level of cholinesterase depletion is reached. Recovery may be complete when the poisoned victim has time to recover and regenerate cholinesterase.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is at all possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH; however, where the potential exists for exposure, the following might be considered: *for reference* (*Azinphos-methyl*). *Up to 2 mg/m^3*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 10 mg/m^3*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, and sources of ignition. Although this compound is chemically stable in storage, it is decomposed at elevated temperatures with evolution of gas, and rapidly decomposed in cold alkali to form anthranilic acid and other decomposition products.[22]

Shipping: This chemical is an organophosphorus pesticide, solid, toxic. The required label is “POISONOUS/TOXIC MATERIALS.” It is in Hazard Class 6.1.

Spill Handling: Do not touch spilled material. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Use water spray to reduce vapors. Remove all ignition sources. If spill is wet, take up with diatomite, clay, expanded mineral, foamed glass, or synthetic absorbent material and deposit in sealed containers. For *small dry spills* use a high-efficiency particulate absolute (HEPA) filter vacuum, *not* a standard shop vacuum, or wet method to reduce dust during cleanups. *Do not dry sweep or create airborne dust.* Wash spill area with common household detergent. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is noncombustible. Wear protective clothing and equipment. Use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides, sulfur oxides, phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

Reference
US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Azinphos-Ethyl.* Washington, DC: Chemical Emergency Preparedness Program

Azinphos-methyl A:1650

Molecular Formula: $C_{10}H_{12}N_3O_3PS_2$
Synonyms: Azinphos-methyl; Azinphos-methyl Guthion®; Bay 9027; Bayer 17147; Benzotriazine derivative of a methyl dithiophosphate; Benzotriazinedithiophosphoric acid dimethoxy ester; Carfene; Cotnion methyl; Crysthion 2L; Crysthyon; DBD; *S*-(3,4-Dihydro-4-oxobenzo[d][1,2,3] triazin-3-ylmethyl) *O*,*O*-dimethyl phosphorodithioate; *S*-(3,4-Dihydro-4-oxo-1,2,3-benzotriazin-3-ylmethyl) *O*,*O*-dimethyl phosphorodithioate; *S*-(3,4-Dihydro-4-oxobenzo[a] [1,2,3] triazin-3-ylmethyl) *O*,*O*-dimethyl phosphorodithioate; *O*,*O*-Dimethyl *S*-(1,2,3-bezotriazinyl-4-keto)methyl phosphorodithioate; *O*,*O*-Dimethyl *S*-(3,4-dihydro-4-keto-1,2,3-bezotriazinyl-3-methyl) dithiophosphate; Dimethyldithiophosphoric acid *N*-methylbenzazimide ester; *O*,*O*-Dimethyl *S*-(4-oxo-3H-1,2,3-benzotriazine-3-methyl) phosphorodithioate; *O*,*O*-Dimethyl *S*-[4-oxobenzotriazino-3)-methyl] phosphorodithioate; *O*,*O*-Dimethyl *S*-[(4-oxo-1,2,3-benzotriazino-3)methyl] thiophosphorodithioate; *O*,*O*-Dimethyl-*S*-[(4-oxo-3H-1,2,3-benzotriazin-3-yl)-methyl] dithiophosphat (German); *O*,*O*-Dimethyl *S*-[oxo-1,2,3-benzotriazin-3-(4H)-yl-methyl] phosphodithioate; *O*,*O*-Dimethyl *S*-(4-oxo-1,2,3-bezotriazin-3(4H)-yl methyl) phosphorodithioate; ENT 23,233; Gothnion®; Gusathion®; Gusathion® M; Guthion®; 3-(Mercaptomethyl)-1,2,3-benzotriazin-4(3H)-one *O*,*O*-dimethyl phosphorodithioate; 3-(Mercaptomethyl)-1,2,3-benzotriazin-4(3H)-one *O*,*O*-dimethyl phosphorodithioate *S*-ester; Methyl azinphos; *N*-Methylbenzazimide, dimethyldithiophosphoric acid ester; Methyl guthion; Metil azinfos (Spanish); NCI-C00066; R 1582
CAS Registry Number: 86-50-0; (alt.) 54182-73-9
RTECS® Number: TE1925000
UN/NA & ERG Number: (organophosphorus pesticides, solid, toxic)/152
EC Number: 201-676-1 [*Annex I Index No.:* 015-039-00-9]
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; no evidence: mouse.
US EPA Gene-Tox Program, Positive: *S. cerevisiae*-homozygosis; Negative: *In vitro* UDS-human fibroblast; TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion-Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.
US EPA, FIFRA 1998 Status of Pesticides: Supported.
Banned or Severely Restricted (Various countries) (UN).[13, 35]
Very Toxic Substance (World Bank).[15]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA) as guthion.
CERCLA/SARA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 1 lb (0.454 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) severe pollutant.
US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.
Canada: Drinking Water MAC.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24; R26/28; R43; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S6 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Azinphos-methyl is a brown, waxy solid, or colorless, crystalline material. Its technical form is a brown waxy solid. Molecular weight = 317.34; Freezing/Melting point = 73−74°C; Vapor pressure = 2.0×10^{-7} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Personnel engaged in the manufacture, formulation, and application of this organophosphorus insecticide and acaricide.
Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.
Permissible Exposure Limits in Air
OSHA PEL: 0.2 mg/m^3 TWA; [skin].
NIOSH REL: 0.2 mg/m^3 TWA; [skin].
ACGIH TLV®[1]: 0.2 mg/m^3 TWA; [skin], not classifiable as a human carcinogen; BEI: Cholinesterase activity in red cells = 70% of individual's baseline, sample time discretionary.
NIOSH IDLH: 10 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 0.7 mg/m^3
PAC-3: 10 mg/m^3
DFG MAK: 0.2 mg/m^3, inhalable fraction; [skin] Peak limitation II(8).
Australia: TWA 0.2 mg/m^3, [skin], 1993; Austria: MAK 0.2 mg/m^3, [skin], 1999; Belgium: TWA 0.2 mg/m^3, [skin],

1993; Denmark: TWA 0.2 mg/m^3, [skin], 1999; Finland: TWA 0.02 mg/m^3, STEL 0.06 mg/m^3, [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Norway: TWA 0.2 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, [skin], 1993; Switzerland: MAK-week 0.2 mg/m^3, [skin], 1999; Thailand: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.2 mg/m^3, STEL 0.6 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: For the protection of freshwater and marine aquatic life, a criterion of 0.01 μg/L has been suggested by EPA. For the protection of human health, a no-adverse-effect-level in drinking water has been calculated by NAS/NRC[46] as 0.088 mg/L. An allowable daily intake of 0.0125 mg/kg/day was calculated. Canada's maximum allowable concentration (MAC) in drinking water is 0.02 mg/L. The state of Maine[61] has set a guideline of 25 μg/L for azinphos-methyl in drinking water.

Determination in Water: Pesticide residue methods which should be applicable involve hydrolysis with KOH in isopropanol to give anthranilic acid, which is diazotized and coupled to give a measurable color. Fish Tox: 0.28636000 ppb MATC (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Symptoms include nausea, vomiting, diarrhea, excessive salivation; blurring of vision and other signs of cholinesterase inhibition; loss of muscle coordination; twitching of muscles, confusion, troubled breathing; convulsions and death. The oral LD_{50} for rat is 11 mg/kg. The acute toxicity rating is extremely toxic. Probable oral lethal dose in humans is 5−50 mg/kg or between 7 drops and 1 teaspoon for a 70-kg (150 lb) person. This is a potent cholinesterase inhibitor which can cause death.

Short Term Exposure: Exposure can cause rapid, fatal organophosphorus poisoning. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system causing weakness, "pins and needles," and poor coordination in arms and legs with repeated exposure, resulting in convulsions and respiratory failure. May cause liver damage. Repeated exposure may cause personality changes of depression, anxiety, or irritability. Human Tox: 10.50000 ppb Health Advisory (INTERMEDIATE).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Prevent skin contact. **8 h** (More than 8 h of resistance to breakthrough >0.1micron->g/cm^2/min): Neoprene™, nitrile rubber gloves, suits, boots. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is at all possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Note: Recommendations are NOT valid for very thin Natural rubber, Neoprene^{TM}, nitrile, and PVC gloves (<0.3 mm thick).

Respirator Selection: *Up to 2 mg/m^3*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 10 mg/m^3*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, and sources of ignition. Although this compound is chemically stable in storage, it is decomposed at elevated temperatures with evolution of gas; rapidly decomposed in cold alkali to form anthranilic acid and other decomposition products.[22]

Shipping: This chemical is an organophosphorus pesticide, solid, toxic. The required label is “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 1000.

Fire Extinguishing: This product may burn but does not readily ignite. Poisonous gases, including carbon monoxide, nitrogen oxides, and sulfur, are produced in fire. Fight fire from maximum distance. On small fires use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. On large fires use water spray, fog, or foam. Dike fire control water for later disposal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 60−65

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Azinphos-Methyl*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1, 1986). *Chemical Fact Sheet*: *Guthion*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May, 1999). *Hazardous Substances Fact Sheet: Guthion*. Trenton, NJ

Azobenzene A:1660

Molecular Formula: $C_{12}H_{10}N_2$
Common Formula: $C_6H_5N{=}NC_6H_5$
Synonyms: Azobenzide; Azobenzol; Azobisbenzene; Azodibenzene; Azodibenzeneazofume; Benzeneazobenzene; Diazobenzene; 1,2-Diphenyldiazene; Diphenyldiazene; Diphenyldiimide; NCI-C02926
CAS Registry Number: 103-33-3
RTECS® Number: CN1400000
UN/NA & ERG Number: UN2811/Toxic solids, organic, n.o.s./154
EC Number: 203-102-5 [*Annex I Index No.:* 611-001-00-6]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.
Banned or Severely Restricted (Great Britain) (UN).[13]
California Proposition 65 Chemical: Cancer.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R20/22; R48/22; R68; R50/53 Safety phrases: S53; S46; S60; S62 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Azobenzene is a combustible, orange-red crystalline solid. Molecular weight = 182.2; Boiling point = 293°C (decomposes); Freezing/Melting point = 68°C; Vapor pressure = 7.6×10^{-5}. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.
Potential Exposure: Those engaged in azobenzene use in dye, rubber, chemical, and pesticide manufacturing.
Incompatibilities: Strong oxidizers.
Permissible Exposure Limits in Air
No standards or TEEL available.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.8$.
Routes of Entry: Inhalation, ingestion, skin absorption.
Harmful Effects and Symptoms
Short Term Exposure: Azobenzene irritates the eyes, skin, and respiratory tract. In serious cases there is a risk of unconsciousness and death. The consumption of alcohol may exacerbate toxic effects. The oral LD_{50} for rat is 1000 mg/kg.
Long Term Exposure: A potential carcinogen. Can affect the blood and cause liver disorders.
Medical Surveillance: Liver function tests. Complete blood count (CBC).
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:
At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store under an inert atmosphere in a freezer or

refrigerator. Protect from air and light.[52] Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Azobenzene may be classified as Toxic solids, organic, n.o.s. and requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Transfer to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including Nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 35−36 (1981) and 7, No. 1, 38−47 (1987)

Azodiisobutyronitrile A:1670

Molecular Formula: $C_8H_{12}N_4$

Common Formula: $NCC(CH_3)_2N{=}NC(CH_3)_2CN$

Synonyms: Aceto azib; AIBN; α,α′-Azobisisobutylonitrile; 2,2′-Azobis(isobutyronitrile); Azobisisobutyronitrile; 2,2′-Azobis(2-methylpropionitrile); α,α′-Azodiisobutyronitrile; 2,2′-Azodiisobutyronitrile; Azodiisobutyronitrile; 2,2′-Dicyano-2,2′-azopropane; Poly-Zole AZDN; Porofor 57; Vazo 64

CAS Registry Number: 78-67-1

RTECS® Number: UG0800000

UN/NA & ERG Number: UN2952/150

EC Number: 201-132-3 [*Annex I Index No.:* 608-019-00-1]

Regulatory Authority and Advisory Bodies

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-8909.

European/International Regulations: Hazard Symbol: E, Xn, N; Risk phrases: R2; R11; R20/22; R52/53; Safety phrases: S2; S39; S41; S47; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Azobisisobutylonitrile is a white crystalline compound. Molecular weight = 164.21; Specific gravity (H_2O:1) = 1.11 at 25°C; Boiling point = decomposes; Freezing/Melting point = 99−103°C (decomposes); Autoignition temperature = 63°C. NFPA 704 M Hazard Identification (based on NFPA-704M Rating System): Health 3, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: Azobisisobutylonitrile is used as a polymerization initiator, free radical generator (or initiator), as a catalyst in vinyl polymerizations, and as a blowing agent for elastomers and plastics.

Incompatibilities: Highly flammable. Unstable and easily oxidized martial; keep away from oxidizers, strong acids. Keep at temperature not exceeding 30°C (may vary by manufacturer). Risk of explosion from heat, shock, friction. Warming causes production of tetramethylsuccinonitrile and cyanide fumes. Keep away from acetone and other ketones, alcohols, lithium, aluminum, aldehydes, and hydrocarbons, such as heptane.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 300 mg/m^3

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

Determination in Air: NIOSH Analytical Method #7904 (Cyanides). See also NIOSH Criteria Document 212 *Nitriles*.

Permissible Concentration in Water: No criteria set. May be harmful to aquatic organisms.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.10.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Azodiisobutyronitrile can affect you by passing through your skin. Contact can cause irritation to the eyes and skin. Inhalation can irritate the nose and throat, causing wheezing and coughing. High exposure can cause dizziness, vomiting, abdominal pain, flushing, headache, shortness of breath, and coma. Convulsions and death may follow.

Long Term Exposure: Azodiisobutyronitrile may cause liver and kidney damage.

Points of Attack: Respiratory system, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood cyanide level. Liver and kidney function tests. Consider thyroid evaluation and complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential for exposures to azodiisobutyronitrile, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

NIOSH (*as cyanides*): *25 mg/m*^{3}: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin--style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Azodiisobutyronitrile must be stored to avoid contact with acetone, lithium, aluminum hydride, and water, since violent reactions occur. Azodiisobutyronitrile is self-reactive and will explode at elevated temperatures. It should be stored under nitrogen, dry ice, or ice. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Self-reactive solid type C, temperature controlled materials must be labeled "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not sweep or raise dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Do not use water or wet method.* Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Azodiisobutyronitrile may self-ignite at elevated temperatures. Use dry chemical, CO_2, water spray, or foam extinguishers. Use water spray to keep fire-exposed containers cool. Poisonous gases are produced in fire, including oxides of nitrogen, tetramethylsuccinonitrile, and cyanide fumes. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Azodiisobutyronitrile*. Trenton, NJ

B

Bacitracin B:0050

Molecular Formula: $C_{66}H_{103}N_{17}O_{16}S$

Synonyms: Ayfivin; Baciguent; Baci-Jel; Baciliquin; Bacitek ointment; Fortracin; Parentracin; Penitracin; Topitracin; Zutracin

CAS Registry Number: 1405-87-4

RTECS® Number: CP0175000

UN/NA & ERG Number: UN3249 (medicine, solid, toxic, n.o.s.)/151

EC Number: 215-786-2

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory.

List of Acutely Toxic Chemicals, Chemical Emergency Preparedness Program (EPA) and formerly on CERCLA/SARA 40CFR302, Table 302.4 Extremely Hazardous Substances List. Dropped from listing in 1988.

Listed on Canada's DSL List.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bacitracin is a white to light tan powder which is odorless or having a slight odor and very bitter taste. Molecular weight = 1422.69; Freezing/Melting point: 221−224°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: Bacitracin is used as an ingredient in antibiotic ointments to treat or prevent topical or eye infections. Commercial Bacitracin is a mixture of at least 9 bacitracins. Also used as a feed and drinking water additive in animals; as an additive in food for human consumption.

Incompatibilities: Oxidizers, such as peroxides, perchlorates, chlorates, nitrates, chlorine, bromine, and fluorine.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Through the skin, inhalation.

Harmful Effects and Symptoms

LD_{50} = (oral-mouse) 25 mg/kg (highly toxic). This data has been questioned, however, and it has been stated that as a result of a mathematical miscalculation, bacitracin was wrongly included in a list of hazardous chemicals drafted several years ago by the National Institute of Occupational Safety and Health. The mistake was remedied in 1988 when the substance was removed from the EHS list as noted above.

Short Term Exposure: Bacitracin can be absorbed through the skin, thereby increasing exposure. May cause eye irritation. Hypersensitivity reactions may result from application of this compound to the skin but this is uncommon. Exposure may cause nausea, vomiting, and diarrhea.

Long Term Exposure: May cause liver damage and skin allergy.

Points of Attack: Liver, skin.

Medical Surveillance: Evaluation by a qualified allergist. Kidney function tests.

First Aid: In case of large-scale exposure, the directions for medicines (nonspecific, n.o.s.) would be applied as follows: Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Storage: Color Code—Green: General storage may be used.

Shipping: The DOT category of medicine, solid, toxic, n.o.s. calls for the label of "POISONOUS/TOXIC MATERIALS." Bacitracin would fall in Hazard Class 6.1 and in Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide, nitrogen oxides, and sulfur oxides. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Save fire control water for later disposal, do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Bacitracin.*

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00002-3

Washington, DC: Chemical Emergency Preparedness Program
New Jersey Department of Health and Senior Services. (March, 1999). *Hazardous Substances Fact Sheet: Bacitracin*. Trenton, NJ

Barium B:0100

Molecular Formula: Ba
Synonyms: Bario (Spanish); Barium, elemental; Barium metal
CAS Registry Number: 7440-39-3
RTECS® Number: CQ8370000
UN/NA & ERG Number: UN1400/138; UN1854 (alloys, pyrophoric)/135
EC Number: 231-149-1
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Water Pollution Standards Set (EPA)[49] (former USSR-UNEP/IRPTC project)[43] (Several States)[61] (Canada) (Mexico).
US EPA Hazardous Waste Number (RCRA No.): D005.
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 100.0 mg/L.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.
RCRA Maximum Concentration Limit for Ground Water Protection (40CFR264.94), 1.0 mg/L.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.2; Nonwastewater (mg/L), 7.6 TCLP.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List, Suggested methods (PQL μg/L): 6010 (20); 7080 (1000).
Safe Drinking Water Act: MCL, 2 mg/L; MCLG, 2 mg/L; Regulated chemical (47FR9352).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada MAC for drinking water quality: 1.0 mg/L.
Mexico, Drinking Water 1.0 mg/L.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Barium is a flammable, silver white or yellowish metal in various forms including powder. Barium may ignite spontaneously in air in the presence of moisture, evolving hydrogen. Molecular weight = 137.34; Boiling point = 1640°C; Freezing/Melting point = 725°C; Vapor pressure = 10 mmHg at 1049°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 3₩ (water reactive).
Potential Exposure: Metallic barium is used for removal of residual gas in vacuum tubes and in alloys with nickel, lead, calcium, magnesium, sodium, and lithium. Barium compounds are used in the manufacture of lithopone (a white pigment in paints), chlorine, sodium hydroxide, valves, and green flares; in synthetic rubber vulcanization; X-ray diagnostic work, glassmaking, papermaking, beet-sugar purification; animal and vegetable oil refining. They are used in the brick and tile, pyrotechnics, and electronics industries. They are found in lubricants, pesticides, glazes, textile dyes, and finishes; pharmaceuticals; in cements which will be exposed to saltwater; and barium is used as a rodenticide, a flux for magnesium alloys, a stabilizer and mold lubricant in the rubber and plastics industries, an extender in paints; a loader for paper, soap, rubber, and linoleum; and as a fire extinguisher for uranium or plutonium fires.
Incompatibilities: Barium powder may spontaneously ignite on contact with air. It is a strong reducing agent and reacts violently with oxidizers and acids. Reacts with water, forming combustible hydrogen gas and barium hydroxide. Reacts violently with halogenated hydrocarbon solvents, causing a fire and explosion hazard.
Permissible Exposure Limits in Air
OSHA PEL: 0.5 mg[Ba]/m^3 TWA.
NIOSH REL: 0.5 mg[Ba]/m^3 TWA.
ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 50 mg Ba/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 50 mg/m^3
Soluble compounds only
DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2); Pregnancy Risk Group D.
Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1993; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1999; Hungary STEL 0.5 mg/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Sweden: TWA 0.5 mg/m^3, 1999; Switzerland: MAK-week 0.5 mg/m^3, 1999; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: LTEL 0.5 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.
Permissible Concentration in Water: EPA allows 2 ppm. See Regulatory Authority and Advisory Bodies for Canadian and Mexican levels. Russia[43] set a MAC of

4.0 mg/L in water bodies used for domestic purposes. Also, these states have set standards for barium in drinking water[61]: a standard of 100 μg/L in Massachusetts and guidelines of 1000 μg/L in Maine and 1500 μg/L in Minnesota.

Determination in Water: Conventional flame atomization does not have sufficient sensitivity to determine barium in most water samples; however, a barium detection limit of 10 μg/L can be achieved if a nitrous oxide flame is used. A concentration procedure for barium uses thenoyltrifluoroacetone−methylisobutylketone extraction at a pH of 6.8. With a tantalum liner insert, the barium detection limit of the flameless atomic absorption procedure can be improved to 0.1 μg/L according to NAS/NRC.[46]

Routes of Entry: Ingestion or inhalation of dust or fume, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Alkaline barium compounds, such as the hydroxide and carbonate, may cause local irritation to the eyes, nose, throat, and skin. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: Barium poisoning is virtually unknown in industry although the potential exists when the soluble forms are used. When ingested or given orally, the soluble, ionized barium compounds exert a profound effect on all muscles and especially smooth muscles, markedly increasing their contractility. The heart rate is slowed and may stop in systole. Other effects are increased intestinal peristalsis; vascular constriction; bladder contraction, and increased voluntary muscle tension. The inhalation of the dust of barium sulfate may lead to deposition in the lungs in sufficient quantities to produce "baritosis" (a benign pneumoconiosis). This produces a radiologic picture in the absence of symptoms and abnormal physical signs. X-rays, however, will show disseminated nodular opacities throughout the lung fields, which are discrete, but sometimes overlap. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Heart, lungs, central nervous system, skin, respiratory system, eyes.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If a soluble barium compound gets into the eyes, remove any contact lenses at once and irrigate immediately. If a soluble barium compound contacts the skin, flush with water immediately. If a person breathes in large amounts of a soluble barium compound, move the exposed person to fresh air at once and perform artificial respiration. When a soluble barium compound has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician (poisoning from barium compounds): If ingested, there are treatment considerations available including the following: Gastric emptying, a warm aqueous solution of 1−3% soluble sulfates of magnesium sulfate or sodium sulfate administered orally as a gastric lavage (forms insoluble barium sulfate). Atropine sulfate, 0.5−1.0 mg, to decrease colic. Small doses of morphine may be necessary to control abdominal pain. If low potassium (hypokalemia) is present, treat with IV of potassium.

Personal Protective Methods: Employees should receive instruction in personal hygiene and the importance of not eating in work areas. Good housekeeping and adequate ventilation are essential. Dust masks, respirators, or goggles may be needed where amounts of significant soluble or alkaline forms are encountered, as well as protective clothing.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Barium metal should be stored in a dry area, separated from halogenated solvents, strong oxidants, acids, in tightly-closed containers under an inert gas blanket, petroleum, or oxygen-free liquid. Rubber gloves, rubber protective clothing and apron, goggles and gas-filter mask should be worn when working in a barium storage area.

Shipping: Barium metal requires a shipping label of "DANGEROUS WHEN WET." The metal falls in

UN/DOT shipping class 4.3 and Packing Group II.[19, 20] It should be noted that "Barium Alloys" have the same caveats but "Barium Alloys, Pyrophoric" require a "SPONTANEOUSLY COMBUSTIBLE" label. They fall in Hazard Class 4.2.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Small quantities of barium metal may be dissolved in large quantities of water. Soda ash is added and the solution then neutralized with HCl. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium powder is a flammable solid. Reacts violently with fire extinguishing agents, such as water, bicarbonate, powder, foam, and carbon dioxide. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Barium in solution (see spill handling) may be precipitated with soda ash and the sludge may be landfilled.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. 2: Barium*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 71−84

US Environmental Protection Agency. (April 30, 1980). *Barium: Health and Environmental Effects Profile No. 13*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 35−40 (1981) and 3, No. 4, 29−30 (1983)

New Jersey Department of Health and Senior Services. (January, 1996). *Hazardous Substances Fact Sheet: Barium*. Trenton, NJ

Barium azide B:0110

Molecular Formula: BaN_6
Common Formula: $Ba(N_3)_2$
Synonyms: Azida de bario (Spanish)
CAS Registry Number: 18810-58-7
RTECS® Number: CQ8500000 (dry); CQ8510000 (wet)
UN/NA & ERG Number: UN1571 (dry or wetted with <50% water, by mass)/113
EC Number: 242-594-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade). Explosive Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Barium azide is a flammable, crystalline solid which can be used or transported in solution. Molecular weight = 221.4; Boiling point = explodes; Freezing/Melting point = 120°C (decomposes, losing nitrogen). Highly soluble in water.

Potential Exposure: Barium azide is used in high explosives.

Incompatibilities: Carbon disulfide. It can explode when heated or shocked.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

No TEEL available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: No criteria set for barium azide. See entry under "Barium."

Permissible Concentration in Water: No criteria set for barium azide. EPA allows 2 ppm for barium. See entry under "Barium."

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Barium azide irritates the eyes, nose, and respiratory tract; with coughing. Overexposure can cause a drop in blood pressure, with dizziness; blurred vision; headaches; and unconsciousness. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: Repeated exposure to the dust can cause spots on chest X-ray without lung scarring. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If weakness or fainting is present, lay the person down flat with feet elevated. See also First Aid section in "Barium" entry.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- (for liquid) or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (as soluble barium compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Barium azide must be stored to avoid contact with carbon disulfide since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area from anything which could disturb or shock barium azide. Sources of ignition, such as smoking and open flames are prohibited where barium azide is handled, used, or stored. Keeping barium azide wet greatly reduces its fire and explosion hazard. Wherever barium azide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Barium azide wetted with not $<50\%$ water, by mass, requires a shipping label of "FLAMMABLE SOLID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.1 and Packing Group I.[19, 20] Barium azide dry or wetted with $<50\%$ water, by mass must be labeled "EXPLOSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 1.1A and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of

potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium azide will explode when heated or when shocked. If fire or explosion occurs, evacuate the area. Fight the fire from an explosion-resistant location as containers may explode in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Barium Azide*. Trenton, NJ

Barium bromate B:0120

Molecular Formula: $BaBr_2O_6$

Common Formula: $Ba(BrO_3)_2$

Synonyms: Bromato barico (Spanish); Bromic acid, barium salt

CAS Registry Number: 13967-90-3

RTECS® Number: EF8715000

UN/NA & ERG Number: UN2719/141

EC Number: 237-750-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Barium bromate is a white crystalline powder. Molecular weight = 411.2; Boiling point: explodes at 300°C; Freezing/Melting point = 260°C (decomposes). Slightly soluble in water.

Potential Exposure: This material is used as an analytical reagent, oxidizer, and corrosion inhibitor.

Incompatibilities: A strong oxidizer; keep away from reducing agents. Keep away from oxidizable materials; aluminum, arsenic, carbon, copper, metal sulfides; phosphorus, sulfur, organic, and combustible materials (such as wood, paper, oil, fuels) since violent reactions occur.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

No TEEL available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry under "Barium."

Permissible Concentration in Water: No criteria set for barium bromate *per se*. EPA allows 2 ppm for barium. See entry under "Barium."

Routes of Entry: Inhalation, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Barium bromate can affect you when breathed in. Contact can irritate and even burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, barium may show up as spots on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated exposure to Barium bromate can cause bromine to build up in the body. Consult the sheet on "Bromine" entry. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and cracking.

Points of Attack: Lungs, skin.

Medical Surveillance: Serum bromide levels. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where barium bromate is handled, used, or stored. Avoid any possible contact with incompatible materials. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Barium bromate requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 5.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium bromate explodes at 275−300°C. Extinguish fire using an agent suitable for type of surrounding fire. Barium bromate itself does not burn. Poisonous gases are produced in fire, including bromine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Barium Bromate*. Trenton, NJ

Barium chlorate B:0130

Molecular Formula: $BaCl_2O_6$
Common Formula: $Ba(ClO_3)_2$
Synonyms: Barium chlorate (monohydrate); Chloric acid, barium salt; Clorato barico (Spanish)
CAS Registry Number: 13477-00-4 (monohydrate); 10326-27-7 (dihydrate)
RTECS® Number: FN9770000; CQ 8751000 (dihydrate)
UN/NA & ERG Number: UN1445
EC Number: 236-760-7 [*Annex I Index No.:* 017-003-00-8] (monohydrate); dihydrate not found.

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

European/International Regulations (*monohydrate*): Hazard Symbol: O, Xn, N; Risk phrases: R9; R20/22; R51/53; Safety phrases: S2; S13; S27; S61; European/International Regulations (*dihydrate*): not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Barium chlorate is a combustible, colorless to white crystalline solid or powder. Molecular weight = 304.24; 244.3 (dihydrate); Freezing/Melting point = monohydrate decomposes below 250°C; dihydrate at 120°C (loss of water of crystallization). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1, Oxidizer. Soluble in water; solubility = 27 g/100 mL.

Potential Exposure: It is used in fireworks and explosives manufacture; in textile dyeing and in the manufacture of other perchlorates.

Incompatibilities: A strong oxidizer. When heated above 250°C, it begins to give off oxygen and will increase risk of fire. Barium chlorate is a reactive chemical and is an explosion hazard. Violent reaction may occur with reducing materials, strong acids, powdered metals. Contact with combustible materials will increase activity in fire.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

No TEEL available.

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1993; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1999; Hungary STEL 0.5 mg/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Sweden: TWA 0.5 mg/m^3, 1999; Switzerland: MAK-week 0.5 mg/m^3, 1999; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: LTEL 0.5 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry for "Barium."

Permissible Concentration in Water: No criteria set for barium chlorate *per se*. EPA allows 2 ppm for barium. See entry for "Barium."

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes. Higher exposures can damage red blood cells. Symptoms include headache, weakness, abdominal pain, dark urine, and jaundice. The symptoms of paralysis may be delayed for several hours. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. See entry for "Silica quartz." Chlorates can damage red blood cells, leading to kidney damage, or cause methemoglobin to form in the blood, reducing oxygen supply to body organs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and skin cracking.

Points of Attack: Lungs, blood cells, skin.

Medical Surveillance: Lung function tests, complete blood count (CBC), test for methemoglobin. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of paralysis do not become obvious until some hours have passed. Keep under medical observation for 24–48 h. See also First Aid section in "Barium" entry.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to barium chlorate. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of barium chlorate to potentially exposed workers.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Barium chlorate must be stored to avoid contact with organic or combustible materials (such as wood, paper, oil, fuels, and starch) and other easily oxidizable materials (such as sulfur, aluminum, copper, metal sulfides, ammonium salts, etc.) since violent reactions occur. Store in tightly closed containers on nonwood floors in a cool, well-ventilated area. Wherever barium chlorate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This chemical requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." The Hazard Class is 5.1 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar nonorganic material and deposit in sealed containers. May also be covered with weak reducing agents; resulting sludge neutralized and flushed to sewer. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May explode when heated. Contact with combustible, organic, or other easily oxidizable materials, such as paper, oil, fuels or sawdust can cause fires. Rubbing of these mixtures can cause explosions. Use water to extinguish the fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volumes of reducing agent (bisulfite or ferrous salt) solutions. Neutralize and flush to sewer with large volumes of water.[24]

Reference

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Barium Chlorate*. Trenton, NJ

Barium cyanide B:0140

Molecular Formula: BaC_2N_2
Common Formula: $Ba(CN)_2$
Synonyms: Barium cyanide, solid; Barium dicyanide; Cianuro barico (Spanish)
CAS Registry Number: 542-62-1
RTECS® Number: CQ8785000
UN/NA & ERG Number: UN1565/157
EC Number: 208-822-3

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P013.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

RCRA Land Ban Waste Restrictions.

EPCRA Section 313: *as barium compounds*; Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide compounds.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides, soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2; Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s. and Cyanide compounds, inorganic, n.o.s.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R28; R32; R50/53; Safety phrases: S1/2; S7/8; S23; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Barium cyanide is a white crystalline powder. Often used in solution. Molecular weight = 139.4; Heat of combustion = -60.5×10^5 J/kg; Heat of solution = (exothermic) = -6.19×10^5 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 80 g/100 cc at 14°C.

Potential Exposure: Barium cyanide is used in electroplating and in metallurgy.

Incompatibilities: Violent reactions may occur on contact with acids, acid salts, and strong oxidizers.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

NIOSH IDLH: 50 mg [Ba]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.69 mg/m^3
PAC-1: 2.07 mg/m^3
PAC-2: 3.5 mg/m^3
PAC-3: 69 mg/m^3

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg [CN/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 mg/m^3 [skin]. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Permissible Concentration in Water: No criteria set for barium cyanide *per se*. EPA allows 2 ppm for barium. See entry under "Barium." See also entry under "Cyanides."

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Barium cyanide is a deadly poison; can affect you when breathed and by passing through skin. Exposure can cause confusion, weakness, headaches, nausea, vomiting, gasping for air, collapse and even death from cyanide poisoning. On contact with acids, acid mists, or acid salts, flammable hydrogen cyanide gas is formed which can cause rapid poisoning. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Can interfere with the normal functioning of the thyroid gland, causing goiter (enlarged thyroid).

Points of Attack: Thyroid.

Medical Surveillance: Blood cyanide level. Thyroid function tests. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *If cyanide poisoning is confirmed*, use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- (for liquid) or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Barium cyanide must be stored to avoid contact with acids; acid salt (such as potassium bisulfate, calcium biphosphate and calcium nitrate); carbon dioxide and strong oxidizers (such as nitrates, chlorates and chlorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is I.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

Fire Extinguishing: Barium cyanide does not burn, but contact with acids, acid salts, or carbon dioxide in air may produce highly flammable hydrogen cyanide gas. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire, including cyanide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate barium with sulfate. Then add with stirring to alkaline calcium hypochlorite solution. Let stand 24 h, then flush to sewer.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 33−35 (1981) and 3, No. 4, 31−32

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Barium Cyanide*. Trenton, NJ

Barium hypochlorite B:0150

Molecular Formula: $BaCl_2O_2$

Common Formula: $Ba(OCl)_2$

Synonyms: Hypochlorous acid, barium salt

CAS Registry Number: 13477-10-6

RTECS® Number: NH3480000

UN/NA & ERG Number: UN2741 (barium hypochlorite, with more than 22% available chlorine)/141

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Barium hypochlorite is a colorless, sand-like, crystalline solid, often used in solution. A strong oxidizer. There is not much information available on this compound. Reacts with water.

Potential Exposure: This material is used as a bleaching agent and as an antiseptic.

Incompatibilities: Barium hypochlorite is a strong oxidizer. Avoid contact with reducing agents, organic and combustible materials (such as wood, oil, paper, and fuels), acids, and urea since violent reactions occur. Keep away from water or steam.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

No TEEL available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry under "Barium."

Permissible Concentration in Water: No standards set for Barium Hypochlorite *per se*. EPA allows 2 ppm for barium. See entry under "Barium."

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Barium hypochlorite can affect you when breathed in and may enter the body through the skin. Contact can irritate and even burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and cracking.

Points of Attack: Lungs, skin.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to barium hypochlorite and at the end of the work shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of barium hypochlorite to potentially exposed workers. See also First Aid section in "Barium" entry.

Respirator Selection: (BA soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from water and steam. Sources of ignition, such as smoking and open flames, are prohibited where Barium Hypochlorite is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Avoid any possible contact with the incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Barium hypochlorite (with more than 22% available chlorine) requires an "OXIDIZER" label. It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Do not use water. Extinguish fire using an agent suitable for type of surrounding fire. Barium hypochlorite itself does not burn. Poisonous gases are produced in fire, including chlorine and chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Barium Hypochlorite*. Trenton, NJ

Barium nitrate B:0160

Molecular Formula: BaN_2O_6

Common Formula: $Ba(NO_3)_2$

Synonyms: Barium dinitrate; Nitrate de baryum (French); Nitrato barico (Spanish); Nitric acid, barium salt

CAS Registry Number: 10022-31-8

RTECS® Number: CQ9625000

UN/NA & ERG Number: UN1446/141

EC Number: 233-020-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Barium nitrate is a shiny, white crystalline solid. Molecular weight = 261.36; Specific gravity (water = 1) = 3.24 at 23°C; Boiling point = 210°C (decomposes); Freezing/Melting point = 590°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2, Oxidizer. Soluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Barium nitrate is used in fireworks (in green fire pyrotechnics), signal lights, ceramics; and in the electronics industry to make BaO_2. Once used in the vacuum tube industry.

Incompatibilities: A strong oxidizer. Decomposes in heat; may detonate if confined in elevating temperatures. Keep away from strong acids, reducing agents. Contact with organic and combustible materials (such as wood, paper, oil, and fuels) and aluminum−magnesium alloys since violent reactions occur. Contact with sulfur powder and finely divided metals can form a shock-sensitive compounds.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg [Ba]/m^3.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry for "Barium."

Permissible Concentration in Water: No criteria set for barium nitrate *per se*. EPA allows 2 ppm for barium. See entry for "Barium."

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Barium nitrate can affect you when breathed in. Inhaling dust or mist can cause irritation of the respiratory system, causing cough and phlegm. Contact can irritate and even burn the eyes and skin. Exposure can irritate the eyes, nose, and throat. Very high exposure (such as swallowing or extremely high dust exposure) can cause barium poisoning with symptoms of vomiting and diarrhea, irregular heartbeat, paralysis, and death. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders. LD_{50} = (oral-rat) 355 mg/kg.

Long Term Exposure: Repeated high exposure can irritate the lungs, causing cough and phlegm, and may cause an abnormal chest X-ray. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, nervous system, heart.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator).

12.5 mg/m^3: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area. Avoid any possible contact with incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This chemical requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." The Hazard Class is 5.1 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Barium nitrate itself does not burn but heating causes decomposition and gives off oxygen; thereby increasing the intensity of an existing fire. Use flooding amounts of water in early stages of fire; in large fires, the material may melt and water could scatter the molten material. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve waste in 6-M HCl. Neutralize with NH_4OH. Precipitate with excess sodium carbonate. Filter, wash, and dry precipitate and return to supplier.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 36−37

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Barium Nitrate*. Trenton, NJ

Barium oxide B:0170

Molecular Formula: BaO

Synonyms: Barium monoxide; Barium protoxide; Baryta; Calcined baryta; Monoxido barico (Spanish); Oxyde de baryum (French)

CAS Registry Number: 1304-28-5

RTECS® Number: CQ9800000

UN/NA & ERG Number: UN1884/157

EC Number: 215-127-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Barium oxide is a white to yellowish-white, odorless powder. Molecular weight = 153.34; Freezing/Melting point = 1923°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Reacts violently with water.

Potential Exposure: It is used to dry gases and solvents and in producing detergents for lubricating oils.

Incompatibilities: Reacts with water, forming barium hydroxide. Violent reactions occur on contact with hydrogen sulfide, carbon dioxide; hydroxylamine, nitrogen tetroxide or sulfur trioxide. Reacts with triuranium.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.558 mg/m^3

PAC-1: 1.67 mg/m^3

PAC-2: 2.79 mg/m^3

PAC-3: 55.8 mg/m^3

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry for "Barium."

Permissible Concentration in Water: No criteria set for barium oxide *per se*. EPA allows 2 ppm for barium. See entry for "Barium."

Determination in Water: Harmful to the environment.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Barium oxide can affect you when breathed in. Contact can irritate the skin and burn the eyes, causing loss of vision. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. High exposure may cause pulmonary edema, a medical emergency, that can be delayed for several hours. This can cause death. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: May cause lung irritation and bronchitis. After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, nervous system, heart.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a dry, cool, well-ventilated area away from water and the incompatible substances cited above.

Shipping: Barium oxide requires a shipping label of “POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Barium oxide itself does not burn. Do not use water. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Barium Oxide*. Trenton, NJ

Barium perchlorate B:0180

Molecular Formula: $BaCl_2O_8$

Common Formula: $Ba(ClO_4)_2$

Synonyms: Barium perchlorate trihydrate; Perchloric acid, barium salt; Perclorato barico (Spanish)

CAS Registry Number: 13465-95-7

RTECS® Number: SC7550000

UN/NA & ERG Number: UN1447/141

EC Number: 236-710-4 [*Annex I Index No.:* 017-007-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R9; R20/22; Safety phrases: S2; S27 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Barium perchlorate is a white crystalline solid. Molecular weight = 336.2; Freezing/Melting point = 400°C (trihydrate); 505°C (anhydrous). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Highly soluble in water; solubility = 200 g/100 mL at 33°C.

Potential Exposure: It is used to make explosives and in experimental rocket fuels.

Incompatibilities: An oxidizing agent. Contact with organic and combustible materials (such as paper, wood, and oil), finely divided metals (specifically magnesium and aluminum), sulfur, calcium hydride, and strontium hydride since violent reactions occur.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

No TEEL available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 $\mu g/m^3$ (New York) to 5.0 $\mu g/m^3$ (Florida and North Dakota) to 8.0 $\mu g/m^3$ (Virginia) to 10.0 $\mu g/m^3$ (Connecticut) to 12.0 $\mu g/m^3$ (Nevada).

Determination in Air: See entry for "Barium."
Permissible Concentration in Water: No criteria set for Barium perchlorate *per se*. EPA allows 2 ppm for barium. See entry for "Barium."
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Barium perchlorate can affect you when breathed in. Contact can cause severe irritation and burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Overexposure can cause methemoglobinemia, causing dizziness, bluish color to the skin and lips. Higher levels can cause difficult breathing, collapse, and even death.
Long Term Exposure: After repeated exposure, Barium may show up as spots in the lungs on X-ray. Some Barium chemicals are contaminated with silica, which scars the lungs. Perchlorates can interfere with thyroid function, affect the red blood cells (methemoglobinemia) or damage bone marrow (aplastic anemia). Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.
Points of Attack: Lungs, red blood cells.
Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination. Thyroid function tests, complete blood count (CBC), tests for methemoglobin.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine. See also First Aid section in "Barium" entry.
Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from heat sources, sources of shock, or the incompatible materials cited above. Sources of ignition, such as smoking and open flames, are prohibited where Barium perchlorate is handled, used, or stored. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.
Shipping: Barium perchlorate requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 5.1 and Packing Group II.[19, 20]
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in

vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium perchlorate does not burn, but contact with organic and combustible materials or heat or shock may cause fires or explosions. In case of fire, evacuate the area and fight the fire from a safe, protected location. Poisonous gases are produced in fire, including Chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Barium Perchlorate*. Trenton, NJ

Barium permanganate B:0190

Molecular Formula: $BaMn_2O_8$

Common Formula: $Ba(MnO_4)_2$

Synonyms: Barium manganate(VIII); Permanganato barico (Spanish); Permanganic acid, barium salt

CAS Registry Number: 7787-36-2

RTECS® Number: SD6405000

UN/NA & ERG Number: UN1448/141

EC Number: 232-110-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Barium permanganate is a brownish-violet, dark purple to black crystalline solid. Molecular weight = 375.2; Specific gravity (H_2O:1) = 3.77 at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: It is used to make dry cells and other permanganates; and as a disinfectant.

Incompatibilities: Acetic acid, acetic anhydride, and organic or combustible materials (such as wood, paper, oil, and fuels) since violent reactions occur.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 6.83 mg/m^3

PAC-1: 20.5 mg/m^3

PAC-2: 34.1 mg/m^3

PAC-3: 34.1 mg/m^3

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry for "Barium."

Permissible Concentration in Water: No criteria set for barium permanganate *per se*. EPA allows 2 ppm for barium. See entry for "Barium."

Routes of Entry: Inhalation.

Short Term Exposure: Skin and eye contact can cause severe irritation and burns. Barium permanganate can affect you when breathed in. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with Silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated contact may cause chronic drying and cracking skin.

Points of Attack: Lungs, skin.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Barium permanganate to potentially exposed workers.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers is a cool, well-ventilated area. Keep away from incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Barium permanganate requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 5.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium permanganate does not burn, but contact with organic and combustible materials may cause fires or explosions. In case of fire, evacuate the area and fight the fire from a safe, protected location. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only

respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Barium Permanganate*. Trenton, NJ

Barium peroxide B:0200

Molecular Formula: BaO_2

Synonyms: Barium binoxide; Barium dioxide; Bariumperoxid (German); Barium superoxide; Dioxyde de baryum (French); Peroxido barico (Spanish); Peroxyde de baryum (French)

CAS Registry Number: 1304-29-6

RTECS® Number: CR0175000

UN/NA & ERG Number: UN1449/141

EC Number: 215-128-4 [*Annex I Index No.*: 056-001-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.

European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R8; R20/22; Safety phrases: S2; S13; S27 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Barium peroxide is a grayish-white powder. Molecular weight = 169.34; Specific gravity (H_2O:1) = 4.98; Boiling point = 800°C (decomposes below this point); Freezing/Melting point = 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2, ₩, Oxidizer. Very slightly soluble in water.

Potential Exposure: Is used as a bleaching agent; in making hydrogen peroxide, oxygen; in aluminum welding; in textile dyeing and for bleaching fibers; animal substances.

Incompatibilities: A strong oxidizer. Keep away from organic and combustible materials (such as wood, paper, oil, fuels, and other easily oxidized materials) and peroxyformic acid, hydrogen sulfide, and hydroxylamine solutions since violent reactions occur.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m^3 TWA.

NIOSH REL: 0.5 mg[Ba]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.617 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 61.7 mg/m^3

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m^3.

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1993; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1999; Hungary STEL 0.5 mg/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Sweden: TWA 0.5 mg/m^3, 1999; Switzerland: MAK-week 0.5 mg/m^3, 1999; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: LTEL 0.5 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: See entry under "Barium."

Permissible Concentration in Water: No criteria set for Barium peroxide *per se*. EPA allows 2 ppm for barium. See entry under "Barium."

Determination in Water: Environmental hazard for aquatic organisms.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Barium peroxide can affect you when breathed in. Contact can irritate and burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated contact may cause chronic drying and cracking skin. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture, and away from contact with the incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This chemical requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 5.1 and Shipping Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover material with sand/soda ash 9:1 mixture. Mix thoroughly and while stirring, add slowly to sodium bisulfite solution with plastic implements. Neutralize with dilute H_2SO_4. After setting, decant the solution with flushing water and transport the sand to a sanitary landfill.[24] Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium peroxide does not burn, but mixtures of Barium peroxide and combustible, organic, or easily oxidized materials, such as wood, fuels, paper, and charcoal will burn or explode if rubbed or contact a small amount of water. Use large amounts of water to extinguish the fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See Spill Handling.

Reference

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Barium Peroxide*. Trenton, NJ

Barium sulfate B:0210

Molecular Formula: BaO_4S
Common Formula: $BaSO_4$
Synonyms: Actybaryte; Artificial brite; Artificial heavy spar; Bakontal; Baridol; Barite; Baritop; Barosperse; Barotrast; Baryta white; Barytes; Bayrites; Blanc fixe (French); C.I. 77120C.I.; Citobaryum; Colonatrast; Enamel white; Esophotrast; Eweisse-Z-paque; E-Z-paque; Finemeal; Lactobaryt; Liquibarine; Macropaque; Neobar; Oratrast; Permanent white; Pigment white 21; Polybar; Precipitated barium sulphate; Radiobaryt; Raybar; Redi-Flow; Solbar; Sulfato barico (Spanish); Sulfuric acid, barium salt (1:1); Supramike; Travad; Unibaryt
CAS Registry Number: 7727-43-7
RTECS® Number: CR0600000
UN/NA & ERG Number: UN1564/154
EC Number: 231-784-4
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as barium compounds, n.o.s., waste number not listed.
EPCRA Section 313: This does *not* cover barium sulfate (7727-43-7).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.
WGK (German Aquatic Hazard Class): Nonwater polluting agent.
Description: Barium sulfate is a white crystalline solid. Molecular weight = 233.40; Freezing/Melting point = 1580°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: Barium sulfate is used as an opaque medium in radiography; as a mud weighting material in oil well drilling; in paper coating; as a paint pigment.
Incompatibilities: Aluminum powder, phosphorus.
Permissible Exposure Limits in Air
OSHA PEL: 15 mg/m^3, total dust TWA; 5 mg/m^3, respirable fraction TWA.
NIOSH REL: 10 mg/m^3, total dust TWA; 5 mg/m^3, respirable fraction TWA.
ACGIH TLV®[1]: 10 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 350 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: 1.5 mg/m^3 respirable fraction (previously "fine dust"); 4 mg/m^3 inhalable fraction (previously "total dust"). Pregnancy Risk group C.
Australia: TWA 10 mg/m^3, 1993; Austria: MAK 0.5 mg(Ba)/m^3, 1999; Belgium: TWA 10 mg/m^3 (respirable dust), 1993; Denmark: TWA 0.5 mg(Ba)/m^3, 1999; Finland: TWA 0.5 mg (Ba)/m^3, 1999; Norway: TWA 0.5 mg(Ba)/m^3, 1999; Sweden: TWA 0.5 mg(Ba)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg(Ba)/m^3; MAC-TGG 1.5 mg/m^3 (respirable dust), 2003; MAC-TGG 4 mg/m^3 (total dust), 2003; United Kingdom: TWA (respirable dust) 4 mg(Ba)/m^3, 2000; United Kingdom: TWA 10 mg(Ba)/m^3 (total dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3.
Determination in Air: Barium sulfate may be determined by filtration and gravimetric measurement.
Permissible Concentration in Water: EPA allows 2 ppm for barium.
Routes of Entry: Inhalation of dust; ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Irritates eyes and respiratory tract. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.
Long Term Exposure: Lungs may be affected by repeated or prolonged exposure to dust particles, resulting in baritosis (a form of benign pneumoconiosis) (WHO). Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.
Points of Attack: Lungs, nervous system, heart.
Medical Surveillance: Consideration should be given to the skin, eyes, heart, and lung in any placement or periodic examination.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention immediately due to the possibility of barium poisoning. See also "First Aid" section in "Barium" entry.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *12.5 mg/m^3:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Barium sulfate requires a shipping label of "POISONOUS/TOXIC MATERIALS." Barium compounds, n.o.s. fall in Hazard Class 6.1 and Shipping Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 31

Bendiocarb B:0220

Molecular Formula: $C_{11}H_{13}NO_4$

Synonyms: AI3-27695; Bencarbate; Bendiocarbe; 1,3-Benzodioxole, 2,2-dimethyl-1,3-benzodioxol-4-ol methylcarbamate; 1,3-Benzodioxole, 2,2-dimethyl-4-(N-methylcarbamato)-; 1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methylcarbamate; Bicam ULV; Carbamic acid, methyl-, 2,3-(dimethylmethylenedioxy)phenyl ester; Carbamic acid, methyl-, 2,3-(isopropylidenedioxy)phenyl ester; 2,2-Dimethylbenzo-1,3-benzodioxol-4-yl *N*-methylcarbamate; 2,2-Dimethyl-1,3-benzodioxol-4-yl *N*-methylcarbamate; 2,2-Dimethylbenzo-1,3-dioxol-4-yl methylcarbamate; 2,2-Dimethyl-4-(N-methylaminocarboxylato)-; 2,2-Dimethyl-4-(N-methylaminocarboxylato)-1,3-benzodioxole; Dycarb; Ficam; Ficam 80W; Ficam D; Ficam ULV; Ficam W; Fuam; Garvox; Garvox 3G; 2,3-Isopropylidene-dioxyphenyl methylcarbamate; MC 6897; Methylcarbamic acid 2,3-(isopropylidenedioxy)phenyl ester; Multamat; Multimet; NC 6897; Niomil; OMS-1394; Rotate; Seedox; Seedox SC; Tattoo; Turcam

CAS Registry Number: 22781-23-3

RTECS$^®$ Number: FC1140000

UN/NA & ERG Number: UN2757/151

EC Number: 245-216-8 [*Annex I Index No.:* 006-046-00-8]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): U278.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] Reportable Quantity (RQ): 100 lb (45.4 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada: Drinking Water Quality Level Set.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R23/24/25; R50/55; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bendiocarb is a white odorless crystalline powder. Molecular weight = 223.3; Freezing/Melting point = 129−130°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this carbamate insecticide which is used against household pests, in agriculture in seed treatment, and as a foliar spray.

Incompatibilities: Keep away from flammable materials and sources of heat and flame.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: Canada's Drinking Water Quality is 0.04 mg/L MAC.

Determination in Water: Fish Tox = 379.47332000 ppb MATC (LOW).

Routes of Entry: Inhalation, skin, contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Bendiocarb is a toxic carbamate chemical. Bendiocarb can affect you when inhaled. Exposure can cause rapid poisoning, with headaches, sweating, nausea, and vomiting, diarrhea, loss of concentration, and death. Eye contact can cause irritation and blurred vision.

Long Term Exposure: Similar carbamates can affect the central nervous system. Human Tox: 35.00000 ppb Health Advisory (INTERMEDIATE).

Medical Surveillance: Before starting work, at regular times after that, and if symptoms develop or overexposure occurs, the following is recommended: Serum and RBC cholinesterase levels (a test for the body substance affected by bendiocarb). For this substance, these tests are accurate only if done within about 2 h of exposure and can return to normal before the person feels well.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Shampoo hair. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Bendiocarb. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. The *Farm Chemicals Handbook* recommends polyvinyl chloride or rubber as a protective material. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures to bendiocarb, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator for pesticides with a full face-piece operated in the positive-pressure mode, or with a full face-piece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Color Code—Green: General storage may be used. Prior to working with Bendiocarb you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from food, fertilizers, other pesticides, flammable materials, and sources of heat and flame.

Shipping: Carbamate pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group I, II, or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped.

OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 570.

Fire Extinguishing: Bendiocarb may burn but does not readily ignite. Use dry chemical, carbon dioxide, halon, water spray, or standard foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and methyl isocyanate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Dispose in accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers.

Reference

New Jersey Department of Health and Senior Services. (January 2004). *Hazardous Substances Fact Sheet: Bendiocarb*. Trenton, NJ

Benomyl B:0230

Molecular Formula: $C_{14}H_{18}N_4O_3$

Synonyms: Abortrine; Agrocite; Arilate; BBC; BBC6597; Benex; Benlat; Benlate®; Benlate® 40W; Benlate® 50W; Benlate® 50; Benomilo (Spanish); Benomyl 50W; 2-Benzimidazolecarbamic acid, 1-(butylcarbamoyl)-, methyl ester; BNM; 1-(Butylamino)carbonyl-1H-benzimidazol-2-yl-, methyl ester; 1-(Butylcarbamoyl)-2-benzimidazolecarbamic acid, methyl ester; 1-(N-Butylcarbamoyl)-2-(methoxy-carboxamido)-benzamidazol (German); 1-(N-Butylcarbamoyl)-2-(methoxy-carboxamido)-benzimidazol (German); Carbamic acid, 1-(butylamino)carbonyl-1H-benzimidazol-2yl, methyl ester; D1991; Dupont 1991; F1991; Fundazol; Fungacide D-1991; Fungicide 1991; Fungochrom; MBC; Methyl 1-(butylcarbamoyl)-2-benzimidazolyl carbamate; Tarsan®; Tersan® 1991; UZGN

CAS Registry Number: 17804-35-2

RTECS® Number: DD6475000

UN/NA & ERG Number: UN1325 (flammable solid, organic)/133

EC Number: 241-775-7[*Annex I Index No.:* 613-049-00-3]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *Aspergillus*—aneuploidy; TRP reversion; Negative: *Aspergillus*—recombination; Host-mediated assay; Negative: *S. cerevisiae* gene conversion; Inconclusive: TRP reversion.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U271.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] Reportable Quantity (RQ): 10 lb (4.54 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Developmental/Reproductive toxin (male) 7/1/91.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as dustable powder formulations containing a combination of: Benomyl at or >7%; carbofuran at or >10%; thiram at or >15%).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R46; R60; R61; R37/38; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Benomyl is a white crystalline solid with a faint acrid odor. Molecular weight = 290.36. Boiling point = decomposes without melting; Freezing/Melting point = ≥ 300°C (decomposes); Vapor pressure = 1×10^{-10} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 1.9 mg/L at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant. Benomyl is used as an agricultural chemical and pesticide, pharmaceutical, and veterinary drug.

Incompatibilities: Strong bases [forms toxic oxides of nitrogen], strong acids, peroxides, and oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 total dust, TWA; 5 mg/m^3 respirable fraction, TWA.

NIOSH REL: None established. See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: [skin] possible sensitization of skin; Germ Cell Mutagen Group: 3A (2005).

Australia: TWA 0.8 ppm (10 mg/m^3), 1993; Belgium: TWA 0.84 ppm (10 mg/m^3), 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 0.8 ppm (10 mg/m^3), STEL 2.4 ppm (30 mg/m^3), [skin], 1993; France: VME 0.8 ppm (10 mg/m^3), 1999; Switzerland: MAK-week 0.8 ppm (10 mg/m^3), 1999; United Kingdom: TWA 10 mg/m^3, STEL 15 mg/m^3, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Colombia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] has set a limit in ambient air of 0.35 mg/m^3 on a once-a-day basis and 0.05 mg/m^3 on an average daily basis. Several states have set guidelines or standards for benomyl in ambient air[60] ranging from 100 μg/m^3 (North Dakota and Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500, total dust, #0600 (respirable)].

Permissible Concentration in Water: Russia set a MAC of 0.5 mg/L in surface water of benomyl.[35]

Determination in Air: Fish Tox: 2.19089000 ppb MATC (HIGH).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Benomyl is generally felt to have a low order of acute and chronic toxicity.[53] However, a rebuttable presumption against registration for benomyl was issued on December 6, 1978 by US EPA on the basis of reduction in nontarget species, mutagenicity, teratogenicity, reproductive effects, and hazard to wildlife. The ADI for man is 0.02 mg/kg.[23]

Short Term Exposure: The substance irritates the skin, eyes, and upper respiratory system. Exposure could cause depression of the central nervous system and lack of muscular coordination.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Human mutation data reported. Also experimental and reproductive effect. May damage the male reproductive system; cause heritable genetic damage in humans. Animal tests show that this substance possibly causes birth defects in human babies, miscarriage, or cancer. Human Tox: 17.50000 ppb Health Advisory (INTERMEDIATE).

Points of Attack: Eyes, skin, respiratory system; reproductive system.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place or in a refrigerator[52] away from strong bases, strong acids, heat.

Shipping: FLAMMABLE SOLID, N.O.S., Hazard Class 4.1, Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust, then transfer material to a suitable container. Use absorbent paper dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal.[52] Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 1900.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Extinguish fires using an agent suitable for the type of surrounding fire; benomyl itself does not burn.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 20−21

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Benomyl*. Trenton, NJ

Bentazon B:0240

Molecular Formula: $C_{10}H_{12}N_2O_3S$

Synonyms: Asagio®; BAS351-H; Basagran®; Bendioxide; Bentazone; 1H-2,1,3-Benzothiadiazin-4(3H)-one, 3-(1-methylethyl)-, 2,2-dioxide; 3-Isopropyl-2,1,3-benzothiadiazinon-(4)-2,2-dioxid (German); 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one-2,2-dioxide; 3-(1-Methylethyl)-1H-2,1,3-benzothiazain-4(3H)-one-2,2-dioxide; Pledge®

CAS Registry Number: 25057-89-0; 50723-80-3 (sodium bentazon)

RTECS® Number: DK9900000

UN/NA & ERG Number: UN2588/151

EC Number: 246-585-8 [*Annex I Index No.*: 613-012-00-1]; 256-735-4 (sodium bentazon)

Regulatory Authority and Advisory Bodies

Safe Drinking Water Act, 55FR1470 Priority List.

European/International Regulations (*25057-89-0*): Hazard Symbol: Xn, N; Risk phrases: R22; R36; R43; R52/53; Safety phrases: S2; S24; S37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Bentazon is a colorless to white crystalline powder. Molecular weight = 240.3; Boiling point = 200°C (decomposes); Freezing/Melting point = 137−139°C; Vapor pressure = 10^{-3} at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Very slightly soluble in water; solubility = 490 mg/L at 20°C.

Potential Exposure: Those involved in the manufacture, formulation, or application of this selective postemergent herbicide.

Incompatibilities: Keep away from flammable materials, heat, and flame. Risk of fire and explosion if formulations contain flammable/explosive solvents.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: A no-observed adverse-effect-level (NOAEL) of 2.5 mg/kg/day has been determined by EPA based on the absence of prostatic effects in dogs. This led to the determination of a long-term health advisory of 0.875 mg/L for a 70-kg adult. It also led to the establishment of a lifetime health advisory of 0.0175 mg/L. In addition, California[61] has set a guideline in drinking water of 8.0 μg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.48$. Fish Tox (sodium bentazon): 40423.03894000 (VERY LOW).

Fish Tox Type: MATC

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 1100 mg/kg (slightly toxic). Avoid eye contact; may cause severe irritation or injury. May cause skin burns.

Long Term Exposure: May be a reproductive hazard. Human Tox (sodium bentazon): 200.00000 Health Advisory (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved [for pesticides] self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from flammable materials, sources of heat and fire.

Shipping: Pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (sodium bentazon) $K_{oc} = 34$.

Fire Extinguishing: Bentazon is not combustible but may support combustion under fire conditions. Risk of fire and explosion if formulations contain flammable/explosive solvents. Stay upwind of fire. Use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory: Bentazon*. Washington, DC: Office of Drinking Water

Bentonite B:0250

Molecular Formula: $Al_2H_2O_{12}Si_4$

Common Formula: $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$

Synonyms: Albagel premium USP 4444; Bentonite magma; Entonite 2073; Hi-Jel; Imvite I.G.B.A; Magbond; Montmorillonite; Panther Creek bentonite; Southern bentonite; Tixoton; Volclay; Volclay bentonite BC; Wilkinite

CAS Registry Number: 1302-78-9

RTECS® Number: CT9450000

EC Number: 215-108-5

Regulatory Authority and Advisory Bodies

NTP: Carcinogenesis studies; selected, October 2000.

FDA—proprietary drug.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bentonite is a light yellow, creamy, pale brown or gray to black powder or granules. These chemicals contain 1−24% crystalline silica (O_2Si). Specific gravity (H_2O:1) = 2.5. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used as Fuller's earth; as a mineral, natural or synthetic fiber; as an emulsifier for oils; as a base for plasters; in cosmetics, in polishes, and in abrasives; as a food additive; and others. Bentonites are aluminate silicate and can contain crystalline silica. The content varies widely from less than 1% to about 24%.[WHO]

Incompatibilities: Substance is a weak acid in water; avoid contact with strong alkaline material.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 30 mg/m^3

Inasmuch as this material can contain up to 24% crystalline silica, the OSHA PEL is listed for reference: crystalline silica (as respirable quartz): either 250 mppcf /%SiO_2 + 5 or 10 mg/m^3/[%SiO_2 + 2] TWA. Also under study by ACGIH.[1]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Dust may cause irritation to nose, throat, and lungs. Dust may cause eye irritation. The intravenous LD_{50} (inh, rat) = 35 mg/kg.[9]

Long Term Exposure: Repeated inhalation of dust can cause irritation and bronchial asthma. Bentonite contains crystalline silica and may cause silicosis.

Points of Attack: Lungs.
Medical Surveillance: Lung function tests.
First Aid: *Inhalation:* Move person to fresh air. Seek medical attention if necessary. *Skin:* Wash with water. *Eyes:* Wash with water as needed. Seek medical attention if necessary. *Ingestion:* Seek medical attention if necessary.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Wear dust mask.
Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area
Shipping: Bentonite is not cited in the DOT Performance-Oriented Packaging Standards.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen dry material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. Dispose with normal trash. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Not combustible. Use extinguishers suitable for surrounding fires. Poisonous gases are produced in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Landfill disposal.
Reference
New York State Department of Health. (March 1986). *Chemical Fact Sheet: Bentonite*. Albany, NY: Bureau of Toxic Substance Assessment

Benz[a]anthracene B:0260

Molecular Formula: $C_{18}H_{12}$
Synonyms: BA; B(a)A; BA.A13-50599; 1,2-Benzanthracene; Benzanthracene; 1,2-Benzanthrazen (German); 1,2-Benzanthrene; Benzanthrene; 1,2-Benz(a) anthracene; 1,2-Benzo(a)anthracene; Benzo(a)anthracene; Benzo(a)anthrene; 2,3-Benzophenanthrene; Benzo(b)phenanthrene; 2,3-Benzphenanthrene; Naphthaanthracene; NSC 30970; Tetraphene
CAS Registry Number: 56-55-3
RTECS® Number: CV9275000
UN/NA & ERG Number: UN2811/154
EC Number: 200-280-6 [*Annex I Index No.:* 601-033-00-9]
Regulatory Authority and Advisory Bodies
Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Possibly Carcinogenic, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.
US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—mouse prostate; Positive: Cell transform.—RLV F344 rat embryo; Host-mediated assay; Positive: Histidine reversion—Ames test; Positive: V79 cell culture—gene mutation; Negative: Cell transform.—BALB/c-3T3; *In vitro* UDS in rat liver; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *E. coli* polA without S9; *In vivo* SCE—nonhuman; Inconclusive: *D. melanogaster* sex-linked lethal; Inconclusive: *In vitro* UDS—human fibroblast.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Water Pollution Standard Proposed (EPA)[6] (Kansas).[61]
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants; Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total Toxic Organics, 40CFR423, Priority Pollutants; as polynuclear aromatic hydrocarbons (PAH).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US EPA Hazardous Waste Number (RCRA No.): U018.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).
California Proposition 65 Chemical.
EPCRA (Section 313): as (PACs); Form R *de minimis* concentration reporting level: 0.1%.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Benz(a)anthracene is a colorless plate-like material which is recrystallized from glacial acetic acid or a

light yellow to tan powder. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 228.30; Boiling point = 435°C (sublimates); Freezing/Melting point = 158−162°C; Vapor pressure = 4.9×10^{-9} mmHg at 20. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Benz(a)anthracene is a contaminant and does not have any reported commercial use or application although one producer did report the substance for the Toxic Substances Control Act Inventory. Benz(a)anthracene has been reported to be present in cigarette smoke condensate, automobile exhaust gas, soot, and the emissions from coal and gas works and electric plants. Benz(a)anthracene also occurs in the aromatic fraction of mineral oil, commercial solvents, waxes, petrolatum, creosote, coal tar, petroleum asphalt, and coal tar pitch. Microgram quantities of benz(a) anthracene can be found in various foods, such as charcoal broiled, barbecued, or smoked meats and fish, certain vegetables and vegetable oils, roasted coffee, and coffee powders. Human subjects are exposed to Benz(a)anthracene through either inhalation or ingestion. Workers at facilities with likely exposure to fumes from burning or heating of organic materials have a potential for exposure to benz(a) anthracene. Consumers can be exposed to this chemical through ingestion of various foods, with concentrations of 100 μg/kg in some instances. Cigarette smoke condensate has quantities of benz(a)anthracene that range from 0.03 to 4.6 μg/g. Benz(a)anthracene is found in the atmosphere at levels that vary with geography and climatology. These values can range from up to 136 μg/1000 m^3 in summer to 361 μg/1000 m^3 in winter. Drinking water samples may contain up to 0.023 μg/L benz(a)anthracene, and surface waters have been found to contain 0.004−0.185 μg/L. The soil near industrial centers has been shown to contain as much as 390 μg/kg of benz(a)anthracene, whereas soil near highways can have levels of up to 1500 μg/kg, and areas polluted with coal tar pitch can reach levels of 2500 mg/kg.

Incompatibilities: Oxidizing agents. Powder can form an explosive mixture with air.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines “coal tar pitch volatiles” in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; BEIp assigned *as Polycyclic Aromatic Compounds (PAHs).*

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)
TEEL-0: 006 mg/m^3
PAC-1: 0.02 mg/m^3
PAC-2: 0.15 mg/m^3
PAC-3: 15 mg/m^3

DFG MAK: [skin] Carcinogen Category 2; Pregnancy Risk Group 3A.

France: carcinogen, 1993; Norway: TWA 0.04 mg/m^3, 1999.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: Water quality criteria document for polynuclear aromatic hydrocarbons published in final 11/28/80. Total PAH addressed. A concentration of 2.8 mg (PAH)/L is estimated to limit cancer risk to one in a million (EPA). Kansas[61] has set a guideline in drinking water of 0.029 μg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 5.58−5.6. Bioaccumulation can take place in the food chain, especially seafood.

Determination in Water: Extraction with methylene chloride followed by gas chromatography/mass spectrometry (EPA Methods 625 and 1625) are summarized in the EPA Toxicological Profile cited below.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Benz(a)anthracene is absorbed by the oral and dermal routes of exposure; no direct evidence is available for absorption of B(a)A via the lungs. Following oral absorption, B(a)A is distributed to several tissues and accumulates preferentially in the adipose and mammary tissues. It is metabolized to conjugated derivatives and eliminated. It is expected that absorbed B(a)A will be excreted predominantly in the feces, as is true for other PAHs. B(a)A is metabolized to reactive derivatives that are thought to be responsible for its mutagenic activity in experimental systems. B(a)A is a weak experimental carcinogen by the dermal route of exposure. There is some evidence that it is carcinogenic by the oral route as well. Its carcinogenicity by the inhalation route has not been studied. Mutation is thought to be a necessary (although insufficient) step for the carcinogenic activity of B(a)A.

Short Term Exposure: No acute health effects known at this time.

Long Term Exposure: May be a carcinogen in humans. Has shown to cause bladder and skin cancer in animals. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (Category 1) in animal studies.

Points of Attack: Skin, respiratory system, bladder, liver, kidneys as PAH.

Medical Surveillance: Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace. Complete blood count, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests are recommended for coal tar pitch volatiles.[2]

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place away from oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Poisonous solids, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. In Packing Group II, The Hazard Class is 6.1.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atomize into incinerator with a flammable liquid.[22]

References

Agency for Toxic Substance and Disease Registry, US Public Health Service. (October 1987). *Toxicological Profile for Benz[a]Anthracene*. Atlanta, GA: ATSDR

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 1, 32−37

US EPA. (April 1975). *Identification of Organic Compounds in Effluents from Industrial Sources*, EPA-560/3-75-002

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Benz[a]anthracene*. Trenton, NJ

Benzal chloride B:0270

Molecular Formula: $C_7H_6Cl_2$

Common Formula: $C_6H_5CHCl_2$

Synonyms: Benzene, dichloro methyl-; Benzyl dichloride; Benzylene chloride; Benzylidene chloride; Chlorobenzal;

Chlorure de benzylidene (French); Cloruro de benzal (Spanish); (Dichloromethyl)benzene; α,α-Dichlorotoluene; Toluene, α,α-dichloro-

CAS Registry Number: 98-87-3

RTECS® Number: CZ5075000

UN/NA & ERG Number: UN1886 (benzylidene chloride)/156

EC Number: 202-709-2 [*Annex I Index No.:* 602-058-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999.

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; Histidine reversion—Ames test.

Banned or Severely Restricted (Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U017.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 6.0.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R22; R23; R37/38; R40; R41; Safety phrases: S1/2; S36/37; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzal chloride is a combustible, fuming, colorless, oily liquid; fumes on exposure to air. Faint, pungent odor. Molecular weight = 161.03; Specific gravity (H_2O:1) = 1.3; Boiling point = 205−207°C; Freezing/Melting point = −16°C; Specific gravity (H_2O:1) = 1.2557 at 14°C; Relative vapor density (air = 1) = 5.6; Latent heat of vaporization = 2.9×10^5 J/kg; Vapor pressure = 0.30 mmHg at 20°C; Flash point = 93°C; Autoignition temperature = 585°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Insoluble in water; biodegrades.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Benzal chloride is used almost exclusively for the manufacture of benzaldehyde. It can also be used to prepare cinnamic acid and benzoyl chloride.

Incompatibilities: Forms explosive mixture with air. Reacts with water, air, or heat, forming fumes of hydrochloric acid. Reacts (possibly violently) with acids, bases, strong oxidizers; many metals; potassium, sodium, aluminum. Attacks plastics and coatings.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 2.3 mg/m^3

PAC-3: 30 mg/m^3

DFG MAK: [skin] Carcinogen Category 2 *as benzyl dichloride*.

Note: DFG MAK: [skin] Carcinogen Category 1, Confirmed Human Carcinogen (α-chlorinated toluenes, mixtures of Benzoyl and various Benzyl chlorides).

Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data.

Austria: Carcinogen, 1999; Finland: carcinogen, 1993; Russia: STEL 0.5 mg/m^3, 1993; Sweden: carcinogen, 1999.

Permissible Concentration in Water: No criteria set. Benzal chloride hydrolyzes to benzaldehyde and HCl on contact with water.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.2$. Biodegrades in water.

Routes of Entry: Inhalation, ingestion, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Benzal chloride can affect the nervous system; and may be fatal if inhaled, swallowed, or absorbed through the skin. Benzal chloride is irritating to the skin and eyes, causing excessive tearing. Irritates the respiratory tract causing shortness of breath and cough. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Benzal chloride may cause skin cancer. This chemical was found to induce carcinomas, leukemia, and papillomas in mice. Benzal chloride was shown to possess a longer latency period than benzotrichloride before the onset of harmful effects. May affect the central nervous system.

Points of Attack: Central nervous system; skin.

Medical Surveillance: Lung function and nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, flammable materials, sources fire as this material is combustible. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Benzylidene chloride requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and in Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not breathe vapors. Wear eye protection and proper respiratory protection. Wear full protective clothing. Do not touch material. Stop leak if possible. Use water spray to reduce vapors. For *small spills*, take up with sand or other noncombustible material and place in containers for later disposal. For *small dry spills*, place material in clean dry container with shovel and move containers from spill area. For *large spills*, dike far ahead of spills for later disposal.

Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration at 816°C, 0.5 s minimum for primary combustion; 1204°C, 1.0 s for secondary combustion; elemental chlorine formation may be alleviated through injection of steam or methane into the combustion process.

References

US Environmental Protection Agency. (April 30, 1980). *Benzal Chloride: Health and Environmental Effects Profile No. 14*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzal Chloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Benzal Chloride*. Trenton, NJ

Benzaldehyde B:0280

Molecular Formula: C_7H_6O

Common Formula: C_6H_5CHO

Synonyms: Almond artificial essential oil; Artificial almond oil; Benzene carbaldehyde; Benzenecarbonal; Benzene carcaboxaldehyde; Benzenemethylal; Benzoic aldehyde; NCI-C56133; Oil of bitter almond; Phenylmethanal

CAS Registry Number: 100-52-7

RTECS® Number: CU4375000

UN/NA & ERG Number: UN1990/129

EC Number: 202-860-4 [*Annex I Index No.:* 605-012-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies (gavage); some evidence: mouse; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse; (gavage); no evidence: rat.

US EPA Gene-Tox Program, Positive: N crassa-reversion.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

TSCA 40CFR712.30.(e)1 (aldehydes).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; Safety phrases: S2; S24 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzaldehyde is a clear to yellowish liquid with an almond odor. The odor threshold is 0.042 ppm. Molecular weight = 106.13; Specific gravity (H_2O:1) = 1.1; Boiling point = 179°C; Freezing/Melting point = − 56°C; Flash point = 63°C (cc); Vapor pressure = 0.99 mmHg at 20°C; Autoignition temperature = 190°C. Explosive limits: LEL = 1.4%, UEL = 13.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Practically insoluble in water; solubility = 0.3 g/100 mL.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen, Human Data; Primary Irritant. In manufacture of perfumes, dyes, and cinnamic acid; as solvent; in flavors.

Incompatibilities: The substance reacts with air, forming explosive peroxides. Reacts violently with performic acid, oxidants, aluminum, iron, bases, and phenol, causing fire and explosion hazard. May self-ignite if absorbed in combustible material with large surface area or otherwise dispersed over large areas. Reacts with rust, amines, alkalies, strong bases, reducing agents.

Permissible Exposure Limits in Air

AIHA WEEL: 2 ppm TWA; 4 ppm STEL (15-min.), Potential for dermal sensitization.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 4 ppm

PAC-2: 4 ppm

PAC-3: 150 ppm

DFG MAK: [skin] May cause dermal sensitization.

Hungary: TWA 5 mg/m^3, STEL 10 mg/m^3, 1993; Poland: TWA 10 mg/m^3, STEL 40 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; United Kingdom: carcinogen, 2000.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.5.

Routes of Entry: Inhalation, ingestion and skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Anyone with a history of asthma must avoid all contact with this chemical. Absorbed through the skin, thereby increasing exposure. The substance irritates the eyes, skin, and the respiratory tract, causing coughing and shortness of breath. May cause asthma symptoms; this may take hours to develop; physical activity and/or alcohol consumption can aggravate the symptoms. May cause contact dermatitis. Acts as a narcotic in high concentrations; exposure can cause dizziness; and, at higher levels, unconsciousness. LD_{50} = (oral-rat) 1300 mg/kg.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization, rashes, and kidney damage. Causes mutations; may cause cancer or reproductive risks.

Points of Attack: Skin, central nervous system, kidneys.

Medical Surveillance: Examination by a qualified dermatologist and allergist. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers recommend polyvinyl alcohol gloves; styrene−butadiene rubber (SBR), butyl rubber; and polethylene coated materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store under nitrogen in an area away from steam or water, See also, Incompatibilities section. Keep away from strong acids and oxidizers.

Shipping: Benzaldehyde requires "CLASS 9" label. It falls in Hazard Class 9 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzaldehyde is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; add combustible solvent and spray into incinerator with afterburner.[22]

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report,* 1, No. 8, 36−38

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Benzaldehyde*. Trenton, NJ

Benzamide B:0290

Molecular Formula: C_7H_7NO

Common Formula: $C_6H_5CONH_2$

Synonyms: Benzamida (Spanish); Benzoic acid amide; Benzoylamide; Phenylcarboxyamide

CAS Registry Number: 55-21-0

RTECS® Number: CU8700000

EC Number: 200-227-7

Regulatory Authority and Advisory Bodies

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Benzamide is a combustible, colorless to beige, off-white, crystalline solid; Freezing/Melting point = 132−133°C. Molecular weight = 121.15; Specific gravity = 1.34; Boiling point = 288°C; Freezing/Melting point = 130°C; Vapor pressure = (estimate) 1.60×10^{-4} mmHg. Water solubility = 1.34 g in 100 mL; Flash point = 180°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water; solubility = 13 g/L.

Potential Exposure: Benzamide is used in organic synthesis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 350 mg/m^3

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.64. Fish Tox (benzamide) LC_{50} (fathead minnow, 96 h) = 661 mg/L.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, nose, and throat. May produce gastric pain, nausea, and vomiting.[52] The oral LD_{50} (mouse) = 1160 mg/kg (slightly toxic).

Long Term Exposure: Similar chemicals cause methemoglobinemia and liver damage, but it is not known if benzamide has these effects.

Medical Surveillance: Completed blood count (CBC), liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Green: General storage may be used. Store in a refrigerator or a cool, dry place.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60–70% ethanol to avoid dust and transfer to vapor-tight plastic bags for eventual disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: A combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Benzenamine, 3-(trifluoro-methyl)- B:0300

Molecular Formula: $C_7H_6F_3N$

Common Formula: $H_2NC_6H_4CF_3$

Synonyms: *m*-Aminobenzal fluoride; *m*-Aminobenzaltrifluoride; *m*-Aminobenzotrifluoride; 3-Aminobenzotrifluoride; 3-Amino-benzo-trifluoride; 1-Amino-3-(trifluoromethyl)benzene; Toluene, 3-amino-α,α,α-trifluoro-; *m*-(Trifluoromethyl)aniline; 3-(Trifluoromethyl)aniline; *m*-(Trifluoromethyl)benzenamine; 3-(Trifluoromethyl)benzenamine; α,α,α-Trifluoro-*m*-toluidine

CAS Registry Number: 98-16-8

RTECS® Number: XU9180000

UN/NA & ERG Number: UN2948 (3-trifluoromethylaniline)/153

EC Number: 202-643-4

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 pounds.

Reportable Quantity (RQ): 500 lb.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzenamine, 3-(trifluoromethyl)- is a combustible, colorless to yellow oily liquid with an amine-like odor. Molecular weight = 161.14; Boiling point = 187.5°C; Freezing/Melting point = 3°C; Flash point = 85°C.[52] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0.

Potential Exposure: This material is used as a chemical intermediate for herbicides, antihypertensives, and diuretics.

Incompatibilities: Strong oxidizers. Light and air sensitive.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

NIOSH IDLH: 250 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0,75 mg/m^3

PAC-1: 2.5 mg/m^3
PAC-2: 4.4 mg/m^3
PAC-3: 150 mg/m^3
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Permissible Concentration in Water: The former USSR-UNEP/IRPTC/IRPTC joint project[43] set a MAC of 0.02 mg/L in water used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause burns to skin and eyes. May be poisonous if inhaled, swallowed, or absorbed through the skin. LD_{50} = (oral-rat) 480 mg/kg; the oral LD_{50} mouse is 220 mg/kg.

Long Term Exposure: Repeated exposure to fluoride chemicals may cause stiffness in muscles or ligaments and even crippling. Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 mg/m^3 or higher. Mottling of the teeth may occur at this level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.
NIOSH: (*fluorides*) *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or*† *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Green: General storage may be used. Store in tightly closed, light-resistant containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: 3-Trifluoromethylaniline requires a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Wear positive-pressure breathing apparatus and special protective clothing. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzenamine, 3-Trifluoromethyl*. Washington, DC: Chemical Emergency Preparedness Program

Benzene B:0310

Molecular Formula: C_6H_6

Synonyms: (6) Annulene; Benceno (Spanish); Benzelene; Benzol; Benzole; Bicarburet of hydrogen; Carbon naphtha; Carbon oil; Coal naphtha; Coal naphtha, Phenyl hydride; Coal tar naphtha; Cyclohexatriene; Mineral naphtha; Motor benzol; NCI-C55276; Nitration benzene; Phene; Phenyl hydride; Pyrobenzol; Pyrobenzole

CAS Registry Number: 71-43-2

RTECS® Number: CY1400000

UN/NA & ERG Number: UN1114/130

EC Number: 200-753-7 [*Annex I Index No.:* 601-020-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1982; Animal Sufficient Evidence, 1982, *carcinogenic to humans*, Group 1, 1987 NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *In vitro* cytogenetics-human lymphocyte; Positive: *In vivo* cytogenetics-human lymphocyte; Positive: Mammalian micronucleus; Sperm morphology—mouse; Negative: Cell transform.—SA7/SHE; *In vitro* SCE—human lymphocytes; Negative: *In vitro* SCE—human.

Banned or Severely Restricted (several countries) (UN).[13]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1028); (CFR 29,1926.1128).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA)[6, 48] (former USSR-UNEP/IRPTC project)[43] (Several States)[61] (Canada) (Mexico).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). *Note:* Including benzene from gasoline.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U019.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 10.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47FR9352).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/27/87; Developmental/Reproductive toxin (male) 12/26/97.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); Priority Substance List (CEPA).

European/International Regulations: Hazard Symbol: F + , T; Risk phrases: R45; R46; R11; R36/38; R45/23/24/25; Safety phrases: S65; S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzene is a clear, volatile, colorless, highly flammable liquid with a pleasant, characteristic odor. Molecular weight = 78.12; Boiling point at 1 atm = 80.1°C; Melting/Freezing point = 5.5°C; Critical temperature = 288.9°C; Critical pressure = 710 psia; Specific gravity (H_2O:1) = 0.879 at 20°C; Liquid surface tension = 0.0289 N/m at 20°C; Liquid water interfacial tension = 0.035 N/m at 20°C; Relative vapor density (air = 1) = 2.7; Latent heat of vaporization = 3.94×10^5 J/kg; Heat of combustion = -406.0×10^5 J/kg; Vapor pressure = 75 mmHg at 20; Electrical conductivity = 3.8 pS/m; Flash point = −11°C; Autoignition temperature = 498°C. Explosive limits: LEL = 1.2%, UEL = 7.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. The odor threshold in air is 4.9 mg/m^3; the odor threshold in water is 2.0 mg/L. Very slightly soluble in water; solubility = 0.18 g/100 mL.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Benzene is used as a constituent in motor fuels; as a solvent for fats; inks, oils, paints, plastics, and rubber, in the extraction of oils from seeds and nuts; in photogravure printing. It is also used as a chemical intermediate. By alkylation, chlorination, nitration, and sulfonation, chemicals such as styrene, phenols, and malefic anhydride are produced. Benzene is also used in the manufacture of detergents, explosives, pharmaceuticals; in the manufacture of cyclohexane and ethylbenzene; and dyestuffs. Increased concern for benzene as a significant environmental pollutant arises from public exposure to the presence of benzene in gasoline and the increased content in gasoline due to requirements for unleaded fuels for automobiles equipped with catalytic exhaust converters.

Incompatibilities: Strong oxidizers, many fluorides and perchlorates, nitric acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.19 mg/m^3 at 25°C & 1 atm

OSHA PEL: 1 ppm TWA; 5 ppm STEL, cancer hazard. See Appendix F of the *NIOSH Pocket Guide*.

NIOSH REL: 0.1 ppm TWA; 1 ppm STEL, potential carcinogen. Limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.5 ppm TWA; 2.5 ppm [skin] STEL, Confirmed Human Carcinogen; BEI: 25 μg [*S*-Phenylmercapturic acid]/g creatinine in urine/end-of-shift; 500 μg[*t*,*t*-Muconic acid]/g creatinine in urine/end-of-shift.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **52** ppm

PAC-2: **800** ppm

PAC-3: **4000** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: 50 ppm

ERPG-2: 150 ppm

ERPG-3: 1000 ppm

DFG MAK: [skin], Carcinogen Category 1; Germ Cell Mutagen Group: 3A; TRK: 1 mL/m^3/3.3 mg/m^3; 5 μg [Benzene]/L in whole blood/end-of-shift; 0.045 mg[*S*-Phenylmercapturic acid]/g creatinine in urine/end-of-shift; 2 mg[*trans*,*trans*-Muconic acid]/L in urune/end-of-shift, Class 1, human carcinogen.

Australia: TWA 5 ppm (16 mg/m^3), carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 10 ppm (32 mg/m^3), carcinogen, 1993; Denmark: TWA 5 ppm (16 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (15 mg/m^3), STEL 10 ppm (30 mg/m^3), [skin], carcinogen, 1993; United Kingdom: TWA 3 ppm (9.6 mg/m^3), carcinogen, 2000; Hungary: STEL 5 mg/m^3, [skin], carcinogen, 1993; the Netherlands: MAC-TGG 3.25 mg/m^3, [skin], 2003; Japan: 10 ppm (32 mg/m^3), Group 1 carcinogen, 1999; Norway: TWA 1 ppm (3 mg/m^3), 1999; the Philippines: TWA 25 ppm (80 mg/m^3), [skin], 1993; Poland: MAC (time-weighted average) 10 mg/m^3; MAC (STEL) 40 mg/m^3, 1999; Russia: TWA 10 ppm (5 mg/m^3), STEL 25 ppm (15 mg/m^3), [skin], carcinogen, 1993; Sweden: NGV 0.5 ppm (1.5 mg/m^3), KTV 3 ppm (9 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-week 1 ppm (3.2 mg/m^3), [skin], carcinogen, 1999; Thailand: TWA 10 ppm (30 mg/m^3), STEL 25 ppm (75 mg/m^3), 1993; Turkey: TWA 20 ppm (64 mg/m^3), [skin], 1993; United Kingdom: LTEL 10 ppm (30 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2.5 ppm [skin]. Russia[43] set a MAC in ambient air in residential areas on a momentary basis and 0.8 mg/m^3 in residential air on a daily average basis. Several States have set guidelines or standards for benzene in ambient air[60] ranging from zero (North Dakota) to 0.12 μg/m^3 (North Carolina) to 0.14 μg/m^3 (Michigan) to 1.2 μg/m^3 (Massachusetts) to 72 μg/m^3 (Pennsylvania) to 100 μg/m^3 (New York and Rhode Island) to 150 μg/m^3 (Connecticut and South Carolina) to 300 μg/m^3 (Virginia).

The final OSHA benzene standard in 1910.1028 applies to all occupational exposures to benzene except some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sales of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing; and the percentage exclusion for liquid mixtures); *for the excepted subsegments, the benzene limits in Table Z-2 apply* (i.e., an 8-h TWA of 10 ppm, an acceptable ceiling of 25 ppm, and 50 ppm for a maximum duration of 10 min as an acceptable maximum peak above the acceptable ceiling).

Determination in Air: NIOSH Analytical Method #1500, Hydrocarbons, BP = 36−126°C, #1501, Hydrocarbons, aromatic; #3700, Benzene, by portable GC, #3800, OSHA Analytical Method 12.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5300 μg/L on an acute basis. *To protect saltwater aquatic life:* 5100 μg/L on an acute basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results from a concentration of 6.6 μg/L.[6] Several states have set standards and guidelines for benzene in drinking water.[61] The standards range from 1.0 μg/L (Florida and New Jersey) to 10.0 μg/L (New Mexico). A 10-day health advisory for benzene has been calculated[48] at 0.235 mg/L for a 10 kg child. A lifetime health advisory for humans cannot be calculated because of the carcinogenic potency of benzene. Russia[43] set a MAC of 0.5 mg/L of benzene in water bodies used for domestic purposes and the same limit in water used for fishery purposes. The WHO has recommended a limit of 10 μg/L of benzene in drinking water.[35] Canada's drinking water quality: MAC 0.005 mg/L. Mexico's drinking water ecological criteria is 0.01 mg/L.

Determination in Water: Gas chromatography (EPA Method 602) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 1.9-2.1$

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation of Benzene may produce both nerve and blood effects. Irritation of the nose, throat, and lungs may occur (3000 ppm may be tolerated for only 30−60 min). Lung congestion may occur. Nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness, and slurred speech. At high levels, slowed breathing and death may result. Death has occurred at 20,000 ppm for 5−10 min or 7500 ppm for 30 min. Skin contact: Irritation may occur, with redness and blistering if not promptly removed. Benzene is poorly absorbed. Whole body exposure for 30 min has been reported with no health effects. Eye contact may cause severe irritation. Ingestion may cause irritation of mouth, throat, and stomach. Symptoms are similar to those listed under inhalation. One tablespoon may cause collapse, bronchitis, pneumonia, and death. Use of alcoholic beverages enhances the harmful effect.

Long Term Exposure: Benzene is a known human carcinogen. Exposure has been linked to increased risk of several forms of leukemia. The liquid defats the skin. The substance may have effects on the blood forming organs, liver, and immune system. May cause loss of appetite, nausea, weight loss, fatigue, muscle weakness, headache, dizziness, nervousness, and irritability. Mild anemia has been reported from exposures of 25 ppm for several years and 100 ppm for 3 months. At levels between 100 and 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to liver and heart may occur. Temporary partial paralysis has been reported.

Points of Attack: Eyes, skin, respiratory system, blood, central nervous system, bone marrow. *Cancer site:* leukemia.

Medical Surveillance: OSHA mandates the following: complete blood count: leukocyte count, thrombocyte count, hematocrit, hemoglobin, erythrocyte count; pulmonary function tests. NIOSH lists the following tests: complete blood count including leukocyte count, thrombocyte count, hematocrit, hemoglobin, erythrocyte count; white blood cell count/differential; whole blood (chemical/metabolite)*; whole blood (chemical/metabolite), prior to next shift, expired air, expired air*, next shift, prior to next shift; urine (chemical/metabolite)*; urine (chemical/metabolite), during exposure, end-of-shift, end-of-work-week, pre- & postshift*; no time specified. Preplacement and periodic examinations should be concerned especially with effects on the blood and bone marrow and with a history of exposure to other myelotoxic agents or drugs or of other diseases of the blood. Preplacement laboratory exams should include (a) complete blood count (hematocrit, hemoglobin, mean corpuscular volume, white blood count, differential count, and platelet estimation); (b) reticulocyte count; (c) serum bilirubin; and (d) urinary phenol. The type and frequency of periodic hematologic studies should be related to the data obtained from biologic monitoring and industrial hygiene studies, as well as any symptoms or signs of hematologic effects. Recommendations for proposed examinations have been made in the criteria for a recommended standard. Examinations should also be concerned with other possible effects, such as those on the skin, central nervous system, and liver and kidney functions. Biologic monitoring should be provided to all workers subject to benzene exposure. It consists of sampling and analysis of urine for total phenol content. The objective of such monitoring is to be certain that no worker absorbs an unacceptable amount of benzene. Unacceptable absorption of benzene, posing a risk of benzene poisoning, is considered to occur at levels of 75 mg phenol per liter of urine (with urine specific gravity, corrected to 1.024), when determined by methods specified in the NIOSH "Criteria for Recommended Standard—Benzene." Alternative methods shown to be equivalent in accuracy and precision may also be useful. Biological monitoring should be done at quarterly intervals. If environmental sampling and analysis are equal to or exceed accepted safe limits, the urinary phenol analysis should be conducted every 2 weeks. This increased monitoring frequency should continue for at least 2 months after the high environmental level has been demonstrated. Two follow-up urines should be obtained within 1 week after receipt of the original results, one at the beginning and the other at the end of the work week. If original elevated findings are confirmed, immediate steps should be taken to reduce the worker's absorption of benzene by improvement in environment control, personal protection, personal hygiene, and administrative control.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; CPF3® suits; Responder™ suits; Trychem 1000™ suits; **4 h:** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots; Viton™ gloves, suits. Also, safety equipment suppliers/manufacturers can also provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Protect containers against physical damage. Storage preferred in an outdoor or detached building. If storage is indoor, use a standard flammable liquid storage room. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Benzene requires a shipping label of "FLAMMABLE LIQUID." Benzene falls in Hazard Class 3 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep benzene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is highly flammable. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Dilution with alcohol or acetone to minimize smoke is recommended.[22] Bacterial degradation is also possible.

References

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Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 38−41 (1981); 2, No. 4, 33−38 (1982); 3, No. 3, 53−59 (1983); 4, No. 1, 21−22 (1984); and 4, No. 6, 55 (1984)

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New York State Department of Health. *Chemical Fact Sheet: Benzene*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

Mehlman, M. A. (Ed.), *Carcinogenicity and Toxicity of Benzene*. Princeton, NJ: Princeton Scientific Publishers, (1983).

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Benzene*. Trenton, NJ

Benzenearsonic acid B:0320

Molecular Formula: $C_6H_7AsO_3$

Common Formula: $C_6H_5AsO(OH)_2$

Synonyms: Acido fenilarsonico (Spanish); Phenyl arsenic acid; Phenylarsonic acid

CAS Registry Number: 98-05-5

RTECS® Number: CY3150000

UN/NA & ERG Number: UN3465 (organoarsenic compounds, solid, n.o.s.)/151

EC Number: 202-631-9

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted.

Air Pollutant Standard Set.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high risk pollutants (Section 63.74) as arsenic compounds.

Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as arsenic and compounds.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): as an arsenic organic compound. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s. This compound is not specifically cited but falls in these categories since it is an arsenic compound. See entry on "Arsenic."

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzenearsonic acid is a colorless, crystalline powder. Molecular weight = 202.05; Specific gravity (H_2O:1) = 1.76; Freezing/Melting point = 160°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug. This material is used as an analytical reagent for tin.

Permissible Exposure Limits in Air

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA.

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

Protective Action Criteria (PAC)

TEEL-0: 1.35 mg/m^3

PAC-1: 4.05 mg/m^3

PAC-2: 6.74 mg/m^3

PAC-3: 40 mg/m^3

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

NIOSH IDLH: 5 mg[As]/m^3.

Arab Republic of Egypt: TWA 0.2 mg(As)/m^3, 1993; Australia: TWA 0.05 mg(As)/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg(As)/m^3, 1993; Finland: carcinogen, 1999; France: VME 0.2 mg(As)/m^3, 1993; Hungary STEL 0.5 mg (As)/m^3, carcinogen, 1993; India: TWA 0.2 mg(As)/m^3, 1993; the Philippines: TWA 0.5 mg(As)/m^3, 1993; Poland: MAC (time-weighted average) 0.3 mg(As)/m^3, 1993; Sweden: NGV 0.03 mg(As)/m^3, carcinogen, 1999; Switzerland: MAK-week 0.1 mg(As)/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; United Kingdom: LTEL 0.2 mg(As)/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen.

Determination in Air: Use NIOSH Analytical Method #5022, arsenic, organic compounds.

Permissible Concentration in Water: The EPA[61] has set a limit in drinking water of 0.05 μg/L.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of arsenic poisoning usually appear 30 min to 1 h after ingestion but may be delayed many hours. Symptoms include a sweetish metallic taste and garlicky odor; difficulty in swallowing; abdominal pain; vomiting and painful diarrhea; dehydration, thirst, and cramps; dizziness, stupor, delirium, rapid heartbeat; headache, skin disorders; and coma. Benzenearsonic acid is a deadly poison. The LD_{low} oral (rat) is 50 mg/kg; the oral LD_{50} mouse is 270 μg/kg.

Long Term Exposure: Chronic exposure to arsenic compounds can cause dermatitis and digestive disorders. Renal damage may develop.

Points of Attack: Skin, kidneys.

Medical Surveillance: Kidney function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH; however, where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Organoarsenic compounds, solid, n.o.s. and Arsenic compounds, solid, n.o.s., including organic compounds of arsenic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1.

Arsenic compounds, solid, n.o.s. (inorganic, including arsenates, n.o.s.; arsenites, n.o.s.; arsenic sulfides, n.o.s.; and organic compounds of arsenic, n.o.s.) require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material does not burn or burns with difficulty. Extinguish fire using agent suitable for surrounding fire. Use water in flooding quantities as fog. Avoid breathing dusts and fumes; keep upwind; wear self-contained breathing apparatus. Benzenearsonic acid emits poisonous fumes of arsenic when heated to decomposition.

If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzenearsonic Acid.* Washington, DC: Chemical Emergency Preparedness Program

Benzene, 1-(chloromethyl)-4-nitro- B:0330

Molecular Formula: $C_7H_6ClNO_2$

Common Formula: $ClCH_2C_6H_4NO_2$

Synonyms: Benzene, 1-(Chloromethyl)-4-nitro-; *p*-(Chloromethyl)nitrobenzene; 1-(Chloromethyl)-4-Nitrobenzene; 4-(Chloromethyl)nitrobenzene; α-Chloro-*p*-Nitrotoluene; *p*-Nitrobenzyl Chloride

CAS Registry Number: 100-14-1

RTECS® Number: XS9093000

UN/NA & ERG Number: UN1578 (Chloronitrobenzenes, *meta-* or *para-*, solid)/152

EC Number: 202-822-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (chloronitrobenzenes); Human Inadequate Evidence; Animals Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3.

Listed in the TSCA inventory.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Benzene, 1-(chloromethyl)-4-nitro- is a crystalline solid. Molecular weight = 171.58; Freezing/Melting point = 71°C. Slightly soluble in water; slow reaction.

Potential Exposure: Used in organic synthesis.

Incompatibilities: Can react with sulfuric acid.[52] Keep away from oxidizers, amines, bases: sodium hydroxide, potassium hydroxide; may cause fire and explosions. Corrodes steel.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 28 mg/m^3

PAC-3: 125 mg/m^3

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical is a lachrymator.[52] Poisonous if swallowed or dust is inhaled. Can cause headaches, vomiting, cyanosis, difficulty in breathing. May cause skin irritation and sensitization.

Long Term Exposure: Prolonged chronic exposure to nitro compounds of aromatic hydrocarbons may cause liver and kidney damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: Kidney and liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a refrigerator or in a cool, dry place and protect from prolonged exposure to moisture.[52]

Shipping: Chloronitrobenzenes, *meta-* or *para-*, solid require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group II.

A plus sign (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small liquid spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzene, 1-(Chloromethyl)-4-nitro*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Chloronitrobenzenes (mixed isomers)*. Trenton, NJ

Benzenesulfonyl chloride B:0340

Molecular Formula: $C_6H_5ClO_2S$

Common Formula: $C_6H_5SO_2Cl$

Synonyms: Benzene sulfochloride; Benzene sulfonechloride; Benzene sulfone-chloride; Benzenesulfonic (acid) chloride; Benzenesulfonic acid chloride; Benzenesulfonyl chloride; Benzenosulphochloride; BSC-refined D

CAS Registry Number: 98-09-9

RTECS® Number: DB8750000

UN/NA & ERG Number: UN2225/156

EC Number: 202-636-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U020.

RCRA Land Ban Waste Restrictions.

Reportable Quantity (RQ): 100 lb (45.4 kg).

TSCA 40CFR716.120(a).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Benzenesulfonyl chloride is a colorless oily liquid with a pungent odor. Molecular weight = 176.6; Specific gravity = 1.3842 at 15°C; Boiling point = 251−252°C (decomposes); Freezing/Melting point = 15°C; Vapor pressure = 1 mmHg at 20°C; Relative vapor density (air = 1) = 6.12; Flash point = 130°C; Autoignition point = 460°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Moderately soluble in water.

Potential Exposure: It is used as a chemical intermediate for benzenesulfonamides, thiophenol, glybuzole (hypoglycemic agent), *N*-2-chloroethylamides, benzonitrile; for its esters—useful as insecticides and miticides.

Incompatibilities: Violent reaction with strong oxidizers, dimethyl sulfoxide, and methyl formamide. It is very reactive with bases and many organic compounds. Incompatible with ammonia, aliphatic amines. Water contact forms hydrochloric and chlorosulfonic acids. Aqueous solutions of this chemical are strong acids that react violently with bases. Attacks metals in presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 200 mg/m^3

Permissible Concentration in Water: The former USSR-UNEP/PRPTC project[43] set a MAC of 0.5 mg/L in water used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause severe irritation and burns to skin and eyes. Breathing this chemical may cause liver damage. Symptoms may include allergic reactions and severe shock. Benzenesulfonyl chloride is poisonous; may be fatal if inhaled, swallowed, or absorbed through the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Reversible toxic damage to the liver is possible after dermal exposure. LD_{50} = (oral-rat) 1960 mg/kg.[9]

Long Term Exposure: May cause chronic irritation of the air passages and lungs, bronchitis with cough and phlegm. Repeated exposure may cause liver damage. Repeated skin contact may cause dry skin, redness, rash, and sores.

Points of Attack: Liver, lungs.

Medical Surveillance: Lung function tests, liver function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a "CORROSIVE" label.[19] It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not breathe vapors. Wear proper respiratory protection, eye protection, and full protective clothing. Do not touch spilled material; stop leak, use water spray to reduce vapors. *Small spills:* take up with sand or other non-combustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, or foam extinguishers. *Do not use water.* Poisonous gases are produced in fire, including hydrogen chloride and sulfur dioxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Benzene Sulfonyl Chloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Benzene Sulfonyl Chloride*. Trenton, NJ

Benzidine B:0350

Molecular Formula: $C_{12}H_{12}N_2$
Common Formula: $NH_2C_6H_4C_6H_4NH_2$
Synonyms: Bencidina (Spanish); *p,p*-Bianiline; 4,4′-Bianiline; (1,1′-Bifenyl)-4,4′-diamine; (1,1′-Biphenyl)-4,4′diamine; (1,1′-Biphenyl)-4,4′-diamine; 4,4′-Biphenyldiamine; Biphenyl, 4,4′-diamino-; 4,4′-Biphenylenediamine; C.I. 37225; C.I. azoic diazo; C.I. azoic diazo component 112; Component 112; *p,p*′-Diaminobiphenyl; 4,4′-Diamino-1,1′-biphenyl; 4,4′-Diaminobiphenyl; *p*-Diaminodiphenyl; 4,4′-Diaminodiphenyl; *p,p*′-Dianiline; 4,4′-Diphenylenediamine; Fast corinth base B; NCI-C03361
CAS Registry Number: 92-87-5
RTECS® Number: DC9625000
UN/NA & ERG Number: UN1885/153
EC Number: 202-199-1 [*Annex I Index No.:* 612-042-00-2]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Sufficient Evidence, 1982; Animal Sufficient Evidence, 1982*, carcinogenic to humans*, Group 1, 1987; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—mouse embryo; Positive: Cell transform.—RLV F344 rat embryo; Positive: Mammalian micronucleus; Histidine reversion—Ames test; Positive: *In vitro* UDS in rat liver; Negative: Sperm morphology—mouse; Inconclusive: *E. coli* polA without S9; *In vitro* UDS—human fibroblast; Positive: CHO gene mutation
Banned or Severely Restricted (many countries) (UN).[13, 35]
Very Toxic Substance (World Bank).[15]
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1010).
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U021.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 1 lb (0.45 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer (benzidine and its salts) 2/27/87; (benzidine-based dyes) 10/1/92.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Benzidine is a white, grayish-yellow crystalline solid or powder. Turns brownish-red on exposure to air and light; Molecular weight = 184.26; Freezing/Melting point = 128°C. Molecular weight = 184.2; Boiling point = 400°C; Freezing/Melting point = 128°C (anhydrous, rapid heat); 115−120°C (slow heat)[icsc]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.04% at 12°C.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. Benzidine is used primarily in the manufacture of azo dyestuffs; there are over 250 of these produced. Other uses, including some which may have been discontinued, are in the rubber industry as a hardener; in the manufacture of plastic films; for detection of occult blood in feces, urine, and body fluids; in the detection of H_2O_2 in milk; in the production of security paper; and as a laboratory reagent in determining HCN, sulfate, nicotine, and certain sugars. No substitute has been found for its use in dyes. Free benzidine is present in the benzidine-derived azo dyes. According to industry, quality control specifications require that the level not exceed 20 ppm and in practice the level is usually below 10 ppm. Regulations in the United States concerning this chemical define strict procedures to avoid worker contact: mixture containing 0.1% or more must be maintained in isolated or closed systems; employees must observe special personal hygiene rules, and certain procedures must be followed in case of emergencies. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.
Incompatibilities: Violent reaction with strong oxidizing materials. Contact with red fuming nitric acid may cause fire. Oxidizes in air.
Permissible Exposure Limits in Air
OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.
NIOSH IDLH: Not determined. Potential occupational carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 0.15 mg/m^3
PAC-1: 0.5 mg/m^3
PAC-2: 3.5 mg/m^3
PAC-3: 125 mg/m^3
Note: OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens

and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine (and dyes based on them) may present a cancer risk to workers and should be handled with caution and exposure minimized.

DFG MAK: [skin] Carcinogen Category 1. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Australia: (prohibited) [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Finland: carcinogen, 1999; France: VME 0.001 ppm (0.008 mg/m^3), carcinogen, 1999; Poland: MAC (time-weighted average) 0 mg/m^3; MAC (STEL) 0 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for benzidine in ambient air[60] ranging from zero (New York, North Dakota, South Carolina, Virginia) to 0.014 ng/m^3 (North Carolina) to 0.02 ng/m^3 (Rhode Island) to 30 μg/m^3 (30,000 ng/m^3) (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method #5509, Benzidine, #8306, in urine, OSHA Analytical Method ID-65.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 2500 μg/L on an acute basis; insufficient data to yield a value for saltwater aquatic life. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results from a concentration of 0.0012 μg/L.[6] Kansas has set a guideline in drinking water of 0.0015 μg/L.[61]

Determination in Water: High-performance liquid chromatography (EPA Method 605) or an oxidation/colorimetric method using Chloramine T (available from EPA) or a gas chromatography/mass spectrometric method (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 1.34$.

Routes of Entry: Inhalation, percutaneous absorption, and ingestion of dust.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. Corrosive to the skin and respiratory tract. Easily absorbed thought the skin. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ingestion: animal studies suggest 0.01−0.08% in food may cause a decrease in liver, kidney, and body weight; an increase in spleen weight; swelling of the liver, and blood in the urine.

Long Term Exposure: May cause skin allergy. Benzidine is a human carcinogen. Exposure may cause an increase in urination, blood in the urinary tract tumors. Can affect the blood and cause bladder tumors; liver and kidney damage.

Points of Attack: Skin, bladder, kidney, liver.

Medical Surveillance: OSHA mandates the following be investigated: reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; NIOSH lists the following tests: cystoscopy; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine); urinalysis (routine), cytology every 6 months, hematuria every month; urinalysis (routine) every month. Placement and periodic examinations should include an evaluation of exposure to other carcinogens; use of alcohol, smoking; medications; and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations. Urine cytology. Evaluation by a certified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Use gastric lavage if ingested followed by saline catharsis. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: These are designed to supplement engineering controls (such as a prohibition on open-vessel operation) and to prevent all skin or respiratory contact. Full body protective plastic clothing and butyl rubber gloves should also be used. On exit from a regulated area employees should shower and change into street clothes, leaving their protective clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Store in a dark, cool, well-ventilated area in closed, sealed containers. Keep out of sunlight and away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Benzidine requires a shipping label of "POISONOUS/TOXIC MATERIALS." Benzidine falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with a mixture of 9 parts sand to 1 part soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzidine may burn but does not readily ignite. Use dry chemical, carbon dioxide, or foam extinguishers. Use water spray in flooding quantities as fog. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.[22] Package spill residues and sorbent media in 17H epoxy-lined drums and move to an EPA-approved disposal site. Treatment may include destruction by potassium permanganate oxidation, high-temperature incineration, or microwave plasma methods. Encapsulation by organic polyester resin or silicate fixation. These disposal procedures should be confirmed with responsible environmental engineering and regulatory officials.

References

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US Public Health Service. (December 1988). *Toxicological Profile for Benzidine*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

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Benzo[b]fluoranthene B:0360

Molecular Formula: $C_{20}H_{12}$

Synonyms: B(b)F; 3,4-Benz[e]acephenanthrylene; Benz[e]acephenanthrylene; 2,3-Benzfluoranthene; 3,4-Benzfluoranthene; 2,3-Benzfluoranthrene; 3,4-Benzfluoranthrene; 2,3-Benzofluoranthene; 3,4-Benzofluoranthene; 4,5-Benzofluoranthene; Benzo[e]fluoranthene; NSC 89265

CAS Registry Number: 205-99-2

RTECS® Number: CU1400000

UN/NA & ERG Number: UN2811/154

EC Number: 205-911-9 [*Annex I Index No.:* 601-034-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1987.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Inconclusive: *In vivo* SCE—nonhuman.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollutant Standard Set (EPA) (Mexico).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater. *Note*: Difficult to distinguish from benzo(k) fluoranthene (mg/L), 0.11; Nonwastewater (mg/kg), 6.8.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): as polycyclic aromatic compounds (PAC): Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 7/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzo(b)fluoranthene is a colorless, needle-shaped solid. Molecular weight = 252.32; Boiling point = 480°C; Freezing/Melting point = 168°C; Vapor pressure = 5.0×10^{-7} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = <1 mg/mL at 19°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen. There is no commercial production of this compound. Benzo(b)fluoranthene is a chemical substance formed during the incomplete burning of fossil fuel, garbage, in cigarette smoke, or any organic matter and is found in smoke in general; it is carried into the air, where it condenses onto dust particles and is distributed into water and soil and on crops. B(b)F is a polycyclic aromatic hydrocarbon (PAH) and a component of coal tar pitch used in industry as a binder for electrodes. It is also a component of creosote, which is used to preserve wood. PAHs are also found in limited amounts in bituminous materials and asphalt used for paving, roofing, and insulation. B(b)F has some use as a research chemical. It is available from some specialty chemical firms in low quantities (25−100 mg).

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines “coal tar pitch volatiles” in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: Exposure by all routes should be carefully controlled to levels as low as possible; Suspected Human Carcinogen.

Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 20 mg/m^3

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Group 2.

Austria: carcinogen, 1999; France: carcinogen, 1993; Norway: TWA 0.04 mg/m^3, 1999.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: The Environmental Protection Agency (EPA) developed guidelines for permissible levels of carcinogenic PAHs in ambient water based on data from a carcinogenicity study on benzo(a)pyrene. EPA recommended that for the protection of human health from potential carcinogenic effects of exposure to PAHs through the ingestion of contaminated water, fish, and shellfish, the ambient water concentrations of total carcinogenic PAHs may not be possible to achieve because of naturally occurring levels in the environment; EPA consequently estimated ambient water concentrations of total carcinogenic PAHs at 28, 2.8, and 0.28 ng/L of water, corresponding to incremental lifetime cancer risk levels of one additional cancer case for every 100,000, 1 million, and 10 million people exposed, respectively, based on consumption of contaminated water, fish, and shellfish as an aid for developing water quality regulations (1 ng is one-billionth of a gram). Kansas has set a guideline for drinking water of 0.029 μg/L.

Determination in Water: The analytical methods required by EPA for the analysis of B(b)F in water are procedures 610 (HPLC/FS), 625 (GC/MS), and 1625 (GC/MS). These are the required test procedures under the Clean Water Act for municipal and industrial wastewater-discharging sites. GC/MS is also the method recommended by the EPA Contract Laboratory Program for analysis of B(b)F and other PAHs in water and soil. Octanol/water partition coefficient as Octanol−water coefficient: Log $K_{ow} = 6.1$.

Routes of Entry: Inhalation, passing through the skin. B(b)F enters the body primarily through breathing polluted air containing the compound or from inhaling tobacco smoke. Drinking contaminated water or accidentally swallowing soil or dust particles containing B(b)F can also result in B(b)F entering the body. Smoking or charcoal-broiling food can cause B(b)F to be formed. B(b)F can then enter the body through consumption of the contaminated food. Under normal conditions of environmental exposure, B(b)F does not usually enter the body through the skin; however, small amounts could enter the body if contact occurs with soil that contains high levels of B(b)F (e.g., near a hazardous waste site) or if contact occurs with heavy oils containing B(b)F.

Harmful Effects and Symptoms

B(b)F is a toxic chemical that causes cancer in laboratory animals when it is applied to their skin. B(b)F has not been studied adequately, and, consequently, it is not known whether it causes cancer if it is breathed or ingested or if it causes harmful effects other than cancer. Because B(b)F causes skin cancer in animals, it is possible that humans exposed in the same manner or by other routes could develop cancer as well.

Short Term Exposure: The substance can be absorbed into the body by inhalation of its aerosol skin absorption. Skin contact may cause irritation or skin allergy, which is greatly aggravated by sunlight on contaminated skin. Eye contact or "fume" exposure may cause irritation and a reaction greatly aggravated by sunlight during or shortly following exposure. Direct contact or "fumes" can cause irritation of the nose, throat, and bronchial tubes; skin irritation, redness, and possible swelling.

Long Term Exposure: Repeated skin contact may cause thickening, pigment changes, and skin growths, including warts, pimples, and skin cancer. B(b)F is a probable carcinogen in humans. May cause eye allergy. Repeated inhalation of fumes, especially with heating may cause chronic bronchitis with cough and phlegm.

Points of Attack: Skin, eyes.

Medical Surveillance: Periodic skin examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention.

Personal Protective Methods: Sun screen lotion or creams with a high ability to screen out ultraviolet light can help prevent skin allergic reactions. These may need frequent reapplication if the user is sweating. Ultraviolet-screening sunglasses can help with eye allergic reactions. Consult your doctor or pharmacist in selecting these. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: There is no commercial production of this compound. A reference material of certified high purity is available for research. If shipped, it may be categorized as poisonous solids, n.o.s. requiring a "POISONOUS/TOXIC MATERIALS" label.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Residues and sorbent media may be packaged in 17H epoxy-lined drums and disposed of at an EPA-approved site. Destroy by permanganate oxidation, high-temperature incineration with scrubbing equipment, or microwave plasma treatment, if available. Confirm disposal procedures with responsible environmental engineer and regulatory officials.

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Agency for Toxic Substance and Disease Registry, US Public Health Service. (November 1987). *Toxicological Profile for Benzo [b] fluoranthene*. Atlanta, GA: ATSDR

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 1, 37−39

Eller, P. M., & Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)*, (4th ed.), 2nd Supplement, DHHS (NIOSH), Publication No. 98−119. Cincinnati, OH: National Institute for Occupational Safety and Health

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Benzo[b]-fluororanthene*. Trenton, NJ

Benzoic acid B:0370

Molecular Formula: $C_7H_6O_2$

Common Formula: C_6H_5COOH

Synonyms: Acide benzoique (French); Acido benzoico (Spanish); Benzenecarboxylic acid; Benzeneformic acid; Benzenemethanoic acid; Benzoate; Benzoesaeure (German); Carboxybenzene; Carboxylbenzene; Dracyclic acid; Phenyl carboxylic acid; Phenylformic acid; Retarder BA; Retarder Bax; Salvo; Tennplas

CAS Registry Number: 65-85-0

RTECS® Number: DG0875000

UN/NA & ERG Number: UN3077/171

EC Number: 200-618-2

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

FDA—over-the-counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Benzoic acid is a white crystalline or flaky solid with a faint, pleasant odor. Molecular weight = 122.13; Boiling point = 249°C; Freezing/Melting point = 122.4°C (sublimes); Specific gravity = 1.27 at 28°C; Relative vapor density (air = 1) = 4.21; Vapor pressure = <0.076 mmHg at 20°C; Flash point = 121°C; Autoignition temperature = 570°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility 0.3% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Human Data; Primary Irritant. Benzoic acid is used in production of plasticizers, benzoyl chloride, sodium benzoate, and alkyl resins; in the manufacture of benzoates; in the manufacture of food preservatives; as a dye binder in calico printing; in curing of tobacco, flavors, perfumes, dentifrices; standard in analytical chemistry; antifungal agent.

Incompatibilities: Incompatible with strong oxidizers, caustics, ammonia, amines, isocyanates. Dust forms an explosive mixture with air.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 400 mg/m^3

Permissible Concentration in Water: Russia has proposed a MAC of 0.6 mg/L in surface water.[35]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.88.

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritating to skin, eyes (possibly severe), and mucous membranes. Skin contact may cause irritation, skin rash, or burning feeling on contact. Ingestion causes nausea and GI troubles. For most people, ingestion of 1/10−2/10 oz will have no effect although some sensitive people may experience allergic reactions. Larger amounts may cause stomach upset. Information from animal studies shows that about 6 oz may be lethal to a 150-lb person. LD_{50} (oral, rat) = 1700 mg/kg.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Mutation data reported.

Points of Attack: Skin, eyes, and mucous membranes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Cannister mask recommended.

Storage: Color Code—Green: General storage may be used. Store away from excessive heat. Benzoic acid must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Vapor may explode if ignited in an enclosed area. Solutions should be neutralized with soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Then flush the area with water. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzoic acid is a combustible solid. Benzoic acid may burn but does not readily ignite. High levels of dust may form an explosive concentration in air. Use dry chemical, CO_2, or water spray extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 38−40 (1981) and 3, No. 4, 37−40 (1983)

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Benzoic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Benzoic Acid*. Trenton, NJ

Benzonitrile B:0380

Molecular Formula: C_7H_5N

Common Formula: C_6H_5CN

Synonyms: Benzene, cyano-; Benzenenitrile; Benzoic acid nitrile; Benzonitrilo (Spanish); Cyanobenzene; Fenylkyanid; Phenyl cyanide

CAS Registry Number: 100-47-0

RTECS® Number: DI2450000

UN/NA & ERG Number: UN2224/152

EC Number: 202-855-7 [*Annex I Index No.:* 608-012-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 5000 lb (2270 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions, or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2; S23 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzonitrile is a colorless, oily liquid. It has an almond odor. Molecular weight = 103.13. Boiling point = 191°C; Freezing/Melting point = −13°C; Critical temperature = 426°C; Critical pressure = 611 psia; Specific gravity (H_2O:1) = 1.01 at 25°C; Relative vapor density (air = 1) = 3.6; Electrical conductivity = 2×10^6 pS/m; Ratio of specific heats of vapor (gas) = 1.091; Latent heat of vaporization = 3.67×10^5 J/kg; Heat of combustion = -351×10^5 J/kg. Explosive limits in air: Lower = 1.4%, Upper = 7.2%; Flash point = 71°C; Autoignition temperature = 550°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Poor solubility in water.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Benzonitrile is used as an electroplating agent; in organic synthesis of pharmaceuticals; dyestuffs; rubber chemicals; as a solvent and chemical intermediate.

Incompatibilities: Strong acids which can liberate hydrogen cyanide. Forms explosive mixture with air.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

Protection Action Criteria (PAC)*

TEEL-0: 1 ppm
PAC-1: 3 ppm
PAC-2: **22** ppm
PAC-3: **56** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Russia[43] set a MAC of 1.0 mg/m^3 in work-place air.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.6$.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Benzonitrile can affect you when breathed in by passing through your skin. Lower exposures can cause you to feel dizzy and lightheaded. Exposure to high levels, by breathing or skin contact, can cause trouble breathing, convulsions, coma, and death. Exposure may impede cellular or tissue respiration causing cyanosis and unconsciousness. Contact can irritate the eyes and skin. Prolonged contact can cause skin burns. The oral LD_{50} for cat and rabbit is 800 mg/kg.

Long Term Exposure: Repeated exposure may damage the liver and nervous system.

Points of Attack: Liver, nervous system.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention. If cyanide poisoning is suspected use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Butyl rubber and polyvinyl alcohol gloves have been tested and found to be resistant to permeation by benzonitrile. Wash thoroughly immediately after exposure to benzonitrile and at the end of the work shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of benzonitrile to potentially exposed workers. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area. Away from strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Benzonitrile requires a shipping label of "POISONOUS/TOXIC MATERIALS." Benzonitrile falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Before entering confined space where benzonitrile may be present, check to make sure that an explosive concentration does not exist. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzonitrile is a combustible liquid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Water may be ineffective in controlling fire. Poisonous gases are produced in fire, including nitrogen oxides and hydrogen cyanide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: (1) Mix with calcium hypochlorite and flush to sewer with water or (2) incinerate.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 40−42 (1981) and 3, No. 4, 40−42 (1983)

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Benzonitrile*. Trenton, NJ

Benzophenone B:0390

Molecular Formula: $C_{13}H_{10}O$

Common Formula: $C_6H_5COC_6H_5$

Synonyms: Benzofenona (Spanish); Benzoyl Benzene; Diphenyl Ketone; Diphenyl Methanone; α-Oxodiphenylmethane; alpha-Oxoditane; Phenyl Ketone

CAS Registry Number: 119-61-9

RTECS® Number: DI9950000

EC Number: 204-337-6

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *E. coli* polA without S9 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzophenone is a combustible, white, crystalline solid with a rose-like odor. Molecular weight = 182.23; Specific gravity (H_2O:1) = 1.085 at 50°C; Boiling point = 305°C; Freezing/Melting point = 48.5°C; Latent heat of vaporization = 2.93×10^5 J/kg; Heat of combustion = -358×10^5 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Benzophenone is used in UV curing of inks and coatings; as an intermediate; as an odor fixative in fragrances, flavoring, soaps; in the manufacture of pharmaceuticals and insecticides; in organic syntheses.

Incompatibilities: Oxidizing materials such as dichromates and permanganates.

Permissible Exposure Limits in Air

AIHA WEEL: 0.5 mg/m^3 TWA

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 350 mg/m^3

PAC-3: 500 mg/m^3

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.4$.

Routes of Entry: Inhalation, through the skin, and by ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact can cause irritation. Ingestion can cause nausea, vomiting, and stomach pain. Estimated lethal dose is 8 oz.

Medical Surveillance: See NIOSH Criteria Document: 78-173 *Ketones.*

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention.

Personal Protective Methods: Adequate ventilation; sinks, showers, and eyewash stations should be available. Goggles or face shields and rubber gloves should be worn if contact is likely.

Respirator Selection: Local exhaust or breathing protection.

Storage: Color Code—Green: General storage may be used. Store in a cool, well-ventilated area away from sources of ignition and incompatible materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Use dry chemical, alcohol foam, or CO_2.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Publication No. 78-173. Washington, DC

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Benzophenone*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 77−78

Benzo[a]pyrene B:0400

Molecular Formula: $C_{20}H_{12}$

Synonyms: B(a)P; BAP; Benzo(d,e,f)chrysene; Benzopireno (Spanish); 3,4-Benzopyrene; 6,7-Benzopyrene; Benzopyrene; 3,4-Benzpyren (German); 6,7-Benzpyren (German); 3,4-Benz(a)pyrene; 3,4-Benzypyrene; 3,4-BP; BP; NSC21914

CAS Registry Number: 50-32-8

RTECS® Number: DJ3675000

UN/NA & ERG Number: UN3077/171

EC Number: 200-028-5 [*Annex I Index No.:* 601-032-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; Carcinogenicity: EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; US EPA Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity—mouse/rat; Positive: Cell transform.—SA7/F344 rat; SHE—focus assay; Positive: Cell transform.—mouse embryo; Positive: Cell transform.—mouse prostate; Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; Host-mediated assay; Positive: L5178Y cells *In vitro*—TK test; Mammalian micronucleus; Positive: Mouse spot test; *E. coli* polA with S9; Positive: Histidine reversion—Ames test; Positive: *In vitro* SCE—human lymphocytes; *In vitro* SCE—human; Positive: Sperm morphology—mouse; *D. melanogaster* sex-linked lethal; Positive: *In vitro* UDS in rat liver; V79 cell culture—gene mutation; Positive/dose response: Cell transform.—BALB/c-3T3; SHE—clonal assay; Positive/dose response: Cell transform.—C3H/10T1/2; Positive/dose response: *In vitro* SCE—nonhuman; *In vivo* SCE—nonhuman; Negative: *D. melanogaster*—nondisjunction; Negative: Rodent heritable translocation; Mouse specific locus; Negative: UDS in mouse germ cells; *S. cerevisiae*—homozygosis; Inconclusive: *E. coli* polA without S9; *In vitro* UDS—human fibroblast; Positive: CHO gene mutation.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1001) as coal tar pitch volatiles.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Water Pollution Standard Set (EPA) (Canada).

Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total Toxic Organics, 40CFR423, Priority Pollutants, as polynuclear aromatic hydrocarbons (PAH).

US EPA Hazardous Waste Number (RCRA No.): U022.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.061; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Safe Drinking Water Act: MCL, 0.0002 mg/L; MCLG, zero.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): as polycyclic aromatic compounds (PAC), Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 7/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as Benzo(*a*)pyrene and coal tar pitch volatiles; Drinking water quality.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R46; R60; R61; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: B(a)P appears as yellowish needles,[2] crystals, or powder. Odorless. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 252.32; Freezing/Melting point = 179°C[2]; Boiling point = 311°C at 10 mmHg[2]; Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Benzo[a]pyrene (B[a]P) is a polycyclic aromatic hydrocarbon (PAH) that has no commercial-scale production. B(a)P is produced in the United States by one chemical company and distributed by several specialty chemical companies in quantities from 100 mg to 5 g for research purposes. Although not manufactured in great quantity, B(a)P is a by-product of combustion. It is estimated that 1.8 million pounds per year are released from stationary sources, with 96% coming from: (1) coal refuse piles, outcrops, and abandoned coal mines; (2) residential external combustion of bituminous coal; (3) coke manufacture; and (4) residential external combustion of anthracite coal. Human exposure to B(a)P can occur from its presence as a by-product of chemical production. The number of persons exposed is not known. Persons working at airports in tarring operations, refuse incinerator operations, power plants, and coke manufacturers may be exposed to higher B(a)P levels than the general population. Scientists involved in cancer research or in sampling toxic materials may also be occupationally exposed. The general population may be exposed to B(a)P from air pollution, cigarette smoke, and food sources. B(a)P has been detected in cigarette smoke at levels ranging from 0.2 to 12.2 μg per 100 cigarettes. B(a)P has been detected at low levels in foods ranging from 0.1 to 50 ppb.

Incompatibilities: Strong oxidizers, nitrogen dioxide, and ozone.

Permissible Exposure Limits in Air

Polynuclear aromatic hydrocarbons (PAH)

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens; See NIOSH Pocket Guide, Appendix C.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; Suspected Human Carcinogen; BEIp assigned *as Polycyclic Aromatic Compounds (PAHs).*

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 80 mg/m^3

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutagen Group 2.

Australia: carcinogen, 1993; Belgium: carcinogen, 1993; Finland: TWA 0.01 mg/m^3, [skin], carcinogen, 1999; France: carcinogen, 1993; Norway: TWA 0.04 mg/m^3, 1999; Poland: TWA 0.003 mg/m^3, 1999; Russia: STEL 0.00015 mg/m^3, carcinogen, 1993; Sweden: NGV 0.002 mg/m^3, KTV 0.02 mg/m^3, [skin], carcinogen, 1999; Switzerland: MAK-week 0.0002 ppm (0.002 mg/m^3), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Russia[43] set a MAC of 0.001 μg/m^3 in ambient residential air. In addition, several states have set guidelines or standards for benzo[a]pyrene in ambient air[60] ranging from zero (New York and Virginia) to 0.0007 μg/m^3 (Pennsylvania) to 0.10 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: Water quality criteria document for PAH published in final 11/2/80. Total PAH addressed. A concentration of PAH 2.8 ng/L (0.0028 μg/L) is estimated to limit a cancer risk to one in a million (EPA). Canada's MAC for drinking water quality is 0.00001 mg/L. Russia[43] set a MAC of 0.005 μg/L water used for domestic purposes. The WHO[35] has set a maximum limit of 0.2 μg/L in drinking water and a guideline level of 0.01 μg/L. Kansas has set a guideline of 0.03 μg/L in drinking water[60] and New Mexico a standard of 10.0 μg/L.

Determination in water: Octanol−water coefficient: Log $K_{ow} = 6.0$.

Routes of Entry: Inhalation skin absorption.

Harmful Effects and Symptoms

B(a)P has produced tumors in all of the nine species for which data are reported following different administrations including oral, skin, and intratracheal routes. It has both a local and a systemic carcinogenic effect. In subhuman primates, there is convincing evidence of the ability of B(a)P to produce local sarcomas following repeated subcutaneous injections and lung carcinomas following intratracheal instillation. It is also an initiator of skin carcinogenesis in mice, and it is carcinogenic in single-dose experiments and following prenatal exposure. In skin carcinogenesis studies in mice, B(a)P was consistently found to produce more tumors in a shorter period of time than did other polycyclic aromatic hydrocarbons (PAH), with the possible exception of DB(a,h)A. In a dose-response study involving subcutaneous injection in mice, the minimal dose at which carcinogenicity was detected was higher for B(a)P than for DB(a, h)A and for MC. However, the latent periods were shorter for B(a)P than for DB(a, h)A. In studies using intratracheal administration, B(a)P appeared to be less effective than 7H-dibenzo(c,g)carbazole in the hamster.[1] No epidemiological studies on the significance of B(a)P exposure to humans are available, and studies are insufficient to prove that B(a)P is carcinogenic for man. However, coal tar and other materials which are known to be carcinogenic to humans may contain B(a)P. The substance has also been detected in other environmental situations. A 1% solution applied to the skin caused skin irritation, swelling, flaking, coloration of skin, and formation of warts.

Short Term Exposure: B(a)P can cause exposure by inhalation and passing through the unbroken skin. Can cause skin irritation with rash and/or burning sensations. Exposure to sunlight can increase these effects. Eye contact can cause irritations and burns.

Long Term Exposure: B(a)P is a probable carcinogenic in humans. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (Category 1) in animal studies. May damage the developing fetus. May affect male reproductive glands and cause genetic damage. May be transferred to nursing infants through exposed mother's milk. Repeated exposure can cause skin changes, such as thickening, darkening, and pimples. Later skin changes include loss of color, reddish areas, thinning of the skin, and warts. Sunlight may cause rash to develop, and increased risk of skin cancer. Skin cancer is very often easily cured when detected early.

Points of Attack: Skin, respiratory system, bladder, liver, kidneys as PAH.

Medical Surveillance: Complete blood count, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles.[2]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Avoid exposure of (pregnant) women!* Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing chemicals (such as chlorates, perchlorates, permanganates, and nitrates). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Flammable, but generally found in such low quantities it is not considered a fire hazard. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including Carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a flammable solvent.[22]

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 1, 42−49

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Benzo[a]pyrene*. Albany, NY: Bureau of Toxic Substance Assessment

Agency for Toxic Substance and Disease Registry, US Public Health Service. (October 1987). *Toxicological Profile for Benzo[a]pyrene*. Atlanta, GA: ATSDR

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Benzo[a] pyrene*. Trenton, NJ

US EPA. (April 1975). *Identification of Organic Compounds in Effluents from Industrial Sources*, EPA-560/3-75-002

Eller, P. M., Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods* (NMAM®) (4th ed.). 2nd Supplement. DHHS (NIOSH) Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health

Benzotrichloride B:0410

Molecular Formula: $C_7H_5Cl_3$

Common Formula: $C_6H_5CCl_3$

Synonyms: Benzene, trichloromethyl-; Benzenyl chloride; Benzenyl trichloride; Benzotrichloride; Benzotricloruro (Spanish); Benzylidynechloride; Benzyl trichloride; Chlorure de benzenyle (French); Phenyl chloroform; Phenylchloroform; Phenyltrichloromethane; Toluene trichloride; Trichlormethylbenzol (German); 1-(Trichloromethyl)benzene; Trichloromethylbenzene; Trichlorophenylmethane; α,α,α-Trichlorotoluene; *O*,*O*,*O*-Trichlorotoluene; Trichlorotoluene

CAS Registry Number: 98-07-7

RTECS® Number: XT9275000

UN/NA & ERG Number: UN2226/156

EC Number: 202-634-5 [*Annex I Index No.*: 602-038-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Cancer Review Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; *B. subtilis* rec assay; Positive: Histidine reversion—Ames test.

Banned or Severely Restricted (Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U023.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24; R26/28; R43; R50/53; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzotrichloride is a combustible, colorless to yellow-brown, oily liquid that fumes on contact with air. It has a penetrating odor. Molecular weight = 195.47; Specific gravity (H_2O:1) = 1.38; Boiling point = 220°C; Freezing/Melting point = −4.8°C; Flash point = 127°C (cc); Autoignition temperature = 211°C. Explosive limits in air: LEL 2.1%; UEL 6.5% at 160°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slowly reacts in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Benzotrichloride is used as a chemical and dye intermediate; extensively used in the dye industry for the production of Malachite green, Rosamine, Quinoline red, and Alizarin yellow A. It can also be used to produce ethyl benzoate. Commercial grades may contain hydrochloric acid, benzylidene chloride, or benzyl chloride.

Incompatibilities: Benzotrichloride decomposes on heating, on contact with acids and/or water, producing toxic and corrosive hydrogen chloride and benzoic acid. Reacts violently with strong oxidizers, iron and other metals, alkali and earth alkali metals, bases and organic substances, and may cause fire and explosions. On contact with air it emits toxic and corrosive hydrogen chloride. Attacks many metals in the presence of water. Attacks many plastics.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.1 ppm/0.8 mg/m^3 TWA [skin]; Ceiling; Suspected Human Carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7 mg/m^3

PAC-3: 10 mg/m^3

DFG MAK: [skin] Carcinogen Category 2.

Austria: carcinogen, 1999; Finland: carcinogen, 1999; Russia: STEL 0.2 mg/m^3, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000. Several states have set guidelines or standards for benzotrichloride in ambient air ranging from zero in North Dakota to 0.0007 μg/m^3 in Rhode Island.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Permissible Concentration in Water: No criteria set. (Benzotrichloride decomposes in the presence of water to benzoic acid and hydrogen chloride.)

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.9$.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause irritation and chemical burns to the nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Based on animal study information, permanent injury or death may occur from exposure to 125 ppm for 4 h. Skin contact may cause irritation and chemical burns. Eye contact can cause severe irritation and chemical burns. Ingestion may cause severe irritation and chemical burns to the mouth, throat, and stomach. Additionally, it may be aspirated into the lungs with the risk of chemical pneumonitis. The damage may be permanent. LD_{50} = (oral-rat) 6 mg/kg.

Long Term Exposure: Benzotrichloride may affect the liver, kidneys, thyroid, central nervous system, and hematopoietic system, causing impaired functions and anemia. Probable carcinogen in humans.

Points of Attack: Lungs, liver, kidneys, thyroid glands, blood.

Medical Surveillance: Liver function tests; examination of the nervous system; thyroid function, complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzotrichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a dark, cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Benzotrichloride requires a shipping label of "CORROSIVE." This material falls in Hazard Class 8 and Packing Group II.[19, 20]

Spill Handling: Material is extremely hazardous to health but areas may be entered with extreme care. Full protective clothing including self-contained breathing apparatus should be provided. No skin surface should be exposed. Spilled material should not be touched. For *large spills* dike far ahead of spill for later disposal. Water should be used in copious amounts because of reaction with water and formation of toxic by-products. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may react violently with water. Fire may produce irritating and/or poisonous gases. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a

secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with flammable solvent added in incinerator with afterburner and alkaline scrubber.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzotrichloride*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (April 30, 1980). *Benzotrichloride: Health and Environmental Effects Profile No. 20.* Washington, DC: Office of Solid Waste

New York State Department of Health. (April 1997). *Chemical Fact Sheet: Benzotrichloride*. Albany, NY: Bureau of Toxic Substance Assessment

Benzoyl chloride B:0420

Molecular Formula: C_7H_5ClO

Common Formula: C_6H_5COCl

Synonyms: Benzaldehyde, α-chloro-; Benzenecarbonyl chloride; Benzoic acid, chloride; α-Chlorobenzaldehyde; Cloruro de benzoilo (Spanish)

CAS Registry Number: 98-88-4

RTECS® Number: DM6600000

UN/NA & ERG Number: UN1736/137

EC Number: 202-327-6 [*Annex I Index No.*: 607-012-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence; Animals Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1999.

US EPA Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R20/21/22; R34; R43; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Benzoyl chloride is a colorless to slight brown liquid with a strong, penetrating odor. Molecular weight = 140.57; Boiling point = 197.2°C at 760 mmHg; Freezing/Melting point = −1°C; Flash point = 72°C; Vapor pressure = 0.38 mmHg at 20°C; Autoignition temperature = 197°C. Explosive limits in air: Lower = 2.5%; Upper = 27%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩ (water reactive). Decomposes in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. Benzoyl chloride is used as a chemical intermediate; in organic synthesis; to produce other chemicals, dyes, perfumes, herbicides, and medicines.

Incompatibilities: Forms explosive mixture with air. Contact with heat, hot surfaces, and flames cause decomposition, forming phosgene and hydrogen chloride. Water contact may be violent; forms hydrochloric acid. Reactions with amines, alcohols, alkali metals, dimethyl sulfoxide, strong oxidizers, and metal salts may be violent, causing fire and explosions. Attacks metals in the presence of moisture, forming explosive hydrogen gas. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 ppm/0.8 mg/m^3 Ceiling Concentration; not classified as a human carcinogen.

AIHA WEEL: 5 ppm/7.2 mg/m^3, Ceiling Limit, (skin), Potential for dermal sensitization.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: **0.3** ppm

PAC-2: **5** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 3B.

Hungary: TWA 5 mg/m^3, STEL 10 mg/m^3, 1993; Russia: STEL 5 mg/m^3, 1993.

Determination in Air: By photometry.[11]

Permissible Concentration in Water: EPA has suggested a limit of 69 μg/L.[52]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive if ingested. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can cause chronic rash, warts, sore throat, and reduced sense of smell. Can cause bronchitis with cough and phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, and mucous membranes.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Use in a well-ventilated area. Showers, sinks, and eyewash stations should be readily available. Wear an apron, gauntlets, rubber gloves, boots, and any additional protective clothing to prevent skin contact. Wear safety goggles.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—White: (2) Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Store in a cool, dry, well-ventilated area preferably in a detached warehouse. Keep away from sources of ignition. Avoid physical damage to the container.

Shipping: Benzoyl chloride requires a shipping label of "CORROSIVE." The Hazard Class is 8 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water or wet method.* Absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers; or cover any spills with sodium bicarbonate. Remove the resulting mixture to a fiber container or plastic bag for disposal by incineration.[24] Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzoyl Chloride is a combustible liquid. *Do not use water.* Reacts violently with water or steam releasing heat, phosgene and hydrogen chloride fumes. Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour into sodium bicarbonate solution and flush to sewer.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 78−80

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Benzoyl Chloride.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Benzoyl Chloride*. Trenton, NJ

Benzoyl peroxide B:0430

Molecular Formula: $C_{14}H_{10}O_4$

Common Formula: $C_6H_5CO{-}O{-}O{-}COC_6H_5$

Synonyms: Abcure S-40-25; Acetoxyl; Acnegel; Aztec benzoyl peroxide 70; Aztec benzoyl peroxide 77; Aztec BPO; Aztec BPO-Dry; Benox L-40V; Benoxyl; Benzac; Benzaknew; Benzoic acid; Benzoic acid benzoperoxide; Benzoic acid peroxide; Benzoperoxide; Benzoylperoxid (German); Benzoyl superoxide; BPO-W40; BPZ-250; BZF-60; Cadet; Cadet BPO-70W; Cadox; Cadox 40E; Cadox benzoyl peroxide-W40; Cadox BTW-50; Clearasil acne treatment cream; Clearasil antibacterial acne lotion; Clearasil benzoyl peroxide lotion; Clearasil super strength; Cuticura acne cream; Debroxide; Dermoxyl; Dibenzoylperoxid (German); Dibenzoyl peroxide; Diphenylglyoxal peroxide; Eloxyl; Epiclear; Florox; Fostex; Garox; Incidol; Loroxide-HC lotion; Lucidol; Lucidol 75-FP; Lucidol-78; Lucidol GS; Lucipal; Luperco AFR-250; Luperco A; Luperco AA; Luperco AC; Luperco AFR; Lupercol; Luperox FL; Nericur Gel 5; Norox;

Novadelox; Oxy-10; Oxy-5 acne pimple medication; Oxylite; Oxy wash antibacterial skin wash; Pan oxyl; Panoxyl; Panoxyl aquagel; Panoxyl wash; Perlygel; Peroxide, dibenzoyl; Peroxido de benzoilo (Spanish); Peroxyde de benzoyle (French); Persadox; Persadox cream lotion; Persadox HP cream lotion; Persa-gel; Quinolor compound; Sulfoxyl lotion; the raderm; Topex; Vanoxide-HC lotion; Xerac

CAS Registry Number: 94-36-0

RTECS® Number: DM8575000; DM8576000 (≥30% <52% with inert solid); DM8576200 (>52% with inert solid); DM8577000 (≤72% as a paste); DM8578000 (≤77% with water); DM8579000 (>72% <95%); DM8579000 (>77% <95% with water)

UN/NA & ERG Number: UN3102 (organic peroxide type B, solid)/146

EC Number: 202-327-6 [*Annex I Index No.:* 617-008-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Gene-Tox Program, Inconclusive: *E. coli* polA without S9.

FDA—over-the-counter drug.

Banned or Severely Restricted (in consumer products) (Sweden).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb (3504 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, Xi; Risk phrases: R3; R7; R36; R43; Safety phrases: S2; S3/7; S14; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Benzoyl peroxide is an odorless, white or colorless crystalline powder. Molecular weight = 242.24; Boiling point = EXPLOSIVE DECOMPOSITION; Freezing/Melting point = 103–105°C (possible explosive decomposition heated); Flash point = 80°C; Vapor pressure = <1 mmHg at 20°C. Poor solubility in water; Autoignition temperature = 80°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 3 (Oxidizer). Poor solubility in water. Commercial formulations use carrier solvents that may alter the physical properties shown.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Used as polymerization initiator, curing agent, and cross-linking agent.

Incompatibilities: May explode when heated above melting point, 103°C. A strong oxidizer. Extremely explosion-sensitive to heat, shock, friction, and concussion. May explode or cause fire on contact with reducing agents, combustible substances, organic substances, wood, paper, metal powders, lithium aluminum hydride. Violent reaction with alcohols, organic and inorganic acids, and amines.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA, not classifiable as a human carcinogen.

NIOSH IDLH: 1500 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 5 mg/m^3, inhalable fraction TWA; Peak limitation Category I(1).

Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3 [skin] 1999; France: VME 5 mg/m^3, 1999; Hungary: TWA 5 mg/m^3; STEL 10 mg/m^3 [skin] 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000. Occupational Exposure Limit; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. In addition, four states have set guidelines or standards for benzoyl peroxide in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5009, Benzoyl peroxide.[18]

Determination in Water: Octanol–water coefficient: Log K_{ow} = 3.4–3.5.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes, skin, and respiratory tract. *Inhalation:* 1.3 mg/m^3 may cause nose and throat irritation. 12 mg/m^3 may cause lung irritation, asthmatic wheezing, decreased pulse rate and temperature, difficult breathing, and stupor. *Skin:* a 5% solution left on the skin for 12 h has caused redness, swelling, and burning. A 5% solution left on the skin for 48 h may cause severe irritation. Solutions greater than 20% left on for more than a few minutes caused severe irritation. *Eyes:* 2.6 mg/m^3 has caused irritation. *Ingestion:* there is little or no information available on human ingestion. However, results from animal studies suggest that the lethal dose for humans is about ¾ pound. LD$_{50}$ = (oral-rat) 7710 mg/kg.[9]

Long Term Exposure: May cause skin sensitization; allergic reaction may develop. May cause lung irritation and bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Skin, respiratory system, and eyes.

Medical Surveillance: Preplacement and periodic medical examinations should be conducted with particular attention to skin conditions. Lung function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Protective clothing and safety glasses with side shields or safety goggles should be worn by employees to reduce the possibility of skin contact and eye irritation. Such protection is especially important where benzoyl peroxide and other powder or granular benzoyl formulations may become airborne or where liquid or paste formulations of benzoyl peroxide might be spattered or spilled. Protective clothing should be fire resistant. Any fabric that generates static electricity is not recommended. To prevent the buildup of static electricity, appropriate conductive footwear should be worn. Gloves made of rubber, leather, or other appropriate material should be worn by employees. Aprons made of rubber or other appropriate material is recommended for added protection when handling benzoyl peroxide and its formulations. Plastic aprons that may generate static electricity should not be used. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily if it may be contaminated. Remove nonimpervious clothing promptly if contaminated.

Respirator Selection: Respiratory protection as follows must be used whenever airborne concentrations of benzoyl peroxide cannot be controlled to the recommended workplace environmental limit by either engineering or administrative controls. NIOSH: *50 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *125 mg/m^3*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1500 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Protect containers against physical damage. Isolate in well-detached, fire-resistive, cool and well-ventilated building with no other materials stored therein; provide explosion venting in a safe direction and prohibit any electrical installation or heating facilities. Dibenzoyl peroxide should be stored in and used from original containers. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Benzoyl peroxide requires an "ORGANIC PEROXIDE" label. Benzoyl peroxide falls in Hazard Class 5.2 and Packing Group II. IATA UN9999 Proper Shipping Name: FORBIDDEN MATERIALS.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Mix spilled material with water-wetted vermiculite, and deposit in sealed containers. Do not use spark-generating materials or materials made of paper or wood for sweeping or handling spilled benzoyl peroxide*. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. At high temperatures it may explode. Poisonous gases are produced in fire. Use water only. Do not use chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Clean up and salvage operations after a fire should not be attempted until all of the peroxide has cooled completely.

Disposal Method Suggested: Pretreatment involves decomposition with sodium hydroxide. The final solution of sodium benzoate, which is very biodegradable, may be flushed into the drain. Disposal of large quantities of solution may require pH adjustment before release into the sewer or controlled incineration after mixing with a noncombustible material.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Benzoyl Peroxide*, NIOSH Document No. 77-166. Washington, DC

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 80−82

New York State Department of Health. (July 1998). *Chemical Fact Sheet: Benzoyl Peroxide.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Benzoyl Peroxide.* Trenton, NJ

Benzyl bromide B:0440

Molecular Formula: C_7H_7Br

Common Formula: $C_6H_5CH_2Br$

Synonyms: (Bromomethyl)benzene; *p*-(Bromomethyl)nitrobenzene; Bromophenylmethane; α-Bromotoluene; ω-Bromotoluene; Bromuro de bencilo (Spanish); Toluene, α-bromo-

CAS Registry Number: 100-39-0

RTECS® Number: XS7965000

UN/NA & ERG Number: UN1737/156

EC Number: 202-847-3 [*Annex I Index No.:* 602-057-00-2]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S2; S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzyl bromide is a combustible, colorless to yellow liquid with a pleasant odor. Molecular weight = 171.05; Specific gravity (H_2O:1) = 1.438; Boiling point = 198°C; Freezing/Melting point = −4.0°C; Flash point = 79°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Insoluble in water (slowly decomposes).

Potential Exposure: Compound Description: Mutagen. It is used as a chemical intermediate; in organic syntheses; as a foaming and frothing agent.

Incompatibilities: Forms explosive mixture with air. Contact with water forms hydrogen bromide and benzyl alcohol. Incompatible with strong oxidizers, bases, magnesium. Attacks metals, except nickel and lead, in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 60 mg/m^3

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.9.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory system. Eye contact can cause severe irritation and burns. Skin contact can cause severe irritation, redness, swelling, and sores. High levels can cause dizziness because it attacks the nervous system.

Long Term Exposure: Mutation data reported. Repeated skin contact can cause chronic irritation with dry skin, redness, rash, and sores. Similar very irritating substances can cause lung damage.

Points of Attack: Skin, lungs.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Store in tightly closed containers in a cool, well-ventilated area away from water and other incompatible materials listed above.

Shipping: Benzyl Bromide requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." Benzyl bromide falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid on vermiculite, dry sand, earth, or similar noncombustible material. Collect material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including bromine gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour into vermiculite, sodium bicarbonate, or a sand-soda ash mixture and transfer to paper boxes, then to an open incinerator. Alternatively, mix with flammable solvent and spray into incinerator equipped with afterburner and alkali scrubber.

References

New Jersey Department of Health and Senior Services. (February 1987). *Hazardous Substances Fact Sheet: Benzyl Bromide.* Trenton, NJ

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 66−68

Benzyl chloride B:0450

Molecular Formula: C_7H_4Cl

Common Formula: $C_6H_2CH_2Cl$

Synonyms: Benzene, (chloromethyl)-; Benzylchlorid (German); Benzyle (chlorure de) (French); Chloromethylbenzene; Chlorophenylmethane; α-Chlorotoluene; ω-Chlorotoluene; α-Chlortoluol (German); Chlorure de benzyle (French); Cloruro de bencilo (Spanish); NCI-C06360; Tolyl chloride

CAS Registry Number: 100-44-7

RTECS® Number: XS8925000

UN/NA & ERG Number: UN1738/156

EC Number: 202-853-6 [*Annex I Index No.:* 602-037-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; inadequate evidence, rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; *B. subtilis* rec assay; Positive: *E. coli* polA without S9; *E. coli* polA with S9; Positive: Histidine reversion—Ames test; Positive: *In vitro* UDS—human fibroblast; *S. cerevisiae*—homozygosis; Positive/limited: Carcinogenicity—mouse/rat; Negative: Host-mediated assay; Inconclusive: CHO gene mutation.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P028.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; R23; R37/38; R41; R48/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Benzyl chloride is a colorless to slight yellow liquid with a strong, unpleasant, irritating odor. The odor threshold is 0.05 ppm.[41] Molecular weight = 126.6; Specific gravity (H_2O:1) = 1.10; Boiling point = 179.4°C; Freezing/Melting point = − 43°C; Vapor pressure = 1 mmHg at 20°C; Flash point = 67°C (cc); Autoignition temperature = 585°C. Flammable Limits in Air: LEL = 1.1%; UEL = 14.0%.[52] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Practically insoluble in water; solubility = 0.05%.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Used as an intermediate and as an irritant gas in chemical warfare. In contrast to phenyl halides, benzyl halides are very reactive. Benzyl chloride is used in the production of benzal chloride, benzyl alcohol, and benzaldehyde. Industrial usage includes the manufacture of plastics, dyes, synthetic tannins, perfumes, and resins. It is used in the manufacture of many pharmaceuticals. Suggested uses of benzyl chloride include the vulcanization of fluororubbers and the benzylation of phenol and its derivatives for the production of possible disinfectants.

Incompatibilities: Forms explosive mixture with air. Contact with water forms hydrogen chloride fumes. Strong oxidizers may cause fire and explosions. Unstabilized benzyl chloride undergoes polymerization with copper, aluminum, iron, zinc, magnesium, tin, and other common metals, except lead and nickel, with the liberation of heat and hydrogen chloride gas. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks some plastics and rubber. Decomposition and polymerization reactions are inhibited, to a limited extent, by addition of triethylamine, propylene oxide, or sodium carbonate.[17]

Permissible Exposure Limits in Air

OSHA PEL: 1 ppm/5 mg/m^3 TWA.

NIOSH REL: 1 ppm/5 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/5.2 mg/m^3 TWA; Confirmed Carcinogen with unknown relevance to humans.

NIOSH IDLH: 10 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 1 ppm

PAC-2: 10 ppm

PAC-3: 50 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 1 ppm (5 mg/m^3), 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (5.2 mg/m^3), 1993; Denmark: TWA 1 ppm (5 mg/m^3), 1999; Finland: TWA 1 ppm (5 mg/m^3); STEL 3 ppm (15 mg/m^3), 1999; France: VME 1 ppm (5 mg/m^3), VLE 2 ppm (11 mg/m^3); STEL 3 ppm (15 mg/m^3), carcinogen, 1993; Hungary: STEL 0.5 mg/m^3 [skin] 1993; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Philippines: TWA 1 ppm (5 mg/m^3), 1993; Poland: 3 mg/m^3, ceiling 5 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, 1993; Sweden: NGV 1 ppm (5 mg/m^3), KTV 2 ppm (11 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 1 ppm (5 mg/m^3), carcinogen, 1999; Turkey: TWA 1 ppm (5 mg/m^3), 1993; United Kingdom: TWA 0.5 ppm (2.6 mg/m^3); STEL 1.5 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several States have set guidelines or standards for benzyl chloride in ambient air[60] ranging from 0.01 μg/m^3 (Rhode Island) to 0.7 μg/m^3 (Massachusetts) to 16.7 μg/m^3 (New York) to 20.0 μg/m^3 (Rhode Island) to 25 μg/m^3 (South Carolina) to 50 μg/m^3 (North Dakota) to 85 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada) to 500 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Methods 1003, Hydrocarbons, halogenated.[18]

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of 69 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.3$.

Routes of Entry: Inhalation of vapor, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation exposure may result in severe irritation of upper respiratory tract with coughing, burning of the throat, headache, dizziness, and weakness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Eye contact may result in immediate and severe eye irritation and prolonged exposure may cause permanent eye damage. Ingestion may cause severe burns of the mouth, throat, and gastrointestinal tract resulting in nausea, vomiting, cramps, and diarrhea. It is intensely irritating to skin, eyes, and mucous membranes. Highly toxic; may cause death or permanent injury after very short exposure to small quantities. Large doses cause central nervous system depression, with possible unconsciousness.

Long Term Exposure: Causes thyroid cancer in animals. Has been listed as a direct-acting or primary carcinogen. May damage the developing fetus. May cause liver damage and affect the nervous system.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: NIOSH recommends pulmonary function tests; chest X-ray; Expired air test. Preplacement and periodic examinations should include the skin, eyes, and an evaluation of the liver, kidney, respiratory tract, blood, and nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$)*:* 4H™ and Silver Shield™ gloves, CPF3® suits; Responder™ suits; Trychem 1000™ suits; **4 h:** (At least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 ppm:* CcrOvAg* (APF = 10) [any chemical cartridge respirator with organic vapor and acid gas cartridge(s)] or GmFOvAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor or acid gas canister] or PaprOvAg* (APF = 25) [any powered, air-purifying respirator with organic vapor and acid gas cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor or acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. This material should be stored in tightly closed containers in a cool, well-ventilated area away from sunlight, heat, moisture, active metals, oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Benzyl chloride requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." The Hazard Class is 6.1 and the packing Group is II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. If leak or spill has not ignited, use water spray to disperse vapors and to provide protection for persons attempting to stop leak. Use water spray to flush spills away from exposures. Take up small spills with sand or other noncombustible absorbent material and place into containers for later disposal. For larges spills, dike for later disposal. Always wear positive pressure breathing apparatus and special protective clothing. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzyl chloride is a combustible liquid. Use dry chemical, carbon dioxide, or foam extinguishers. *Do not use water.* Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration at 816°C for 0.5 s minimum for primary combustion and 1204°C for 12.0 s for secondary combustion. Elemental chlorine formation may be alleviated by injection of steam or methane into the combustion process.[24]

References

US Environmental Protection Agency. (December 9, 1977). *Chemical Hazard Information Profile: Benzyl Chloride.* Washington, DC

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards, Benzyl Chloride*, Report PB 276,678. Rockville, MD, pp. 2−7

US Environmental Protection Agency. (April 30, 1980). *Benzyl Chloride: Health and Environmental Effects Profile No. 21*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 9−11

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzyl Chloride.* Washington, DC: Chemical Emergency Preparedness Program

NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. (1981−1995). DHHS (NIOSH) Publication No. 81−123; 88−118; Suppls. I–IV. Cincinnati, OH.

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Benzyl Chloride.* Trenton, NJ

Benzyl cyanide B:0460

Molecular Formula: C_8H_4N

Common Formula: $C_6H_2CH_2CN$

Synonyms: Benzeneacetonitrile; Benzylkyanid; Benzylnitrile; Cianuro de bencilo (Spanish); (Cyanomethyl) benzene; α-Cyanotoluene; 2-Phenylacetonitrile; Phenylacetonitrile; Phenyl acetyl nirtile; α-Tolunitrile

CAS Registry Number: 140-29-4 [phenylacetonitrile, liquid]

RTECS® Number: AM1400000

UN/NA & ERG Number: UN2470/152

EC Number: 205-410-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Benzyl cyanide is a colorless, oily liquid with an aromatic odor. Molecular weight = 117.2; Boiling point = 233.5°C; Freezing/Melting point = −24; Vapor pressure = low < 0.40 at 20°C; Flash point = 113°C (oc),[17] also cited as 101°C.[52] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description (as CN): Organometallic, Mutagen; Reproductive Effector; Human Data. Benzyl cyanide is used in organic synthesis, especially of penicillin precursors. It is used as a chemical intermediate for amphetamines, phenobarbital; the stimulant, methyl phenidylacetate; esters as perfumes and flavors.

Incompatibilities: Violent reaction with strong oxidizers, sodium hypochlorite, lithium aluminum hydride.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

NIOSH IDLH: 25 mg[CN]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 4.3 mg/m^3

PAC-3: 30 mg/m^3

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling

Concentration 5 mg/m^3 [skin]. Russia[43] set a MAC of 0.8 mg/m^3 in work-place air.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.58.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous. May be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. LD_{50} = (oral-rat) 270 mg/kg.[9]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. For cyanide poisoning, use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH/OSHA (as cyanides): *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials listed above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Phenylacetonitrile requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. When heated to decomposition, it emits very toxic fumes of cyanide and nitrogen oxides. Container may explode in heat of fire. Runoff from fire control water may give off poisonous gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Benzyl Cyanide*. Washington, DC: Chemical Emergency Preparedness Program

Beryllium and compounds B:0470

Molecular Formula: Be

Synonyms: Berilio (Spanish); Beryllium-9; Beryllium dust; Beryllium metal powder; Glucinium; Glucinum

CAS Registry Number: 7440-41-7 (metal)

Other compounds as [Be]: 12770-50-2 (Beryllium-aluminium alloy); 11133-98-5 (Beryllium-copper alloy); 1302-52-9 (Beryl); 7787-47-5 (Beryllium chloride); 7787-49-7 (Beryllium fluoride); 13327-32-7 (Beryllium hydroxide); 13510-49-1(Beryllium sulfate); 7787-56-6 (Beryllium sulfate tetrahydrate); 1304-56-9; (Beryllium oxide); 1319-43-3 (Beryllium carbonate basic); 13597-99-4 (Beryllium nitrate); 7787-55-5 (Beryllium nitrate trihydrate); 13510-48-0 (Beryllium nitrate tetrahydrate); 13598-15-7 (Beryllium phosphate); 13598-00-0 (Beryllium silicate); 39413-47-3 (Zinc beryllium silicate)

RTECS® Number: DS1750000

UN/NA & ERG Number: UN1566/154 (compounds); UN1567 (powder)/134

EC Number: 231-150-7 [*Annex I Index No.:* 004-001-00-7], *as beryllium*

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (beryllium and beryllium compounds)[9]; Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: known to be a human carcinogen. Cancer site: lung; EPA: Limited evidence of carcinogenicity based on epidemiologic studies; Likely to produce cancer in humans when inhaled; Cannot be determined when ingested; NTP: Known to be a human carcinogen.

US EPA Genetox Program, positive: carcinogenicity—mouse/rat.

California Proposition 65 Chemical: Cancer.

Banned or Severely Restricted (UN).[35]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): P015.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.82; Nonwastewater (mg/L), 0.014 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (3); 7090 (50); 7091 (2).

Safe Drinking Water Act: MCL, 0.004 mg/L; MCLG, 0.004 mg/L.

Reportable Quantity (RQ): 10 lb (4.54 kg). *Note:* No report required if the diameter of the pieces of solid metal is equal to or exceeds 0.004 in.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; CEPA, Schedule 3, Part 2, Ocean Dumping Restriction.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R49; R25; R26; R36/37/38; R43; R48/23; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*Beryllium nitrate*).

Description: Beryllium is a gray shiny metal or powder, or fine granules which resemble powdered aluminum. Beryllium is slightly soluble in water. All beryllium compounds are soluble to some degree in water. Beryl ore is the primary source of beryllium, although there are numerous other sources. Molecular weight = 9.0; Boiling point = 2970°C; Freezing/Melting point = 1278°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Beryllium is used extensively in manufacturing electrical components, chemicals, ceramics, nuclear reactors; in the aerospace industry; and X-ray tubes. A number of alloys are produced in which beryllium is added to yield greater tensile strength, electrical conductivity, and resistance to corrosion and fatigue. The metal is used as a neutron reflector in high-flux test reactors. Human exposure occurs mainly through inhalation of beryllium dust or fumes by beryllium ore miners, beryllium alloy makers, and fabricators; phosphor manufacturers; ceramic workers; missile technicians; nuclear reactor workers; electric and electronic equipment workers; and jewelers. The major source of beryllium exposure of the general population is thought to be the burning of coal. Approximately 250,000 pounds of beryllium is released from coal and oil-fired burners. EPA estimates the total release of beryllium to the atmosphere from point sources is approximately 5500 pounds per year. The principal emissions are from beryllium-copper alloy production. Approximately 721,000 persons living within 12.5 miles (20 km) of point sources are exposed to small amounts of beryllium (median concentration 0.005 $\mu g/m^3$). Levels of beryllium have been reported in drinking water supplies and in small amounts in food.

Incompatibilities: Beryllium metal reacts with strong acids, alkalis (forming combustible hydrogen gas), oxidizable materials. Forms shock-sensitive mixtures with some chlorinated solvents, such as carbon tetrachloride and trichloroethylene. Incompatible with caustics, chlorinated hydrocarbons, oxidizers, molten lithium.[NIOSH]

Permissible Exposure Limits in Air

OSHA PEL: 0.002 mg[Be]/m^3 TWA; 0.005 mg[Be]/m^3 Ceiling Concentration; 0.025 mg[Be]/m^3/30 min maximum peak-per 8 h shift.

NIOSH REL: 0.0005 mg[Be]/m^3 STEL (do not exceed); Limit exposure to lowest feasible concentration.

ACGIH TLV®[1]: 0.00005 mg[Be]/m^3 TWA, inhalable fraction; Confirmed Human Carcinogen.

NIOSH IDLH: 4 mg[Be]/m^3.

Protective Action Criteria (PAC)*

Metal

TEEL-0: 0.00005 mg/m^3
PAC-1: 0.0035 mg/m^3
PAC-2: **0.025** mg/m^3
PAC-3: **0.1** mg/m^3

AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in* ***bold face*.

Chloride

TEEL-0: 0.0177 mg/m^3
PAC-1: 0.0177 mg/m^3
PAC-2: 0.0443 mg/m^3
PAC-3: 35.5 mg/m^3

Fluoride

TEEL-0: 0.000261 mg/m^3
PAC-1: 0.0035 mg/m^3
PAC-2: 0.0261 mg/m^3
PAC-3: 20.9 mg/m^3

Hydroxide

TEEL-0: 0.000239 mg/m^3
PAC-1: 0.035 mg/m^3
PAC-2: 0.239 mg/m^3
PAC-3: 19.1 mg/m^3

Nitrate

TEEL-0: 0.00104 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 10.4 mg/m^3
PAC-3: 83 mg/m^3

Oxide

TEEL-0: 0.000139 mg/m^3
PAC-1: 0.02 mg/m^3
PAC-2: 1.39 mg/m^3
PAC-3: 11.1 mg/m^3

Potassium beryllium oxide

TEEL-0: 0.016 mg/m^3
PAC-1: 0.016 mg/m^3
PAC-2: 0.02 mg/m^3
PAC-3: 32 mg/m^3

Sodium beryllium oxide

TEEL-0: 0.0124 mg/m^3
PAC-1: 0.0311 mg/m^3
PAC-2: 0.0311 mg/m^3
PAC-3: 24.9 mg/m^3

DFG MAK: Danger of sensitization of the airways; Carcinogen Category 1, proven carcinogens in humans.

Arab Republic of Egypt: TWA 0.002 mg/m^3, 1993; Australia: TWA 0.002 mg/m^3, carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.002 mg/m^3, Carcinogen 1993; Denmark: TWA 0.001 mg/m^3, 1999; Finland: TWA 0.002 mg/m^3; STEL 0.006 mg/m^3, carcinogen, 1999; France: VME 0.002 mg/m^3, continuous carcinogen, 1999; Hungary: STEL 0.001 mg/m^3, carcinogen, 1993; India: TWA 0.002 mg/m^3, carcinogen, 1993; Japan: TWA 0.002 mg/m^3, 2A carcinogen, 1999; Norway: TWA 0.001 mg/m^3, 1999; the Philippines: TWA 0.002 mg/m^3, 1993; Poland: MAC (TWA) 0.001 mg/m^3, MAC STEL 0.003 mg/m^3, 1999; Russia: STEL 0.001 mg/m^3, carcinogen, 1993; Sweden: NGV 0.002 mg/m^3, carcinogen, 1999; Switzerland: MAK-W 0.002 mg/m^3, carcinogen, 1999; Thailand: TWA 0.002 mg/m^3; STEL 0.005 mg/m^3, 1993; Turkey: TWA 0.002 mg/m^3, 1993; United Kingdom: TWA 0.002 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for beryllium in ambient air[60] ranging from zero (North Dakota) to 0.0042 μg/m^3 (Massachusetts) to 0.01 μg/m^3 (Connecticut, Pennsylvania, South Carolina) to 0.02 μg/m^3 (South Dakota and Virginia) to 0.1 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7704.[18] Beryllium in Air by Field-Portable Fluorometry (4/6/2007); 9110[18] Beryllium in Surface Wipes by Field-Portable Fluorometry (4/6/2007). (See also the ATSDR profile cited below).

Permissible Concentration in Water: In 1980 the EPA set the following criteria: *To protect freshwater aquatic life:* 130 μg/L on an acute basis: 5.3 μg/L on a chronic basis. *To protect saltwater aquatic life:* insufficient data to set criteria. *To protect human health:* preferable zero. An additional lifetime cancer risk of 1 in 100,000 results from a concentration of 0.037 μg/L.[6] Russia[43] set a MAC of 0.0002 mg/L (0.2 μg/L) in water bodies used for domestic purposes. Kansas and Rhode Island have set guidelines for beryllium in drinking water[61]: 0.13 μg/L in Kansas and 131 μg/L in Rhode Island.

Determination in Water: Total beryllium may be determined according to EPA, by digestion followed by atomic absorption by a colorimetric method, or by inductively coupled plasma (ZCP) optical emission spectrometry. Dissolved beryllium can be determined by 0.45 micron filtration prior to the above method for total beryllium. See also the ATSDR Profile cited below.

Routes of Entry: Inhalation of fume or dust.

Harmful Effects and Symptoms

Local: The soluble beryllium salts are cutaneous sensitizers as well as primary irritants. Contact dermatitis of exposed parts of the body is caused by acid salts as well as primary irritants. Contact dermatitis of exposed parts of the body is caused by acid salts of beryllium. Onset is generally delayed about 2 weeks from the time of first exposure. Complete recovery occurs following cessation of exposure. Eye irritation and conjunctivitis can occur. Accidental implantation of beryllium metal or crystals of soluble beryllium compound in areas of broken or abraded skin may cause granulomatous lesions. These are hard lesions with a central nonhealing area. Surgical excision of the lesion is necessary. Exposure to soluble beryllium compounds may cause nasopharyngitis, a condition characterized by swollen and edematous mucous membranes; bleeding points, and ulceration. These symptoms are reversible when exposure is terminated. *Systemic:* Beryllium and its compounds are highly toxic substances. Entrance to the body is almost entirely by inhalation. The acute systemic effects of exposure to beryllium primarily involve the respiratory tract and are manifested by a nonproductive cough, substernal pain, moderate shortness of breath, and some weight loss. The character and speed of onset of these symptoms, as well as their severity, are dependent on the type and extent of exposure. An intense exposure, although brief, may result in severe chemical pneumonitis with pulmonary edema. Chronic beryllium disease can be classified by its clinical variants according to the disability the disease process produces. (1) Asymptomatic nondisabling disease is usually diagnosed only by routine chest X-ray changes and supported by urinary or tissue assay. (2) In its mildly disabling form, the disease results in some nonproductive cough and dyspnea following unusual levels of exertion. Joint pain and weakness are common complaints. Diagnosis is by X-ray changes. Renal calculi containing beryllium may be a complication. Usually, the patient remains stable for years, but eventually shows evidence of pulmonary or myocardial failure. (3) In its moderately severe disabling form, the disease produces symptoms of distressing cough and shortness of breath, with marked X-ray changes. The liver and spleen are frequently affected, and spontaneous pneumothorax may occur. There is generally weight loss, bone and joint pain, oxygen desaturation, increase in hematocrit, disturbed liver function, hypercalciuria, and spontaneous skin lesions similar to those of Boeck's sarcoid. Lung function studies show measurable decreases in diffusing capacity. Many people in this group survive for years with proper therapy. Bouts of chills and fever carry a bad prognosis. (4) The severely disabling disease will show all of the above-mentioned signs and symptoms in addition to severe physical wasting and negative nitrogen balance. Right heart failure may appear, causing a severe nonproductive cough which leads to vomiting after meals. Severe lack of oxygen is the predominant problem, and spontaneous pneumothorax can be a serious complication. Death is usually due to pulmonary insufficiency or right heart failure.

Short Term Exposure: Eye or skin contact can cause irritation, itching, and burning. Sometimes an allergic eye problem develops, breaking out with future exposure. Inhalation overexposure can severely irritate the airways and lungs, causing nasal discharge, tightness of the chest, cough, shortness of breath, and/or fever. Death can occur in severe cases. Seek prompt medical attention. Future exposures can cause further attacks. Symptoms may be delayed for days following exposure. Some persons later develop lung scarring after such exposures.

Long Term Exposure: Be is a probable cancer causing agent in humans. There is some evidence that it causes lung and bone cancer in humans and animals. High or repeated exposure can permanently scar the lungs or other body organs. If Be particles get under cuts in the skin, ulcers or lumps can develop; these must be surgically removed. Allergic skin rashes can occur. High or repeated exposure can cause kidney stones to develop.

Points of Attack: Skin, eyes, respiratory system, lungs, liver, spleen, heart.

Medical Surveillance: Preemployment history and physical examinations for worker applicants should include chest X-rays, baseline pulmonary function tests (FVC and FEV_1), and measurement of body weight. Beryllium workers should receive a periodic health evaluation that includes spirometry (FVC and FEV_1), medical history questionnaire directed toward respiratory symptoms and a chest X-ray, blood/urine trace metals. General health, liver and kidney functions, and possible effects of the skin should be evaluated. See NIOSH Criteria Document 72-10268.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Work areas should be monitored to limit and control levels of exposure. Personnel samplers are recommended. Good housekeeping, proper maintenance, and engineering control of processing equipment and technology are essential. The importance of safe work practices and personal hygiene should be stressed. When beryllium levels exceed the accepted standards, the workers should be provided with respiratory protective devices of the appropriate class, as determined on the basis of the actual or projected atmospheric concentration of airborne beryllium at the worksite. Protective clothing should be provided to all workers who are subject to exposure in excess of the standard. This should include shoes or protective shoe covers as well as other clothing. The clothing should be reissued clean on a daily basis. Workers should shower following each shift prior to changing to street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red (powder): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Beryllium must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Use only nonsparking tools and equipment, especially when opening and closing containers of beryllium. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Beryllium powder requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE SOLID." (powder) It falls in Hazard Class 6.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Be is a combustible solid. Smother fire with dry sand, dry clay, dry ground limestone, or use approved Class "D" extinguishers (NFPA). *Do not use carbon dioxide or halogenated extinguishing agents. Do not use water.* Poisonous gases, including beryllium oxide fume, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For beryllium (powder), waste should be converted into chemically inert oxides using incineration and particulate collection techniques. These oxides should be returned to suppliers if possible. Recovery and recycling is an alternative to disposal for beryllium scrap and pickle liquors containing beryllium.[22]

References

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New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Beryllium (dust and powder)*. Trenton, NJ

Note: Beryllium Chloride (July 2004), Fluoride (July 2004), Nitrate (June 2005) and Oxide (July 2004) are the

subject of fact sheets from the state of New Jersey, quite similar to one another. Also, the chloride, fluoride, nitrate and oxide are the topics of articles cited above. To avoid duplication, separate entries for those four compounds are therefore not included here.

Binapacryl B:0475

Molecular Formula: $C_{15}H_{18}N_2O_6$
Synonyms: Acricid®; Ambox®; BP 855®; BP 736®; 2-*sec*-Butyl-4,6-dinitrophenyl-3,3-dimethylacrylate; 2-*sec*-Butyl-4,6-dinitrophenyl-3-methyl-2-butenoate; 2-*sec*-Butyl-4,6-dinitrophenyl-3-methylcrotonate; 2-*sec*-Butyl-4,5-dinitrophenyl senecioate; Dapacryl®; 3,3-Dimethyl-acrylate de 2,4-dinitro-6-(1-methylpropyle) phenyle (French); 3,3-Dimethylacrylic acid 2-*sec*-butyl-4,5-dinitrophenyl ester; Dinapacryl®; 4,6-Dinitro-2-*sec*-butylphenyl β,β-dimethylacrylate; 2,4-Dinitro-6-*sec*-butylphenyl-2-methylcrotonate; 4,6-Dinitrophenyl-2-*sec*-butyl-3-methyl-2-butenonate; Dinoseb methacrylate; Endosan®; ENT 25,793; FMC 9044®; HOE 2784®; 3-Methylcrotonic acid 2-*sec*-butyl-4,6-dinitrophenyl ester; (6-(1-Methyl-propyl)-2,4-dinitro-phenyl)-3,3-dimethyl acrylat (German); 2-(1-Methylpropyl)-4,6-dinitrophenyl-β,β-dimethacrylate; 2-(1-Methylpropyl)-4,6-dinitrophenyl ester 3-methyl-2-butenoic acid; Morocide®; Morrocid®; Niagara® 9044 (FMC)
CAS Registry Number: 485-31-4
RTECS® Number: GQ5600000
UN/NA & ERG Number: UN2780/(Substituted nitrophenol pesticide, liquid, flammable, poisonous)/131; UN2779 (substituted nitrophenol pesticides, solid, toxic)/153
EC Number: 207-612-9; 609-024-00-1
Regulatory Authority and Advisory Bodies
EPA: Group C, possible carcinogen as dinoseb, the parent chemical.
California Prop. 65: Developmental toxin and male reproductive toxin, as dinoseb, the parent chemical.
Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 307 Toxic Pollutants as nitrophenols.
US EPA Hazardous Waste Number (RCRA No.): P020.
Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol. 71, No. 158] Reportable Quantity (RQ) = 1000 lb (454 kg).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as dinoseb and its salts and esters).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R61; R21/22; R50/53; Safety phrases: S53; S26; S45; S60; S61; S45; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned. However, its parent chemical, dinoseb is 2—Hazard to waters.
Description: Binapacryl is a nitrophenol pesticide and the dimethyl acrylic ester of dinoseb. Binapacryl is a colorless, crystalline solid or powder. Crystals may turn pale-yellow to brownish on contact with air. The solid may be dissolved in a flammable liquid carrier. Mild, ammonia odor. Molecular weight = 322.31; Density = 1.238 g/cm^3 at 20°C. Melting/Freezing = 66°C; Boiling Point = 437°C at 760 mmHg; Vapor pressure = 4.2×10^{-7} mmHg at 20°C; Flash point = 172°C; but may be dissolved in a flammable liquid carrier. Practically insoluble in water.
Potential Exposure: Mutagen; cholinesterase inhibitor. Used as an acaricide, fungicide, and miticide. Not registered in the United States.
Incompatibilities: Slight hydrolysis on long contact with water. Keep away from caustics and concentrated acids that can cause decomposition. Slowly decomposed by ultraviolet light. When heated to decomposition it emits fumes of nitrogen oxides. Contact with metals may evolve flammable hydrogen gas. A nitrophenol may be an oxidizer (of unknown strength); incompatible with reducing agents including alkali metals, hydrides, nitrides, and sulfides, which might cause a violent reaction or detonation. Nitrophenols may explode when heated. Nitrophenols may react as a weak organic acid. Do not mix with Nitric or Sulfuric acid as explosive shock- and impact-sensitive salts may be formed.
Permissible Exposure Limits in Air:
No standards or TEEL available.
Determination in Air: No methods available.
Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution. To protect freshwater aquatic life—230 μg/L on an acute toxicity basis for nitrophenols as a class. To protect saltwater aquatic life—4,850 μg/L on an acute toxicity basis for nitrophenols as a class. To protect human health—70.0 μg/L(6). Octanol–water partition: Log $K_{ow} = 4.72$. Values above 3.0 are likely to bioaccumulate in marine organisms.
Determination in Water: Filter/Bubbler; 2-Propanol; High-pressure liquid chromatography/Ultraviolet detection; NIOSH II(5) Method #S166(18). Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection. EPA Method 604, or gas chromatography plus mass spectrometry EPA Method 625.
Routes of Entry: Inhalation, skin contact, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Severely irritates eyes, skin, and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, yellowish

tint to skin and lips, anxiety and confusion, convulsions, risk of lung edema. The effects may be delayed. Medical observation is recommended. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Severe exposure can cause death from heart failure.

LD_{50} = (oral-rat) 58 mg/kg.

Long Term Exposure: May damage the liver, kidneys, and blood cells. May stain yellow the skin, eyes, and fingernails. Repeated exposure can cause anxiety, fatigue, insomnia, excessive perspiration, unusual thirst, weight loss, and cataracts in the eyes.

Points of Attack: Skin, liver, kidneys, lungs, peripheral nervous system, eyes, thyroid gland, blood.

Medical Surveillance: Before beginning employment, at regular times after that and if symptoms develop or overexposure has occurred, the following may be useful: Examination of eyes for cataracts. Examination of skin and nails for staining. Blood tests for dinitro-*o*-cresol. Persons with blood levels over 10 ppm (10 mg/L) should be kept away from further exposure until levels return to normal. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. If working with liquid wear splash-proof chemical goggles, if working dry material wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Wear a positive pressure self-contained breathing apparatus (SCBA) when fighting fires involving binapacryl.

Storage: Color Code—Red (*dissolved material in a flammable liquid carrier*): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code (*dry, solid material*)—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinoseb you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store at temperatures from 0 to 6°C.

Shipping: Binapacryl, solid: label "SUBSTITUTED NITROPHENOL PESTICIDES, SOLID, TOXIC." It falls into DOT/UN Hazard Class 6.1(b) and Packing Group III. The DOT-required shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." The Hazard Class is 3 and the Packing Group is I.[19, 20]

Spill Handling: Remove all ignition sources. Evacuate personnel not wearing protective equipment from spill or leak until cleanup is complete. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water. *Dry material*: Keep dry spilled material wet. Do not attempt to sweep up dry material. Use HEPA vacuum or wet method to reduce dust during clean up. *Do not dry sweep*. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep material out of water sources and sewers. It will be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep material out of water sources and sewers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Binapacryl is a combustible material; it may burn but does not ignite readily. In heat of fire it emits fumes of nitrogen oxides. When heated, vapors may form explosive mixtures with air. Extinguish fire using agent suitable for type of surrounding fire. Use water in flooding quantities as fog. Use "alcohol" foam, dry chemical, or carbon dioxide. Cool all affected containers with flooding quantities of water. If fire becomes uncontrollable, evacuate for a radius of 1 mile. Nitrophenol pesticides may be dangerously explosive. Containers may explode when heated. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Runoff will pollute waterways. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Avoid release to the environment. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Conduct at 1000°C for 2.0 s minimum with scrubber for nitrogen oxides removal is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices.

References

US Environmental Protection Agency. (1980). *Nitrophenols: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 25–27 (1982) and 3, No. 2, 38–44 (1983)

New Jersey Department of Health. (October 1996, rev. February 2003). *Hazardous UN2753/151 Substance Fact Sheet: Dinitrophenol*. Trenton, NJ. <http://www.state.nj.us/health/eoh/rtkweb/0780.pdf>

California Environmental Protection Agency. (February 5, 2010). *Chemical List of Lists*. Sacramento, CA

Biotoxins

A substance produced by a living organism, such as a plant or fish, that has toxic effects.
Abrin see A:0025.
Ricin see R:0135.

Biphenyl B:0480

Molecular Formula: $C_{12}H_{10}$
Common Formula: $C_6H_5C_6H_5$
Synonyms: Bibenzene; 1,1′-Biphenyl; Dibenzene; 1,1′-Diphenyl; Diphenyl; Dowtherm A; Lemonene; Phenador-X; Phenylbenzene; PHPH; Xenene
CAS Registry Number: 92-52-4
RTECS® Number: DU8050000
UN/NA & ERG Number: UN2811 Toxic solids, organic, n.o.s./154
EC Number: 202-163-5 [*Annex I Index No.*: 601-042-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence, *probably carcinogenic to humans*, Group 2A (PCBs).
US EPA Gene-Tox Program, Positive/dose response: *In vitro* SCE—nonhuman; Negative: *In vitro* UDS—human fibroblast; *In vitro* UDS in rat liver; Negative: *S. cerevisiae*—homozygosis.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).
European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R36/37/38; R50/53; Safety phrases: S2; S23; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Biphenyl is a combustible, white flakes or crystalline solid with a pleasant, characteristic odor. Molecular weight = 154.2; Specific gravity (H_2O:1) = 1.04; Boiling point = 256°C; Freezing/Melting point = 69–70°C; Vapor pressure = 0.005 mmHg at 20°C; Flash point = 113°C; Autoignition temperature = 540°C. Explosive limits in air: LEL = 0.6% at 111°C, UEL = 5.8% at 166°C.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary

Irritant. Biphenyl is a fungicide (pesticide). It is also used as a heat transfer agent, dye carrier, and as an intermediate in organic synthesis.

Incompatibilities: Mist forms explosive mixture with air. Strong oxidizers may cause fire and explosions.

NIOSH IDLH: 100 mg/m^3.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.31 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.2 ppm/1 mg/m^3 TWA.

NIOSH REL: 0.2 ppm/1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.2 ppm/1.3 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: 1.25 ppm

PAC-2: **9.6** ppm

PAC-3: 15.9 ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 3B.

Arab Republic of Egypt: TWA 0.2 ppm (1 mg/m^3), 1993; Australia: TWA 0.2 ppm (1.5 mg/m^3), 1999; Austria: MAK 0.2 ppm (1 mg/m^3), 1993; Belgium: TWA 0.2 ppm (1.3 mg/m^3), 1993; Denmark: TWA 0.2 ppm (1 mg/m^3), 1999; Finland: TWA 0.2 ppm (1 mg/m^3); STEL 0.6 ppm (3 mg/m^3) [skin] 1993; France: VME 0.2 ppm (1.5 mg/m^3), 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; India: TWA 0.2 ppm (1.5 mg/m^3), 1993; Norway: TWA 0.2 ppm (1 mg/m^3), 1999; Poland: TWA 1 mg/m^3; STEL 2 mg/m^3, 1999; Sweden: NGV 0.2 ppm (1.3 mg/m^3), KTV 0.4 ppm (2.5 mg/m^3), 1999; Switzerland: MAK-W 0.2 ppm (1.3 mg/m^3), 1999; Thailand: TWA 0.2 ppm (1 mg/m^3), 1993; United Kingdom: TWA 0.2 ppm (1.3 mg/m^3); STEL 0.6 ppm (3.8 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV TWA 0.2 ppm. Several states have set guidelines or standards for biphenyl in ambient air[60] ranging from 0.086 μg/m^3 (Massachusetts) to 0.4 μg/m^3 (Rhode Island) to 5.0 μg/m^3 (New York) to 15.0 μg/m^3 (Florida and North Dakota) to 20.0 μg/m^3 (Connecticut) to 25 μg/m^3 (Virginia) to 36 μg/m^3 (Nevada) to 40 μg/m^3 (North Dakota).

Determination in Air: Tenax Gas chromatography; CCl4; Gas chromatography/Flame ionization detection; NIOSH (IV) Method #2530.

Permissible Concentration in Water: No criteria set but EPA has suggested an ambient limit of 13.8 μg/L based on health effects.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 3.2−4.1.

Routes of Entry: Inhalation of vapor or dust; percutaneous absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact contributes significantly to overall exposure. Repeated exposure to dust may result in irritation of skin and respiratory tract. The vapor may cause moderate eye irritation. Repeated skin contact may produce sensitization dermatitis. In acute exposure, biphenyl exerts a toxic action on the central nervous system, on the peripheral nervous system, and on the liver. Symptoms of poisoning are headache, diffuse, gastrointestinal pain, nausea, indigestion, numbness and aching of limbs, and general fatigue. LD_{50} = (oral-rat) 3280 mg/kg.[9]

Long Term Exposure: Chronic exposure is characterized mostly by central nervous system symptoms, fatigue, headache, tremor, insomnia, sensory impairment, and mood changes. However, such symptoms may be rare. May cause lung irritation and bronchitis. Liver and kidney damage. May cause skin allergy with itching and rash.

Points of Attack: Liver, skin, central nervous system, upper respiratory system, eyes.

Medical Surveillance: Consider skin, eye, liver function, and respiratory tract irritation in any preplacement or periodic examination. Examination by a qualified allergist. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Because of its low vapor pressure and low order of toxicity, it does not usually present a major problem in industry. Protective creams, gloves, and masks with organic vapor canisters for use in areas of elevated vapor concentrations should suffice. Elevated temperature may increase the requirement for protective methods or ventilation. Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any possibility of eye contact with molten biphenyl. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily as it may be contaminated. Remove nonimpervious clothing immediately if wet or contaminated.

Respirator Selection: *Up to 10 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 50 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) Any supplied-air respirator with a full face-piece. *Up to 100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD,PP (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Before entering confined space where biphenyl may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Spill material should be dampened with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak following cleanup. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide and acrid smoke. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Diphenyl*, Report PB 274,073. Cincinnati, OH, pp. 274−276

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 42−43

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Diphenyl*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Bis(2-chloroethoxy)-methane B:0490

Molecular Formula: $C_5H_{10}C_{12}O_2$

Common Formula: $ClCH_2CH_2OCH_2OCH_2CH_2Cl$

Synonyms: A13-01455; Bis(β-chlorethyl)formal; Bis(chlorethyl)formal; Bis(2-cloroetoxi)metano (Spanish); β-chloroethyl acetal of formaldehyde; β,β-Dichlorodiethyl formal; Dichlorodiethyl formal; Dichlorodiethyl methylal; 2,2-Dichloroethyl formal; Di-2-chloroethyl formal; Dichloroethyl formal; Dichloromethoxy ethane; Ethane,1,1′-[methylenebis(oxy)]bis(2-chloro-); Formaldehyde bis(β-chloroethyl) acetal;

Formaldehyde bis(2-chloroethyl) acetal; Methane, bis(2-chloroethoxy)-; 1,1-[Methylenebis(oxy)]bis(2-chloroethane)

CAS Registry Number: 111-91-1

RTECS® Number: PA3675000

UN/NA & ERG Number: UN3077/171

EC Number: 203-920-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U024.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 7.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bis(2-chloroethoxy)methane is a colorless liquid. Molecular weight = 173.1; Boiling point = 218°C; Freezing/Melting point = −33°C; Flash point = 110°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slight solubility in water; solubility = 0.8%.

Potential Exposure: The chloroalkyl ethers have a wide variety of industrial uses in organic synthesis, treatment of textiles, the manufacture of polymers, polysulfide rubbers, and insecticides, as degreasing agents and solvents, and in the preparation of ion exchange resins.

Incompatibilities: Oxidizing materials. Contact with mineral acids causes decomposition.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 ppm

PAC-1: 2 ppm

PAC-2: 6 ppm

PAC-3: 6 ppm

Permissible Concentration in Water: No criteria set because of inadequate data according to EPA.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1$.

Harmful Effects and Symptoms

Specific data on BCEXM are very sparse. The reader is referred to the sections on other chloroalkyl ethers: Chloromethyl methyl ether, CMME: Bis(chloromethyl) ether, BCME: Bis(2-chloroethyl) ether, BCEE—Bis (2-chlorosiopropyl) ether, BCIE LD_{50} = (oral-rat) 65 mg/kg.[9] This material is toxic by inhalation and ingestion and is a strong irritant.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to

clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Destroy by high-temperature incineration with HCl scrubber.

References

US Environmental Protection Agency. (1980). *Halo-ethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (1980). *Chloroalkyl Ethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bis (2-chloroethoxy)methane: Health and Environmental Effects Profile No. 23*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 39−42

Bis(2-chloroisopropyl)ether B:0500

Molecular Formula: $C_6H_{12}Cl_2O$

Common Formula: $[ClCH_2CH(CH_3)]_2O$

Synonyms: BCIE; BCMEE; Bis(β-chloroisopropyl) ether; Bis(chloromethyl) ether; Bis(2-chloro-1-methylethyl) ether; Bis(1-chloro-2-propyl) ether; Bis(2-clorometil)eter (Spanish); (2-Chloro-1-methylethyl) ether; DCIP (nematocide); β,β′-Dichlorodiisopropyl ether; Dichlorodiisopropyl ether; 2,2′-Dichloroisopropyl ether; Dichloroisopropyl ether; Ether, bis(2-chloro-1-methylethyl); NCI-C50044; Nemamort; 2,2′-Oxybis(1-chloropropane); Propane, 2,2′-oxybis(1-chloro-); Propane,2,2′-oxybis(1-chloro)

CAS Registry Number: 108-60-1; (alt.) 52438-91-2

RTECS® Number: KN1750000

UN/NA & ERG Number: UN2490/153

EC Number: 203-598-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U027.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 7.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (100); 8270 (10).

Reportable Quantity (RQ): 1000 lb (454 kg).

California Proposition 65 Chemical: Cancer 10/29/99.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichloroisopropyl ether is a colorless liquid. Molecular weight = 171.1. Specific gravity (H_2O:1) = 1.11 at 25°C; Boiling point = 187−189°C; Freezing/Melting point = − 101°C; Flash point = 85°C (oc).[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. BCIE was previously used as a solvent and as an extractant. It may be formed as a by-product of propylene oxide production. It has been found in industrial waste water and natural water.

Incompatibilities: Strong oxidizers, strong acids, and oxygen. It may form dangerous peroxides upon standing; may explode when heated.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.3 ppm

PAC-1: 0.75 ppm

PAC-2: 6 ppm

PAC-3: 40 ppm

Russia: MAC: 5 mg/m^3.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 238,000 μg/L on an acute basis for chloroalkyl ether in general. No criteria developed for saltwater aquatic life due to lack of data. For protection of human health, the ambient water criterion is 34.7 μg/L.[6] Kansas has set a guideline for this compound in drinking water of 34.7 μg/L.[61]

Determination in Water: Gas chromatography (EPA Method 611) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 2.5.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

There is no empirical evidence that BCIE is carcinogenic; however, some chronic toxic effects of the compound have been noted.

Short Term Exposure: Can cause irritation and burns on contact with eyes, nose, and skin. Very high levels of BCIE may cause loss of appetite, fatigue, irritability, and even death. LD_{50} = (oral-rat) 240 mg/kg (moderately toxic).[9]

Long Term Exposure: There is limited evidence that this chemical may cause cancer in animals; lung adenomas. Many similar solvents can cause brain or disturbed sleep; this chemical has not been fully evaluated for these effects. May cause liver and kidney damage.

Medical Surveillance: Kidney and liver function tests. Evaluate for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Ethers tend to form unstable peroxides. Before entering confined space where BCIE may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Dichloroisopropyl ether requires a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use special incinerator due to high HCl content, such as seagoing incinerator ships.[22]

References

US Environmental Protection Agency. (1980). *Chloroalkyl Ethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bis (2-chloroisopropyl) Ether: Health and Environmental*

Effects Profile No. 25. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (July 29, 1983). *Chemical Hazard Information Profile Draft Report: Bis(2-Chloro-1-Methylethyl) Ester (BCMEE)*. Washington, DC

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 3, 47–49

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Bis(2-Chloro-1-Methylethyl)Ether*. Trenton, NJ

Bis(chloromethyl)ether B:0510

Molecular Formula: $C_2H_4Cl_2O$

Common Formula: $ClCH_2OCH_2Cl$

Synonyms: BCME; Bis(2-chloromethyl) ether; Bis(clorometil)eter (Spanish); Bis-CME; Chloro(chloromethoxy)methane; Chloromethyl ether; Dichlordimethylaether (German); a,a′-Dichlorodimethyl ether; *sym*-Dichlorodimethyl ether; Dichlorodimethyl ether; Dichlorodimethyl ether, *symmetrical*; *sym*-Dichloromethyl ether; Dichloromethyl ether; Dimethyl-1,1′-dichloroether; Ether, bis(chloromethyl); Methane oxybis(chloro-); Monochloromethyl ether; Oxybis (chloromethane)

CAS Registry Number: 542-88-1

RTECS® Number: KN1575000

UN/NA & ERG Number: UN2249/131

EC Number: 208-832-8 [*Annex I Index No.:* 603-046-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987; EPA: Human Carcinogen; NTP (*includes technical grades*): Known to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

Banned or Severely Restricted (Finland, Israel, Japan, Sweden) (UN).[13]

Very Toxic Substance (World Bank).[15]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1008).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454 kg).

US EPA Hazardous Waste Number (RCRA No.): P016.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): EHS = 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: F, T+; Risk phrases: R45; R11; R22; R24; R26; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Bis(chloromethyl) ether is a colorless, volatile liquid with a suffocating odor. Molecular weight = 115.0. Specific gravity (H_2O:1) = 1.32 at 25°C; Boiling point = 106.1°C; Freezing/Melting point = −42°C; Vapor pressure = 30 mmHg at 25°C; Flash point = ≤18.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1₩. Insoluble in water (decomposes, creating hydrogen chloride).

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. Exposure to bis(chloromethyl) ether may occur in industry and in the laboratory. This substance can form spontaneously in warm moist air by the combination of formaldehyde and hydrogen chloride. This compound is used as an alkylating agent in the manufacture of polymers; as a solvent for polymerization reactions; in the preparation of ion exchange resins; and as an intermediate for organic synthesis. Haloethers, primarily α-chloromethyl ethers, represent a category of alkylating agents of increasing concern due to the establishment of a causal relationship between occupational exposure to two agents of this class and lung cancer in the United States and abroad. The cancers are mainly oat cell carcinomas. Potential sources of human exposure to BCME appear to exist primarily in areas including: (a) its use in chloromethylating (crosslinking) reaction mixtures in anion-exchange resin production; (b) segments of the textile industry using formaldehyde-containing reactants and resins in the finishing of fabric and as adhesive in the laminating and flocking of fabrics; and (c) the nonwoven industry which uses as binders, thermosetting acrylic emulsion polymers comprising methylol acrylamide, since a finite amount of formaldehyde is liberated on the drying and curing of these bonding agents. NIOSH has confirmed the spontaneous formation of BCME from the reaction of formaldehyde and hydrochloric acid in some textile plants and is now investigating the extent of possible worker exposure to the carcinogen. However, this finding has been disputed by industrial tests in which BCME was not formed in air by the reaction of textile systems employing hydrochloric acid and formaldehyde.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids. Decomposes on contact with water, moist air, and heat, forming corrosive hydrochloric acid, hydrogen chloride, and formaldehyde vapors. May form shock-sensitive compounds on contact with oxidizers, peroxides, and sunlight. Attacks many plastics.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements. See Appendix B of the *NIOSH Pocket Guide*.

NIOSH REL: Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.001 ppm/0.0047 mg/m^3 TWA, Confirmed Human Carcinogen.

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Protective Action Criteria (PAC)*
TEEL-0: 0.001 ppm
PAC-1: 0.006 ppm
PAC-2: **0.044** ppm
PAC-3: **0.18** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 1.

Australia: TWA 0.001 ppm (0.006 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.001 ppm (0.0047 mg/m^3), carcinogen, 1993; Denmark: TWA 0.001 ppm (0.005 mg/m^3), 1999; Finland: TWA 0.001 ppm (0.004 mg/m^3); STEL 0.003 ppm, carcinogen, 1999; France: VME 0.001 ppm (0.006 mg/m^3), carcinogen, 1999; India: TWA 0.001 ppm (0.005 mg/m^3), carcinogen, 1993; Norway: TWA 0.001 ppm (0.005 mg/m^3), 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.001 ppm (0.005 mg/m^3), carcinogen, 1999; United Kingdom: TWA 0.001 ppm (0.005 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. The Czech Republic[35] has set a TWA of 0.00025 mg/m^3 and a ceiling value of 0.005 mg/m^3.

Determination in Air: Collection by charcoal tube, analysis by gas liquid chromatography.

Permissible Concentration in Water: For maximum protection of human health from potential carcinogenic effects of exposure to BCME through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of BCME estimated to result in additional lifetime cancer risks of 1 in 100,000 are presented by a concentration of 0.038 ng/L (3.8×10^{-5} μg/L).[6] Kansas has set a guideline for drinking water also.[61]

Determination in Water: Gas chromatography (EPA Method 611) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 1.1$.

Routes of Entry: Inhalation of vapor, and percutaneous absorption.

Harmful Effects and Symptoms

Bis(chloromethyl) ether has an extremely suffocating odor even in minimal concentration so that experience with acute poisoning is not available. It is not considered a respiratory irritant at concentrations of 10 ppm. Bis(chloromethyl) ether is a known human carcinogen. Animal experiments have shown increases in lung adenoma incidence; olfactory esthesioneuroepitheliomas which invaded the sinuses, cranial vault, and brain; skin papillomas and carcinomas; and subcutaneous fibrosarcomas. There have been several reports of increased incidence of human lung carcinomas (primarily small cell undifferentiated) among ether workers exposed to bis(chloromethyl) ether as an impurity. The latency period is relatively short—10−15 years. Smokers as well as nonsmokers may be affected.

Short Term Exposure: This chemical is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Affects the nervous system. Symptoms can be loss of appetite, nausea, and fatigue; higher exposures can cause irritability, anxiety, and weakness.

Long Term Exposure: Can cause liver and kidney damage. Lungs may be affected by repeated or prolonged exposure. This substance is carcinogenic to humans and has caused lung cancer in humans. May cause genetic damage in humans.

Points of Attack: Skin, respiratory tract, eyes, lungs.

Medical Surveillance: Preplacement and periodic medical examinations should include an examination of the skin and respiratory tract, including chest X-ray. Sputum cytology has been suggested as helpful in detecting early malignant changes; and in this connection, a smoking history is of importance. Possible effects on the fetus should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: These are designed to supplement engineering controls and should be appropriate for protection of all skin or respiratory contact. Full body protective clothing and gloves should be used on entering areas of potential exposure. Those employed in handling operations should be provided with full face, supplied-air respirators of continuous-flow or pressure-demand type. Wash thoroughly *immediately* following exposure to this chemical. On exit from a regulated area, employees should remove and leave protective clothing and equipment at the point of exit, to be placed in impervious containers at the end of the work shift for decontamination or disposal. Showers should be taken before dressing in street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in airtight containers in a cool, dry, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dichlorodimethyl ether, symmetrical, has a DOT label requirement of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group I.[19, 20]

Spill Handling: Evacuate area. Seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). Full body protective clothing and gloves should be used on entering areas of potential exposure. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. *Spill or leak:* do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible material and place into containers for later disposal. *Large spills:* dike far ahead of spills for later disposal. Do NOT let this chemical enter the environment (extra personal protection: complete protective clothing including self-contained breathing apparatus). Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1980). *Chloroalkyl Ethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (1980). *Haloethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bis (chloromethyl) Ether: Health and Environmental Effects Profile No. 26*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 3, 49−52

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Chloromethyl Ether*. Washington, DC: Chemical Emergency Preparedness Program

US Public Health Service. (December 1988). *Toxicological Profile for Bis(chloromethyl)ether*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Bis(2-chloromethyl)ether*. Trenton, NJ

Bis(chloromethyl)ketone B:0520

Molecular Formula: $C_3H_4Cl_2O$

Common Formula: $ClCH_2COCH_2Cl$

Synonyms: Bis(chloromethyl) ketone; *sym*-Dichloroacetone; α,α'-Dichloroacetone; α,γ'-Dichloroacetone; 1,3-Dichloroacetone; 1,3-Dichloro-2-propanone

CAS Registry Number: 534-07-6

RTECS® Number: UC1430000

UN/NA & ERG Number: UN2649/153

EC Number: 208-585-6

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): EHS = 10 lb (4.54 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bis(chloromethyl)ketone is a crystalline solid. Molecular weight = 127.02; Freezing/Melting point = 45°C; Boiling point = 173°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Formerly extensively used in textiles (especially polyester fabrics) and still employed in polyurethane foams, textile backcoating, and adhesives.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.125 mg/m^3

PAC-1: 0.4 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 2 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: It causes tearing and blistering. It may be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes.

Long Term Exposure: Due to the availability of insufficient data on short-term effects, caution should be exercised.

Medical Surveillance: See NIOSH Criteria Document: *78-173 Ketones*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Keep away from sources of ignition. Store in a refrigerator, in a tightly closed container. Store below 4°C. Keep away from oxidizers, heat, flame, and sparks.

Shipping: The DOT label requirement[19] for 1,3-Dichloroacetone is "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation; wear respiratory protection, eye protection, and protective clothing. In case of contact, immediately flush skin or eyes with water. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For small spills, absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *For large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Bis(chloromethyl)ketone*. Washington, DC: Chemical Emergency Preparedness Program

Bismuth and compounds B:0530

Molecular Formula: Bi

Synonyms: Bismuth-209; Bismuto (Spanish)

CAS Registry Number: 7440-69-9

Bismuth compounds:

Bismuth acetate 22306-37-2; Bismuth germanate 12233-73-7; Bismuth hydroxide 10361-43-0; Bismuth hydroxide nitrate oxide 1304-85-4; Bismuth iodide 7787-64-6; Bismuth nitrate 10361-44-1; Bismuth oxide 1304-76-3; Bismuth oxychloride (Bismuth chloride oxide) 7787-59-9; Bismuth(III) nitrate, pentahydrate 10035-06-0; Potassium bismuthate 12589-75-2; Sodium bismuthate 12232-99-4

RTECS® Number: EB2600000

EC Number: 231-177-4

Regulatory Authority and Advisory Bodies

7440-69-9

Listed on the TSCA inventory.

CERCLA/SARA Section 302, Extremely Hazardous Substances: TPQ = 10 lb/10,000 lb (4.54/4540 kg).

Banned or Severely Restricted (In medicine) (UN).[13]

Mexico, wastewater as heavy metals.

On Canada's DSL List.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Bismuth is a pinkish-silver, hard, brittle metal. It is found as the free metal in ores, such as bismutite and bismuthinite and in lead ores. Molecular weight = 209.0; Boiling point = 1420−1560°C; Freezing/Melting point = 271°C. Hazard Identification (based on NFPA-704 M Rating System): (bismuth) Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Bismuth is used as a constituent of tempering baths for steel alloys; in low Freezing/Melting point alloys which expand on cooling; in aluminum and steel alloys to increase machinability; and in printing type metal. Bismuth compounds are found primarily in pharmaceuticals as antiseptics, antacids, antiluetics, and as a medicament in the treatment of acute angina. They are also used as a contrast medium in roentgenoscopy and in cosmetics. For the general population the total intake from food is 5−20 μg with much smaller amounts contributed by air and water.

Incompatibilities: Reacts with strong acids and strong oxidants, chlorine, fused ammonium nitrates, iodine pentafluoride, and nitrosyl fluoride.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Bismuth; bismuth germanate

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 200 mg/m^3

There is no Federal standard for bismuth metal. ACGIH has set TWA values only for bismuth telluride (see B:0540).

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of 3.5 μg/L based on health effects. Russia[43] set a MAC of 0.5 mg/L of trivalent bismuth and 0.1 mg/L of pentavalent bismuth.

Determination in Water: Atomic absorption spectrophotometry may be used.[1] Spark source mass spectrometry may also be used.

Routes of Entry: Ingestion of powder or inhalation of dust.

Harmful Effects and Symptoms

Most accounts of bismuth poisoning are from the soluble compounds used previously in therapeutics. Bismuth compounds have been withdrawn from pharmaceuticals because of reports of encephalopathy.[13] Fatalities and near fatalities have been reported chiefly as a result of intravenous or intramuscular injection of soluble salts.

Short Term Exposure: Bismuth and bismuth compounds have slight effect on intact skin and mucous membrane. Absorption occurs only minimally through broken skin.

Long Term Exposure: All bismuth compounds do not have equal toxicity. Although considered less hazardous than most heavy metals, can cause kidney and possible liver damage. Chronic intoxication from repeated oral or parenteral doses causes "bismuth line." This is a gum condition with black spots of buccal and colonic mucosa, superficial stomatitis, foul breath, and salivation.

Points of Attack: Kidneys, liver.

Medical Surveillance: No special considerations are necessary other than following good general health practices. Liver and kidney function should be followed if large amounts of soluble salts are ingested.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note: Dimercaptol (BAL) brings good results in the treatment of bismuth poisoning if given early. Other measures include atropine and meperidine to relieve gastrointestinal discomfort.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of bismuth poisoning it may have *some* value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Personal hygiene should be stressed, and eating should not be permitted in work areas. Dust masks should be worn in dusty areas to prevent inadvertent ingestion of the soluble bismuth compounds.

Storage: Color Code—Green: General storage may be used.

Shipping: Bismuth is not cited by DOT[19] in its Performance-Oriented Packaging Standards as regards label requirements or maximum permitted shipping quantities.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum amount of concentrated HCl. Dilute with water until precipitate is formed. Redissolve in HCl. Then saturate with H_2S. Filter, wash, dry, and return to supplier.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Bismuth*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 110−123

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 43−45 (1981) and 3, No. 5, 64−65 (1983)

Bismuth telluride B:0540

Molecular Formula: Bi_2Te_3

Synonyms: Bismuth sesquitelluride; Dibismuth telluride

doped: Doped bismuth sesquitelluride; Doped bismuth telluride; Doped tellurobismuthite; Doped bismuth tritelluride; (*Note*: Doped with selenium sulfide. Commercial mix may contain 80% Bi_2Te_3, 20% stannous telluride, plus some tellurium.)[NIOSH]

undoped: Bismuth sesquitelluride, Bismuth telluride, Bismuth tritelluride, Tellurobismuthite

CAS Registry Number: 1304-82-1; 37293-14-4 (doped and undoped)

RTECS® Number: EB3110000 (undoped)

UN3284 (tellurium compound, n.o.s.)/151

EC Number: 215-135-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (1304-82-1).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bismuth telluride is a gray crystalline solid. Molecular weight = 800.83; Specific gravity (H_2O:1) = 7.7; Freezing/Melting point = 573°C; Vapor pressure = 0 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2.

Note: Commercial mix of doped bismuth tritelluride may contain 80% Bi_2Te_3, 20% stannous telluride, plus some tellurium. Insoluble in water. Doped and undoped have similar physical properties.

Potential Exposure: Bismuth telluride is used in thermoelectric cooling, power generation; and in semiconductor manufacture. Exposure involves those working in "Silicon Valley" and similar locations around the world.

Incompatibilities: Reacts with acids. A violent reaction with strong oxidizers. Toxic gas may evolve from contact with moisture.

Permissible Exposure Limits in Air

Undoped

OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction (undoped); None (doped with Se).
NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction; 5 mg/m^3 TWA (doped with Se).
ACGIH TLV®[1]: 10 mg/m^3 (undoped) TWA; 5 mg/m^3 TWA (doped with Se); not classifiable as a human carcinogen.
No TEEL available.
Australia: TWA 10 mg/m^3, 1993; Australia: TWA 5 mg/m^3, 1993; Austria: MAK 0.1 mg(Te)/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 10 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; France: VME 5 mg/m^3, 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Norway: TWA 10 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.5 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for bismuth telluride in ambient air[60] ranging from 0.05 mg/m^3 (North Dakota) to 0.08 mg/m^3 (Virginia) to 0.2 mg/m^3 (Connecticut) to 0.238 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #0500, #0600, or OSHA Analytical Method ID-121 Metal & Metalloid Particulates in work-place Atmospheres (Atomic Absorption).

Routes of Entry: Inhalation/ingestion of dust, eye/skin contact.

Harmful Effects and Symptoms

Bismuth telluride can affect you when breathed in. Exposure may irritate the eyes, nose, and throat. Lung changes may occur. It is not known at this time whether these are permanent.

Short Term Exposure: Harmful if inhaled; may cause respiratory tract irritation. Harmful if absorbed through skin. Causes skin irritation. Eye contact causes irritation and redness. Harmful if swallowed. May cause nausea, headache, and vomiting.

Long Term Exposure: Can affect the kidneys and possibly the liver; bismuth nephropathy (with proteinuria) may occur. Bismuth may affect the amniotic fluid and fetus. In animals: pulmonary lesions (nonfibrotic).[NIOSH]

Points of Attack: Kidneys, liver.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of bismuth poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: *Clothing:* Avoid skin contact with Bismuth Telluride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Bismuth telluride must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluoride), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture.

Shipping: Tellurium compound, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I to III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid containing Bismuth telluride in vermiculite, dry sand, earth, or similar material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires, use dry chemical, carbon dioxide, water spray, or foam. Extinguish fire using an agent suitable for the type of surrounding fire; Bismuth telluride itself does not burn. Poisonous gases are produced in fire, including bismuth oxides and tellurium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2001). *Hazardous Substances Fact Sheet: Bismuth Telluride*. Trenton, NJ

Bisphenol A B:0550

Molecular Formula: $C_{15}H_{16}O_2$
Common Formula: $HOC_6H_4C(CH_3)_2{-}C_6H_4OH$
Synonyms: Bisfenol A (Spanish); Bisferol A (German); Bis(4-hydroxyphenyl)dimethylmethane; β,β′-Bis(*p*-hydroxyphenyl)propane; 2,2-Bis(*p*-hydroxyphenyl)propane; 2,2-Bis(4-hydroxyphenyl)propane; Bis(*p*-hydroxyphenyl)-propane; *p,p*′-Bisphenol A; Dian; Diano; *p, p*′-Dihydroxydiphenyldimethylmetane; 4,4′-Dihydroxydiphenyldimethylmetane; *p,p*′-Dihydroxydiphenylpropane; 2,2-(4,4′-Dihydroxydiphenyl)propane; 4,4′-Dihydroxy-2,2-diphenylpropane; 4,4′-Dihydroxydiphenyl-2,2-propane; 4,4′-Dihydroxydiphenylpropane; β-Di-*p*-hydroxyphenylpropane; 2,2-Di(4-hydroxyphenyl)propane; Dimethyl bis(*p*-hydroxyphenyl)methane; Dimethylmethylene *p,p*′-diphenol; 2,2-Di (4-phenylol)propane; Diphenylolpropane; Ipognox 88; *p, p*′-Isopropilidendifenol (Spanish); Isopropylidenebis(4-hydroxybenzene); *p,p*′-Isopropylidenebisphenol; 4,4′-Isopropylidenebis(phenol); *p,p*′-Isopropylidenediphenol; 4,4′-Isopropylidenediphenol; 4,4′-(1-Methylethylidene) bisphenol; NCI-C50635; Parabis A; Phenol, 4,4′-isopropylidenedi-; Phenol, 4,4′-(1-methylethylidene)bis-; Pluracol 245; Rikabanol; UCAR Bisphenol HP
CAS Registry Number: 80-05-7
RTECS® Number: SL6300000
UN/NA & ERG Number: UN3077/171
EC Number: 201-245-8 [*Annex I Index No.:* 604-030-00-0]
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis: Studies (feed); equivocal evidence: mouse, rat; Bioassay (feed); inadequate studies: mouse, rat.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
TSCA 40CFR716.120(a).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).
European/International Regulations: Hazard Symbol: Xn; Risk phrases: R37; R41; R43; R62; R52; Safety phrases: S2; S26; S36/37; S39; S46; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Bisphenol A is a white or tan crystals or flakes with a mild phenolic odor. Molecular weight = 228.29; Specific gravity (H_2O:1): 1.2; Boiling point = 220°C at 4 mmHg; Freezing/Melting point = 153°C; Flash point = 207°C (oc); Autoignition temperature = 600°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 120 mg/L.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Workers engaged in the manufacture of epoxy, polysulfone, polycarbonate, and certain polyester resins. It is also used in flame retardants, rubber chemicals, and as a fungicide. Bisphenol A (BPA), an environmental estrogen, is found in a wide variety of products, including polycarbonate bottles food and drink containers. According to 2008 research conducted at University of Cincinnati, when it comes to BPA, it is not whether polycarbonate bottles are new or old but the liquid's temperature that has the greatest impact on how much BPA is released. When exposed to boiling hot water, BPA was released 55 times more rapidly than exposure to cold water.

Incompatibilities: Strong oxidizers, strong bases, acid chlorides, and acid anhydrides.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: 5 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(1); photosensitization; Pregnancy Risk Group C.
Russia: STEL 5 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3 (respirable dust); 10 mg/m^3 (total dust), 2003. It should be recognized that bisphenol-A can be absorbed through the skin, thereby increasing exposure.

Determination in Air: Collection by charcoal tube, analysis by gas liquid chromatography.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.32$. Fish Tox (benzamide) LC_{50} (fathead minnow, 96 h) = 4.6 mg/L.

Routes of Entry: Passes through the unbroken skin; inhalation; ingestion.

Harmful Effects and Symptoms

Bisphenol-A and its resins produce a typical contact dermatitis; redness and edema with weeping, followed by crusting and scaling, usually confined to the area of contact. Since the face is frequently affected, this may indicate that vapors are the cause, although contact with contaminated clothing can also be a factor. Areas other than the face and neck, back of hands, and forearms are seldom involved. LD_{50} = (oral-rat) 3250 mg/kg[9] which is slightly toxic. Dusts may cause irritation to mouth, nose, or throat and can cause eye irritation. As regards ingestion, comparison with phenol suggests probable symptoms would include nausea, burning of mouth, throat, and stomach; severe stomach pain; stomach ulcers; vision disturbances; irregular breathing and pulse, dizziness, fainting, coma, and possible death. Animal studies suggest that death may occur from ingestion of about 1/3 pound (6 oz) for a 150-lb person. On long-term exposure, susceptible individuals may become sensitized after repeated or prolonged contact and thereafter exhibit an allergic response. Allergy may include reaction to many epoxy resins containing bisphenol A.

Short Term Exposure: Eye and skin contact can cause irritation and burns. May irritate the respiratory tract.

Long Term Exposure: May cause skin sensitization and allergy. There is limited evidence that this chemical may damage the developing fetus.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Dust mask should be worn to protect against inhaled dust. Fire fighters should wear self-contained breathing apparatus to protect against noxious fumes.

Storage: Color Code—Green: General storage may be used. Store away from heat and strong oxidizers and the incompatible materials listed above.

Shipping: Bisphenol A is not cited in the DOT Performance-Oriented Packaging Standards as regards label requirements or maximum shipping; however, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Vacuum cleaning is preferable to sweeping to keep dust levels down. Use special HEPA vacuum, not a shop vacuum. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Bisphenol A is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (March 29, 1978). *Information Profiles on Potential Occupational Hazards (Bisphenol-A)*. Rockville, MD

New York State Department of Health. (October 1984). *Chemical Fact Sheet: Bisphenol-A*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Bisphenol A*. Trenton, NJ

Bithionol B:0560

Molecular Formula: $C_{12}H_6Cl_4O_2S$

Synonyms: Actamer; Bidiphenbis(2-hydroxy-3,5-dichlorophenyl) sulfide; Bithinol sulfide; Bitin; CP3438; 2,2′-Dihydroxy-3,3′,5,5′-tetrachlorodiphenyl sulfide; 2-Hydroxy-3,5-dichlorophenyl sulphide; Lorothidol; NCI-C60628; Neopellis; TBP; 2,2′-Thiobis(4,6-dichlorophenol); Vancide BL; XL 7

CAS Registry Number: 97-18-7

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

RTECS® Number: SN0525000

EC Number: 202-565-0

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (USA, Japan) (UN).[13]

TSCA 40CFR716.120(a).

Clean Water Act: Toxic Pollutant (Section 401.15) as chlorinated phenols.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%, as chlorophenols.

MARINE POLLUTANT (49CFR, Subchapter 172.101, Appendix B) as chlorophenols.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bithionol is a white or grayish powder with a slight phenolic odor. Molecular weight = 365.03; Freezing/Melting point = 188°C; vapor pressure = very low. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: It is used as a surfactant-formulated antimicrobial against bacteria, molds, and yeast. It is proposed as an agricultural fungicide. Other uses include deodorant, germicide, fungistat, and in the manufacture of pharmaceuticals. It is no longer allowed to be used in cosmetics. A food additive in feed and drinking water of animals. Also a food additive permitted in food for human consumption.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: Danger of photosensitization.

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Probable oral lethal dose for humans is 5−15 g/kg for a 70-kg (150 lb) person. The toxicity of this compound is similar to that of phenol. Major hazard of phenol poisoning stems from its systemic effects which include central nervous system depression with coma, hypothermia, loss of vasoconstrictor tone, cardiac depression, and respiratory arrest. Symptoms of exposure include burning pain in mouth and throat; white necrotic lesions in mouth, esophagus, and stomach; abdominal pain; vomiting, bloody diarrhea; paleness; sweating; weakness; headache; dizziness; tinnitus; scanty, dark-colored urine; weak irregular pulse; and shallow respiration.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a refrigerator or a cool dry place.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust. Stay upwind. Do not touch spilled material. Use water spray to reduce vapors. Absorb spills with noncombustible absorbent material. For *large spills* dike far ahead for later disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 2,2′-Thiobis(4,6-dichlorophenol)*. Washington, DC: Chemical Emergency Preparedness Program

Bitoscanate B:0570

Molecular Formula: $C_8H_4N_2S_2$

Synonyms: Biscomate; 1,4-Diisothiocyanatobenzene; Isothiocyanic acid *p*-phenylene ester; Jonit; 1,4-Phenylene diisosthiocyanic acid; Phenylene 1,4-diisothiocyanate; Phenylene thiocyanate

CAS Registry Number: 4044-65-9

RTECS® Number: NX9150000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 223-741-3

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, as cyanide compounds.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions, or cyanides, inorganic, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bitoscanate is a colorless to beige, odorless, crystalline compound. Molecular weight = 192.3; Freezing/Melting point = 132°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0.

Potential Exposure: Those engaged in the manufacture, formulation, and application of this anthelmintic compound.

Incompatibilities: In general, keep away from strong oxidizers, moisture, strong acids, strong bases. This is a thiocyanate compound. Violent reactions may occur upon contact with chlorates (potassium chlorate, sodium chlorate), nitrates, nitric acid, organic peroxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

This material is highly toxic if ingested. It is a central nervous system and gastrointestinal toxin in humans. LD_{50} = (oral-rat) 2 mg/kg (highly toxic).[9]

Short Term Exposure: Harmful if inhaled; may cause respiratory tract irritation. Harmful if absorbed through skin. Causes skin irritation. Eye contact causes irritation and redness. Harmful if swallowed. May cause nausea, headache, and vomiting.

Long Term Exposure: Inhalation may result in respiratory tract sensitization.

Medical Surveillance: Blood cyanide level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. For cyanide poisoning, use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as cyanides): *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area. Store under inert gas; moisture sensitive.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including cyanide, nitrogen oxides, sulfur oxides, and carbon oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Bitoscanate*. Washington, DC: Chemical Emergency Preparedness Program

Blister agents/Vesicants

Blister agents or vesicants are chemicals which have severely irritating properties and can produce irritated and reddened skin with progression to blisters, swelling and inflammation of tissues surrounding the eyes with progression to light sensitivity and lacrimation. They can damage the skin, eyes, and airways. They have the ability to form widespread vesicular lesions, causing blistering and peeling of the skin. High concentrations of vapor or direct liquid exposures to the eye can cause damage to the eye surface. Warm, moist tissues are most susceptible to damage and the tissues of the upper respiratory tract can also be affected. Symptoms of exposure may be delayed until hours or days after exposure depending on the magnitude of the absorbed dose. The major chemical warfare agents in this category are listed below along with their record number for quick access.

Sulfur Mustard, agents H and HD see M:1460
Sulfur Mustard, agent T or HT see M:1460
Nitrogen Mustard, agent HN-1 see E:0400
Nitrogen Mustard, agent HN-2 see M:0300
Nitrogen Mustard, agent HN-3 see T: 0960
Lewisite, agents L-1 and L-2 see HL L: 0250
Mustard-Lewisite, agent HL see L: 0250
Phosgene oxime, agent CX see P:0555

Blood agents

Blood agents, among the most lethal chemical weapon agents, disrupt the normal biochemical processes required by your cells to use oxygen. The major chemical warfare agents in this category are listed below along with their record number for quick access.

Arsine, agent SA see A:1580
Cyanogen chloride, agent CK see C:1620
Hydrogen cyanide, agent AC 74-90-8 see H:0440
Potassium cyanide (KCN) see P:0910
Sodium cyanide (NaCN) S:0450
Sodium monofluoroacetate see S:0480

Borax B:0573

Molecular Formula: $B_4H_2Na_2O_8$ (borax)

Common Formula: $Na_2B_4O_7 \cdot H_2O$ (borax); $Na_2B_4O_7 \cdot 5H_2O$ (borax pentahydrate)

Synonyms: *Borax:* Borato sodico (Spanish); Borato sodico, anhidro (Spanish); Disodium tetraborate; Sodium borate; Sodium borate decahydrate; Sodium tetraborate

Borax pentahydrate: Borate pentahydrate sodium; Tetraborate pentahydrate

CAS Registry Number: 1303-96-4 (borax); *(alt.) borax*: *(alt.)* 1344-90-7; *(alt.)* 12447-40-4; *(alt.)* 61028-24-8; 1330-43-4 (disodium tetraborate, anhydrous); 12179-04-3 (borax pentahydrate)

RTECS® Number: VZ2275000 (borax)

UN/NA & ERG Number: UN3077/171

EC Number: 215-540-4 [*Annex I Index No.:* 005-011-01-1] (*disodium tetraborate, anhydrous*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act, 55FR1470 Priority List.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% [sodium tetraborate (borax)].

Canada Drinking Water Quality: 5.0 mg/L IMAC.

Mexico Drinking Water Criteria: 1.0 mg/L.

European/International Regulations: (*disodium tetraborate, anhydrous*) Hazard Symbol: T; Risk phrases: R60; R61; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Nonwater polluting agent (*borax, decahydrate*).

Description: Borax is a noncombustible (an inherent fire retardant), bluish-gray or green, odorless crystalline powder or granules. Molecular weight = 301.37; Boiling point = 320°C; Freezing/Melting point = 75°C (rapid heating). Borax is soluble in water; solubility = 6% at 20°C. Borax pentahydrate is a white crystalline solid or free-flowing powder. Odorless. Molecular weight = 291.4; Specific gravity (H_2O:1) = 1.82; Melting Point: 200°C; Density: 1.82 g/cm^3. Soluble in water; solubility = 3%.

Potential Exposure: (*Borax*): Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Borax is used as a soldering flux, preservative against wood fungus, and as an antiseptic. Used in ant poisons, for fly control around refuse and manure piles, as a larvicide. It is used in the manufacture of enamels and glazes, fiberglass insulation; sodium perborate bleach; in tanning, cleaning compounds; for fireproofing fabrics and wood; and in artificial aging of wood.

Incompatibilities: Dissolves in water with some violence forming a basic solution.

Permissible Exposure Limits in Air

Borate compounds, inorganic (including borax)

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®: 2 mg/m^3 TWA (inhalable fraction); 6 mg/m^3 (inhalable fraction) not classifiable as a human carcinogen.

For particulates not otherwise classified (PNOC)

OSHA: 15 mg/m^3 TWA (Total dust); 5 mg/m^3 TWA (Respirable fraction).

DFG MAK: 4 mg/m^3 TWA (Inhalable fraction); 1.5 mg/m^3 TWA (Respirable fraction).

Protective Action Criteria (PAC)

Borax

TEEL-0: 17.6 mg/m^3

PAC-1: 52.9 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

Borax decahydrate (1330-43-4)

TEEL-0: 17.6 mg/m^3

PAC-1: 52.9 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

Borax pentahydrate [12179-04-3]

OSHA PEL: None.

NIOSH REL: 1 mg/m^3 TWA.

ACGIH TLV®: 2 mg/m^3 TWA inhalable fraction; 6 mg/m^3 TWA inhalable fraction; not classifiable as a human carcinogen (2004).

Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).

Determination in Water: Fish Tox: LC_{50} (goldfish, 72 h) = 178 mg/L; EC_{50} [*Daphnia magna* (water flea), 48 h] = 1.085−1.402 mg/L.

Permissible Concentration in Water: EPA in July 1976 established a criterion for boron of 750 μg/L for long-term irrigation on sensitive crops. More recently,[32] EPA has suggested an ambient water limit of 43 μg/L based on health effects.

Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion.

Harmful Effects and Symptoms

These effects vary greatly with the type of borax compound. Acute poisoning in humans from boric acid or borax is usually the result of application of dressings, powders, or ointment to large areas of burned or abraded skin, or accidental ingestion. The signs are nausea, abdominal pain, diarrhea and violent vomiting, sometimes bloody, which may be accompanied by headache and weakness. There is a characteristic erythematous rash followed by peeling. In severe cases, shock with fall in arterial pressure, tachycardia, and cyanosis occur. Marked CNS irritation, oliguria, and anuria may be present. The oral lethal dose in adults is over 30 g. Little information is available on chronic oral poisoning, although it is reported to be characterized by mild GI irritation, loss of appetite, disturbed digestion, nausea, possibly vomiting, and erythematous rash. The rash may be "hard" with a tendency to become purpuric. Dryness of skin and mucous membranes, reddening of tongue, cracking of lips, loss of hair, conjunctivitis, palpebral edema, gastrointestinal disturbances, and kidney injury have also been observed.

Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes, weakness, joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system, enzyme activity, carbohydrate metabolism, hormone function, and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys.

Short Term Exposure: Borax may affect the nervous system. Serious overexposure to borates can cause seizures, unconsciousness, and death.

Long Term Exposure: May cause brain, kidney, and liver damage. Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. Animal tests show that this substance possibly causes toxic effects upon human reproduction (WHO).

Medical Surveillance: No specific considerations are needed for boric acid or borates except for general health and liver and kidney function. In the case of boron trifluoride, the skin, eyes, and respiratory tract should receive special attention. In the case of the boranes, central nervous system and lung function will also be of special concern.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Workers involved with the manufacture of boric acid should be provided with masks to prevent inhalation of dust and fumes.

Storage: Color Code—Green: General storage may be used; Store in a cool, dry place away from incompatible materials listed above.

Shipping: Boric acid and Borax may be classified[52] as ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. These chemicals would require a shipping label of "CLASS 9." They fall in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water, or foam extinguishers. Irritating and toxic fumes are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Borax, dehydrated: The material is diluted to the recommended provisional limit (0.10 mg/L) in water. The pH is adjusted to between 6.5 and 9.1 and then the material can be discharged into sewers or natural streams.

References

Environmental Protection Agency. (August 1975). *Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Vol. 1: Boron*, Report EPA-560/2-75-005A. Washington, DC: Office of Toxic Substances

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Boron and Its Compounds*, Report PB 276,678. Rockville, MD, pp. 63−75

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 42−45 (1981) (Boron and Boric Acid) and 3, No. 5, 65−67 (1983). New York: Van Nostrand Reinhold Co.

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 76−78 (Sodium Borate)

New Jersey Department of Health and Senior Services. (November 2001). *Hazardous Substances Fact Sheet: Sodium Borates*. Trenton, NJ

Boric acid B:0576

Molecular Formula: BH_3O_3

Common Formula: H_3BO_3

Synonyms: Boracic acid; Basilit B; Borofax; Boron trihydroxide; Hydrogen orthoborate; Orthoboric acid

CAS Registry Number: 10043-35-3; *(alt)* 11113-50-1

RTECS$^®$ Number: ED4550000

UN/NA & ERG Number: UN3077/171

EC Number: 233-139-2 [*Annex I Index No.:* 005-007-00-2] (boric acid)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Listed in TSCA inventory.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act, 55FR1470 Priority List.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; Category D-2A.

European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Nonwater polluting agent.

Description: Boric acid is a white, amorphous powder or colorless, crystalline solid. Molecular weight = 61.84; Boiling point = 300°C (decomposes: loses 1/2 its H_2O); Freezing/Melting point = 170.9°C (decomposes above 100°C). Saturated solutions: at 0°C, 2.6% acid; at 100°C, 28% acid. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1. Boric acid is soluble in water; solubility = 4.7 g/100 mL at 20°C.

Potential Exposure: Compound Description (*Boric acid*): Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Boric acid is a fireproofing agent for wood, a preservative, and an antiseptic. It is used in the manufacture of glass, pottery, enamels, glazes, cosmetics, cements, porcelain, borates, leather, carpets, hats, soaps, artificial gems, in tanning leather, printing, dyeing, painting, and photography.

Incompatibilities: Boric acid decomposes in heat above 100°C, forming boric anhydride and water. Boric acid is hygroscopic; it will absorb moisture from the air. Boric acid aqueous solution is a weak acid; incompatible with strong reducing agents including alkali metals and metal hydrides (may generate explosive hydrogen gas), acetic anhydride, alkali carbonates, and hydroxides. Violent reaction with powdered potassium metal, especially if impacted. Attacks iron in the presence of moisture.

Permissible Exposure Limits in Air

Borate compounds, inorganic (including boric acid)

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®: 2 mg/m^3 TWA (inhalable fraction); 6 mg/m^3 (inhalable fraction) not classifiable as a human carcinogen.

For particulates not otherwise classified (PNOC)

OSHA: 15 mg/m^3 TWA (Total dust); 5 mg/m^3 TWA (Respirable fraction).

DFG MAK: 4 mg/m^3 TWA (Inhalable fraction); 1.5 mg/m^3 TWA (Respirable fraction).

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 150 mg/m^3

Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).

Determination in Water: Fish Tox: LC_{50} (goldfish, 72 h) = 178 mg/L; EC_{50} [*Daphnia magna* (water flea), 48 h] = 1.085−1.402 mg/L.

Permissible Concentration in Water: EPA in July 1976 established a criterion for boron of 750 μg/L for long-term irrigation on sensitive crops. More recently,[32] EPA has suggested an ambient water limit of 43 μg/L based on health effects.

Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion.

Harmful Effects and Symptoms

Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes, weakness, joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system, enzyme activity, carbohydrate metabolism, hormone function, and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys. Based on animal studies, may be fetotoxic, affect reproductive material and fertility; teratogenic effects.

Short Term Exposure: Boric acid dust or aqueous solutions cause irritation of the eyes, skin, and the respiratory tract. Boric acid dust is absorbed through mucous membranes but not through the unbroken skin. Solutions and dust can be absorbed in harmful amounts through abraded skin, burns, and open wounds. Prolonged skin contact may cause dermatitis. If absorbed through the broken skin, boron may affect behavior, metabolism, sense organs, the gastrointestinal tract, and respiratory tract (respiratory depression). Ingestion can cause digestive/gastrointestinal tract irritation with symptoms of nausea, vomiting, and diarrhea. Prolonged or high levels of exposure may cause effects on the gastrointestinal tract, liver, and kidneys. Prolonged exposure to boric acid may affect the nervous system. Serious overexposure can cause seizures, unconsciousness, and death. Ingestion of 5 g or more may irritate gastrointestinal tract and affect central nervous system; may be fatal to some adults. LD_{50} = (rat-oral) 2660 mg/kg; 3450 (mouse-oral) mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. May affect behavior, cause damage to the brain, kidneys, liver, cardiovascular system, central nervous system (CNS), peripheral nervous system (PNS), cardiovascular system, blood, liver, urinary system (kidney, ureter, bladder), and endocrine system. Animal tests show that this substance possibly causes toxic effects upon human reproduction.[WHO]

Medical Surveillance: Check for eye and skin disorder problems. Tests for liver, kidney, or respiratory function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Workers involved with the manufacture of boric acid should be provided with masks to prevent inhalation of dust and fumes. Wear impervious gloves: recommended gloves include Butyl rubber, Neoprene, Viton™.

Respirator Selection: A respiratory protection program that meets OSHA's Respiratory Protection Standard 29 CFR 1910.134 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use. Oxygen levels below 19.5% are considered IDLH by NIOSH/OSHA and require use of a full-facepiece pressure/demand SCBA; or, a full facepiece, supplied-air respirator with auxiliary self-contained air supply is required under 1910.134-1998.

Storage: Color Code—Green: General storage may be used. Store in a cool, dry place away from incompatible materials listed above.

Shipping: Boric acid may be classified[52] as ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. This chemical would require a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water, or foam extinguishers. Irritating and toxic fumes are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Boric acids may be recovered from organic process wastes as an alternative to disposal.

References

Environmental Protection Agency. (August 1975). *Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Vol. 1: Boron*, Report EPA-560/2-75-005A. Washington, DC: Office of Toxic Substances

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Boron and Its Compounds*, Report PB 276,678. Rockville, MD, pp. 63−75

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 42−45 (1981) (Boron and boric acid) and 3, No. 5, 65−67 (1983). New York: Van Nostrand Reinhold Co.

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 76−78 (Sodium Borate)

New Jersey Department of Health and Senior Services. (November 2001). *Hazardous Substances Fact Sheet: Sodium Borates*. Trenton, NJ

Boron and compounds B:0580

Molecular Formula: B

Synonyms: There are no common synonyms for boron.

CAS Registry Number: 7440-42-8

RTECS® Number: ED7350000

UN/NA & ERG Number: UN3178 (Flammable solid, inorganic, n.o.s.)/133

EC Number: 231-151-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act, 55FR1470 Priority List.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% [boric acid, sodium tetraborate (borax)].

Canada Drinking Water Quality: 5.0 mg/L IMAC.

Mexico Drinking Water Criteria: 1.0 mg/L.

WGK (German Aquatic Hazard Class): 1—Nonwater polluting agent (*boron, borax*).

Description: Boron is a yellow or brownish-black powder and may be either crystalline or amorphous. It does not occur free in nature and is found in the minerals borax, colemanite, boronatrocalcite, and boracite. Molecular weight = 10.81; Freezing/Melting point = 2190°C; 2079°C (highly purified). Boiling point = 3660°C; 2550°C (highly purified); Autoignition temperature = 580°C. Hazard Identification (based on NFPA-704 M Rating System) (*boron, 1000 μg/mL*) Health 1, Flammability 1, Reactivity 0; (*Boron, 10,000 μg/mL)*: Health 2, Flammability 1, Reactivity 2. Practically insoluble in water.

Potential Exposure: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Boron is used in metallurgy as a degasifying agent and is alloyed with aluminum, iron, and steel to increase hardness. It is also a neutron absorber in nuclear reactors. Boron is frequently encountered in a variety of chemical formulations including boric acid, various borate salts, borax, and boron soil supplements.

Incompatibilities: Boron dust forms explosive mixture in air. Contact with strong oxidizers may cause explosions. Violent reaction (possible explosion) with concentrated nitric acid, hydrogen iodide, silver fluoride. Boron is incompatible with ammonia, bromine tetrafluoride, cesium carbide, chlorine, fluorine, interhalogens, iodic acid, lead dioxide, nitric acid, nitrosyl fluoride, nitrous oxide, potassium nitrite, rubidium carbide. Reacts exothermically with metals at high temperature above 900°C.

Permissible Exposure Limits in Air

For particulates not otherwise classified (PNOC)

OSHA: 15 mg/m^3 TWA (Total dust); 5 mg/m^3 TWA (Respirable fraction).

DFG MAK: 4 mg/m^3 TWA (Inhalable fraction); 1.5 mg/m^3 TWA (Respirable fraction).

Borate compounds, inorganic (including 1330-43-4; 1303-96-4; 10043-35-3; 12179-04-3)

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®: 2 mg/m^3 TWA (inhalable fraction); 6 mg/m^3 (inhalable fraction) not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

Boron (elemental)

TEEL-0: 1.5 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 250 mg/m^3

1303-96-4 (sodium borate decahydrate)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

1330-43-4 (sodium borate; disodium tetraborate; borates, tetrasodium salts)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 500 mg/m^3

16940-66-2 (sodium borohydride)

TEEL-0: 0.015 mg/m^3

PAC-1: 0.05 mg/m^3

PAC-2: 0.35 mg/m^3

PAC-3: 4 mg/m^3

Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).

Determination in Water: Fish Tox: LC$_{50}$ (goldfish, 72 h) = 178 mg/L; EC$_{50}$ [*Daphnia magna* (water flea), 48 h] = 1.085−1.402 mg/L.

Permissible Concentration in Water: Regular use of irrigation water with more than 1 ppm boron is harmful to most kinds of plants. In July 1976 the US EPA established a criterion for boron of 750 μg/L for long-term irrigation on sensitive crops. More recently,[32] EPA has suggested an ambient water limit of 43 μg/L based on health effects. There is no mandatory maximum limit in the United States for boron in drinking water, but when last reported in 1996, US EPA was considering adoption of 0.6 ppm as the standard. The World Health Organization (WHO) and several European countries have adopted or recommended drinking water limits for boron of 0.3 ppm.

Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion; skin absorption.

Harmful Effects and Symptoms

Boron compounds may produce irritation of the nasal mucous membranes, the respiratory tract, and eyes. *Systemic:* These effects vary greatly with the type of compound. Acute poisoning in humans from boric acid or borax is usually the result of application of dressings, powders, or ointment to large areas of burned or abraded skin, or accidental ingestion. The signs are nausea, abdominal pain, diarrhea, and violent vomiting, sometimes bloody, which may be accompanied by headache and weakness. There is a characteristic erythematous rash followed by peeling. In severe cases, shock with fall in arterial pressure, tachycardia, and cyanosis occur. Marked CNS irritation, oliguria, and anuria may be present. The oral lethal dose in adults is over 30 g. Little information is available on chronic oral poisoning, although it is reported to be characterized by mild GI irritation, loss of appetite, disturbed digestion, nausea, possibly vomiting, and erythematous rash. The rash may be "hard" with a tendency to become purpuric. Dryness of skin and mucous membranes, reddening of tongue, cracking of lips, loss of hair, conjunctivitis, palpebral edema, gastrointestinal disturbances, and kidney injury have also been observed. Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes, weakness, joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system, enzyme activity, carbohydrate metabolism, hormone function, and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys. No toxic effects have been attributed to elemental boron.

Short Term Exposure: Irritating by skin and eye contact. Can be absorbed through the skin. Harmful by inhalation and ingestion. LD_{50} = (mouse-oral) 560 mg/kg; (oral-rat) 650 mg/kg. High exposure may cause central nervous system (CNS) disturbances.

Long Term Exposure: May cause brain, kidney, and liver damage. Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. Animal tests show that this substance possibly causes toxic effects upon human reproduction (WHO). Repeated exposure may cause central nervous system (CNS) effects.

Medical Surveillance: No specific considerations are needed for boric acid or borates except for general health and liver and kidney function. In the case of boron trifluoride, the skin, eyes, and respiratory tract should receive special attention. In the case of boranes, central nervous system and lung function will also be of special concern.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Safety glasses, respirator, adequate ventilation.

Respirator Selection: A respiratory protection program that meets OSHA's 29 CFR 1910.134 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use. In many cases, a dust respirator meeting these standards may suffice.

Storage: Dust is a flammable solid. Store in a cool, dry place away from incompatible material, sources of heat and ignition. Boron powder may decompose on exposure to air and may have to be stored under a nitrogen blanket.

Shipping: These materials are not specifically cited in the DOT performance-oriented packaging regulations.[19] However, boron requires a shipping label of "FLAMMABLE SOLID." Based on this description, it would fall in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water, or foam extinguishers. Irritating and toxic fumes are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Environmental Protection Agency. (August 1975). *Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Vol. 1: Boron*, Report EPA-560/2-75-005A. Washington, DC: Office of Toxic Substances

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Boron and Its Compounds*, Report PB 276,678. Rockville, MD, pp. 63−75

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 42−45 (1981) (Boron and Boric Acid) and 3, No. 5, 65−67 (1983). New York: Van Nostrand Reinhold Co.

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 76−78 (Sodium Borate)

New Jersey Department of Health and Senior Services. (November 2001). *Hazardous Substances Fact Sheet: Sodium Borates.* Trenton, NJ

Oregon Department of Human Services, Environmental Toxicology Section, Drinking Water Section. (January 1996). *Technical Bulletin, Health Effects Information, Boron.* Portland, OR

Boron oxide B:0590

Molecular Formula: B_2O_3

Synonyms: Anhydrous boric acid; Boric anhydride; Boron sesquioxide; Boron trioxide; Diboron trioxide; Fused boric acid; Oxido de boro (Spanish)

CAS Registry Number: 1303-86-2

RTECS® Number: ED7900000

UN/NA & ERG Number: UN3077/171

EC Number: 215-125-8 [*Annex I Index No.:* 005-008-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as boric anhydride.

European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Boron oxide is a noncombustible, colorless, semitransparent lumps or hard, white, odorless crystals, with slightly bitter taste. Molecular weight = 69.64; Boiling point = about 1860°C; Freezing/Melting point = about 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Moderately soluble in water; solubility = (moderate) 3%; slow reaction.

Potential Exposure: Compound Description: Primary Irritant. Boron oxide is used in glass manufacture and the production of other boron compounds. It is used in fluxes, enamels, drying agents, and as a catalyst.

Incompatibilities: Bromine pentafluoride, calcium oxide. Reacts slowly with water, forming boric acid.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA (total dust).

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 10 mg/m^3 TWA.

NIOSH IDLH: 2000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 300 mg/m^3

PAC-3: 500 mg/m^3

Austria: MAK 15 mg/m^3, 1993; Denmark: TWA 10 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 10 mg/m^3, 1999; the Philippines: TWA 15 mg/m^3, 1993; Poland: MAC (TWA) 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3. Several states have set guidelines or standards for boron oxide in ambient air[60] ranging from 10 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Collection on a filter and gravimetric analysis. Use NIOSH Analytical Method #0500 Particulates NOR, total dust.[18]

Determination in Water: Fish Tox: LC50 (goldfish, 72 h) = 570 mg/L; EC$_{50}$ [*Daphnia magna* (water flea), 48 h] = 370−490 mg/L.

Permissible Concentration in Water: No criteria set but EPA has suggested[32] an ambient water limit of 138 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May irritate the skin, causing a rash or burning feeling on contact. May cause nasal irritation, conjunctivitis, erythema. Ingestion causes abdominal pain, diarrhea, nausea, vomiting. Low toxicity. The oral LD$_{50}$ mouse is 3163 mg/kg.[9]

Long Term Exposure: Unknown at this time.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *100 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *250 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *500 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *2000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a dry, well-ventilated area away from incompatible materials listed above and water.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical may require a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Moisten dry material to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Boron oxide is a noncombustible solid. Extinguish fire using an agent suitable for type of surrounding fire. Boron oxide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Boron Oxide*. Trenton, NJ

Boron tribromide B:0600

Molecular Formula: BBr_3

Synonyms: Borane, tribromo-; Boron bromide; Boron tribromide 6; Tribromoborand; Tribromuro de boro (Spanish); Trona

CAS Registry Number: 10294-33-4

RTECS® Number: ED7400000

UN/NA & ERG Number: UN2692/157

EC Number: 233-657-9 [*Annex I Index No.:* 005-003-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 (≥12.67% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, C; Risk phrases: R14; R26/28; R35; Safety phrases: S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Boron tribromide is a colorless, fuming liquid. Molecular weight = 250.57. Boiling point = 90°C; Freezing/Melting point = −46°C; Vapor pressure = 53 hPa at 14°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2. Soluble in water; dangerous reaction.

Potential Exposure: Boron tribromide is highly toxic and corrosive, it is used as a catalyst in organic synthesis, making diborane, high purity boron, and semiconductors.

Incompatibilities: Reacts violently and explosively with water, steam, or alcohols, forming toxic, corrosive, and potentially explosive hydrogen bromide gas. Mixtures with potassium or sodium can explode on impact. Incompatible with oxidizers, strong bases. Attacks some metals, rubbers, and plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.25 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/10 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: **0.33** ppm

PAC-2: **7.3** ppm

PAC-3: **40** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Australia: TWA 1 ppm (10 mg/m^3), 1993; Austria: MAK 1 ppm (10 mg/m^3), 1999; Belgium: STEL 1 ppm (10 mg/m^3), 1993; Denmark: TWA 1 ppm (10 mg/m^3), 1999; Finland: TWA 1 ppm (10 mg/m^3); STEL 3 ppm (30 mg/m^3), 1999; Norway: TWA 1 ppm (10 mg/m^3), 1999; Switzerland: MAK-W 1 ppm (10 mg/m^3), 1999; the Netherlands: MAC 10 mg/m^3 (total dust), 2003; Argentina, Bulgaria, Columbia, Israel, Jordan, South Korea, New Zealand, Singapore, Vietnam: use ACGIH TLV Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron tribromide in ambient air[60] ranging from 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Water: No method established. Reaction.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Eyes, skin, respiratory system.

Harmful Effects and Symptoms

Short Term Exposure: Boron tribromide is highly toxic and can affect you when inhaled, on skin contact and by eye contact. Boron tribromide is a corrosive liquid and exposure can cause severe burns of the eyes, nose, throat, lungs, and skin. Boron tribromide may cause cough, headache, nose bleeds, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause a brownish color of the tongue and/or runny nose. May cause irritation of the lungs and bronchitis to develop. May cause kidney damage and affect the nervous system.

Points of Attack: Kidneys, nervous system, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests, kidney function tests, examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Gloves made of chlorinated polyethylene are considered fair to good protection for boron tribromide. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over* 1 ppm, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with an acid gas canister. Increased protection is obtained from full face-piece-powered air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where boron tribromide may be present, check to make sure that an explosive concentration does not exist. Store in airtight, unbreakable containers in a cool well-ventilated area away from water, steam, potassium, sodium, alcohol, and other incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Boron tribromide requires a "CORROSIVE, POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 8 and Packing Group I. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stop discharge if possible. Avoid contact with liquid or vapor.[41] Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Ventilate area of leak or spill after cleanup is complete. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)

when spilled in water

Day 0.3/0.5
Night 0.6/1.4
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.9/3.1

Fire Extinguishing: This chemical decomposes in heat and may explode. Use dry chemical or carbon dioxide. Do not use foam. Do not use water on material itself. Water can be used to cool intact containers and to absorb vapors. Poisonous gases are produced in fire, including hydrogen bromide and boron oxides. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Boron Tribromide*. Trenton, NJ

Boron trichloride B:0610

Molecular Formula: BCl_3

Synonyms: Borane, trichloro-; Boron chloride; Chlorure de bore (French); Trichloroborane; Trichloroboron; Tricloruro de boro (Spanish); Trona

CAS Registry Number: 10294-34-5; *(alt.)* 31012-04-1

RTECS® Number: ED1925000

UN/NA & ERG Number: UN1741 (poison gas, corrosive)/125

EC Number: 233-658-4 [*Annex I Index No.:* 005-002-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration). *Theft hazard* 45 (≥84.70% concentration).

Listed on the TSCA inventory.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R14; R26/28; R34; Safety phrases: S1/2; S9; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Boron trichloride is a colorless liquid or liquefied gas with a pungent, irritating odor. Molecular weight = 117.2; Specific gravity (H_2O:1) = 1.35 at 11°C; Boiling point = 12.5°C; Freezing/Melting point = − 107°C;

Vapor pressure = 985 mmHg at 20°C; Relative vapor density (air = 1) = 4.02. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Insoluble in water (reaction).

Potential Exposure: Used in refining of aluminum, magnesium, copper alloys, and in polymerization of styrene. Manufacture and purification of boron; catalyst in organic reactions; semiconductors; bonding of iron or steel; purification of metal alloys to remove oxides, nitrides, and carbides; chemical intermediate for boron filaments; soldering flux; electrical resistors; and extinguishing magnesium fires in heat treating furnaces.

Incompatibilities: Incompatible with lead, graphite-impregnated asbestos, potassium, sodium. Vigorously attacks elastomers, packing materials, natural and synthetic rubber; viton, tygon, saran, silastic elastomers. Avoid aniline, hexafluorisopropylidene amino lithium, nitrogen dioxide, phosphine, grease, organic matter, and oxygen, nitrogen, peroxide, and phosphine. Fat or grease reacts vigorously with boron trichloride. It reacts with water or steam to produce heat, boric acid, and corrosive hydrochloric acid fumes. Oxygen and boron trichloride react vigorously on sparking. Attacks most metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.3 ppm
PAC-2: 2.09 ppm
PAC-3: 2.5 ppm

Boron trichloride is a poisonous, corrosive gas. Other than TEELs shown above, no other numerical standards have been established. Since the hydrolysis product, HCl, tends to govern the effect in moist air, reference should be made to the limit for hydrogen chloride as follows:

OSHA PEL: 5 ppm/7 mg/m^3 Ceiling Concentration.
NIOSH REL: 5 ppm/7 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 5 ppm/7.5 mg/m^3 Ceiling Concentration; not classifiable as a human carcinogen.
NIOSH IDLH: 50.
DFG MAK: 5 ppm/7.6 mg/m^3, Pregnancy Risk Group C.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Extremely corrosive to the eyes, skin, and respiratory tract. Contact with eyes produces severe pain, swelling, corneal erosions, and blindness. Viscid white or blood-stained foamy mucus and threads of tissue may appear in mouth. Inhalation can cause low blood oxygen, difficulty in breathing; chest pain and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms of overexposure include depression of circulation, persistent vomiting and diarrhea, profound shock and coma. Temperature becomes subnormal and rash may cover entire body. Boron affects the central nervous system causing depression of circulation as well as shock and coma. May result in marked fluid and electrolyte loss and shock.

Long Term Exposure: Can cause liver, kidney, and brain damage.

Medical Surveillance: Consider X-ray following acute overexposure. Liver, kidney, and lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention immediately. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Before entering confined space where boron trichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated, fireproof place. Metal containers involving the transfer of this chemical should be grounded and bonded. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: This chemical requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3 (poison) hazard Zone B, with no Packing Group cited.[19, 20]

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Seek expert help. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid breathing vapors. Keep upwind. Remove all ignition sources. Ventilate area of leak or spill. Isolate area until gas has dispersed. Stop leak if you can do so without risk. Keep material out of water sources and sewers. Use water spray to knock down vapors. Do not use water on material itself. Neutralize spilled material with crushed limestone, soda ash, or lime. Collect neutralized material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day	0.4/0.6
Night	1.0/1.5

when spilled in water

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day	0.8/1.2
Night	2.4/3.8

Fire Extinguishing: Boron trichloride is not combustible but decomposes in heat forming chlorine. Reacts with water forming boric acid and hydrochloric acid fumes. Use dry chemical, carbon dioxide, or dry sand to extinguish. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog. Use water spray to absorb vapors. For large fires use water spray, fog, or foam. *Do not get water on material itself.* Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed, undamaged containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Boron Trichloride*. Washington, DC: Chemical Emergency Preparedness Program

Boron trifluoride B:0620

Molecular Formula: BF_3

Synonyms: Borane, trifluoro-; Boron fluoride; Fluorure de bore (French); Leecure B; Leecure, B series; Trifluoroborane; Trifluoroboron; Trifluoruro de boro (Spanish)

CAS Registry Number: 7637-07-2; 13319-75-0 (dihydrate)

RTECS® Number: ED2275000

UN/NA & ERG Number: UN1008/125

EC Number: 231-569-5 [*Annex I Index No.:* 005-001-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration); *Theft hazard* 45 (≥26.87% concentration).

Listed in the TSCA inventory.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

Safe Drinking Water Act as boron: Priority List (55FR1470).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, C; Risk phrases: R14; R26; R35; Safety phrases: S1/2; S9; S26; S28; S36/37/39; S45; European/International Regulations (*dihydrate*): not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Boron trifluoride is a nonflammable, colorless gas with a pungent, suffocating odor. Forms dense white fumes in moist air. Shipped as a nonliquefied compressed gas. Molecular weight = 67.8; Relative vapor density (air = 1) = 2.38; Boiling point = −100°C; Freezing/Melting point = −127°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1₩. Reacts with water; solubility in cold water = 106%.

Potential Exposure: Boron trifluoride is a highly reactive chemical used primarily as a catalyst in chemical synthesis. It is stored and transported as a gas, but can be reacted with a variety of materials to form both liquid and solid compounds. The magnesium industry utilizes the fire-retardant and antioxidant properties of boron trifluoride in casing and heat treating. Nuclear applications of boron trifluoride include neutron detector instruments; boron-10 enrichment; and the production of neutroabsorbing salts for molten-salt breeder reactors.

Incompatibilities: Boron trifluoride reacts with polymerized unsaturated compounds. Decomposes on contact with water, moist air, and other forms of moisture, forming toxic and corrosive hydrogen fluoride, fluoroboric acid, and boric acid. Reacts violently with alkali and alkaline earth metals (except magnesium); metals, such as sodium, potassium, and calcium oxide, and with alkyl nitrates. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

OSHA PEL: 1 ppm/3 mg/m^3 Ceiling Concentration.

NIOSH REL: 1 ppm/3 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/2.8 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 25 ppm.

Protective Action Criteria (PAC)*

Includes dihydrate

TEEL-0: 0.75 mg/m^3

PAC-1: **2.5** mg/m^3

PAC-2: **37** mg/m^3

PAC-3: **110** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Arab Republic of Egypt: TWA 1 ppm (3 mg/m^3), 1993; Australia: TWA 1 ppm (3 mg/m^3), 1993; Austria: MAK 1 ppm (3 mg/m^3), 1999; Belgium: STEL 1 ppm (2.8 mg/m^3), 1993; Denmark: TWA 1 ppm (3 mg/m^3), 1999; Finland: TWA 1 ppm (3 mg/m^3); STEL 3 ppm (8.3 mg/m^3), 1999; France: VLE 1 ppm (3 mg/m^3), 1999; the Netherlands: MAC 3 mg/m^3, 2003; Japan: 0.3 ppm (0.83 mg/m^3), 1999; Norway: TWA 1 ppm (3 mg/m^3), 1999; the Philippines: STEL 1 ppm (3 mg/m^3), 1993; Russia: TWA 0.3 ppm; STEL 1 mg/m^3, 1993; Switzerland: MAK-W 1 ppm (3 mg/m^3), KZG-W 2 ppm (6 mg/m^3), 1999; Thailand: TWA 1 ppm (3 mg/m^3), 1993; Turkey: TWA 1 ppm (3 mg/m^3), 1993; United Kingdom: STEL 1 ppm (2.8 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron trifluoride in ambient air[60] ranging from 0 μg/m^3 (Connecticut) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (North Dakota) to 71 μg/m^3 (Nevada).

Determination in Air: Collection by an impinger preceded by a filter followed by colorimetric analysis.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Boron trifluoride gas, upon contact with air, immediately reacts with water vapor to form a mist; which, if at a high enough concentration, provides a visible warning of its presence. The gas or mist is severely irritating and corrosive to the skin, eyes, and respiratory system. Inhalation causes coughing and breathing difficulties. Boron trifluoride is highly toxic; may cause death, by inflammation, lung congestion, or pulmonary edema, a medical emergency that can be delayed for several hours. Death or permanent injury can result from very short exposure to small quantities (an estimated 40−60 ppm for 30−60 min.). Contact with the skin and eyes can cause redness, pain, and serious burns. May cause depression of the central nervous system. Rapid evaporation of the liquid may cause frostbite.

The toxic action of the halogenated borons (boron trifluoride and trichloride) is considerably influenced by their halogenated decomposition products. They are primary irritants of the nasal passages, respiratory tract, and eyes in man. Animal experiments showed a fall in inorganic phosphorus level in blood and on autopsy, pneumonia, and degenerative changes in renal tubules.

Long Term Exposure: May cause liver and kidney damage. Long-term exposure leads to irrigation of the respiratory tract, dysproteinemia, reduction in cholinesterase activity, increased nervous system liability.

Points of Attack: Respiratory system, kidneys, eyes, skin.

Medical Surveillance: In the absence of a suitable monitoring method, NIOSH recommends that medical surveillance, including comprehensive preplacement and annual periodic examinations be made available to all workers employed in areas where boron trifluoride is manufactured, used, handled, or is evolved as a result of chemical processes.

First Aid: If contact with liquid, treat for frostbite. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Engineering controls should be used to maintain boron trifluoride concentrations at the lowest feasible level. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots; Responder™ suits. Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* SA* (any supplied-air respirator). *25 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison gas. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Protect cylinders against extreme temperature changes; dropping, falling, or physical damage. Store outdoors or in a cool, well-ventilated, dry area in a noncombustible structure away from incompatible materials listed above. Cylinders must not be exposed to temperatures below −28.9°C or above 54.4°C.

Shipping: This chemical requires a shipping label of "POISON GAS." The Hazard Class is 2.3 (poison) Hazard Zone B, with no Packing Group cited.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse gas. Stop leak if you can do it without risk. Use water spray to reduce vapor but do not put water on leak or spill area. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Do not get water inside container. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

Liquid

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.2/1.9
Night 3.0/4.8

Compressed

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.2/1.9
Night 3.0/4.8

Fire Extinguishing: Do not use water. For small fire use dry chemical or carbon dioxide. On larger fires use any agent suitable for surrounding fire. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chemical reaction with water to form boric acid and fluoroboric acid. The fluoroboric acid is reacted with limestone, forming boric acid and calcium fluoride. The boric acid may be discharged into a sanitary sewer system while the calcium fluoride may be recovered or landfilled. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Boron Trifluoride*, NIOSH Document No. 77−122, Washington, DC

US Environmental Protection Agency. (1987). *Chemical Hazard Information Profile: Boron Trifluoride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 1996). *Hazardous Substances Fact Sheet: Boron Trifluoride*. Trenton, NJ

Boron trifluoride etherates B:0630

Molecular Formula: $C_2H_6BF_3O$ (*with methyl ether*); $C_4H_{10}BF_3O$ (*with ethyl ether*)

Common Formula: $CH_3OCH_3 \cdot BF_3$ (*with methyl ether*); $C_2H_5OC_2H_5 \cdot BF_3$ (*with ethyl ether*)

Synonyms: Boron trifluoride diethyl etherate; Boron trifluoride dimethyl ether; Boron trifluoride dimethyl etherate; Boron trifluoride etherate; Fluorid bority dimethyl ether

CAS Registry Number: 353-42-4 (*compounded with methyl ether*); 109-63-7 (*compounded with ethyl ether*); 373-57-9 (*methanol complex in excess methanol*)

RTECS® Number: ED8400000 (*with methyl ether*); KX7375000 (*with ethyl ether*)

UN/NA & ERG Number: UN2965 (dimethyl etherate)/139; UN2604 (diethyl etherate)/132

EC Number: 206-532-1 (*with dimethyl ether*); 203-689-8 (*with diethyl ether*)

Regulatory Authority and Advisory Bodies

The following is for 353-42-4 (with methyl ether), except as noted.

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 ($\geq$1.00% concentration) [Boron trifluoride compound with methyl ether (1:1)].

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

Safe Drinking Water Act as boron: Priority List (55FR1470).

Reportable Quantity (RQ): 1000 lb (454 kg) (with methyl ether).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg) (with methyl ether).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% [109-63-7 (*boron trifluoride diethyletherate*)].

WGK (German Aquatic Hazard Class): No value assigned.

Description: Boron trifluoride etherates:

(*compounded with methyl ether*) is moisture-sensitive, corrosive, flammable liquid. Molecular weight = 113.9; Boiling point = 126−127°C; Freezing/Melting point = −14°C. Hazard Identification (based on NFPA-704 M Rating System): (*dimethyl etherate/UN 2965*) Health 4, Flammability 4, Reactivity 1₩.

(*compounded with ethyl ether*) is a moisture-sensitive, corrosive, flammable liquid. Molecular weight = 141.9; Boiling point = 126°C; Freezing/Melting point = −58°C; Flash point = 64°C (oc). Hazard Identification (based on NFPA-704 M Rating System) (*methyl ether*): Health 3, Flammability 3, Reactivity 1₩. Decomposes in water.

(*methanol complex in excess methanol*) Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 1.

Potential Exposure: Used as a catalyst.

Incompatibilities: Reacts with air forming corrosive hydrogen fluoride vapors. Incompatible with oxidizers (may cause fire and explosion), water, steam or heat, forming corrosive and flammable vapors. Peroxide containing etherate reacts explosively with aluminum lithium hydride, magnesium tetrahydroaluminate. Mixtures with phenol react explosively with 1,3-butadiene. Presumed to form explosive peroxides.

Permissible Exposure Limits in Air

There are no airborne exposure limits for the etherates. Exposure limits for boron trifluoride may be applicable in most cases as follows:

OSHA PEL: 1 ppm/3 mg/m^3 Ceiling Concentration.

NIOSH REL: 1 ppm/3 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/2.8 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 25 ppm.

Protective Action Criteria (PAC)*

With methyl ether

TEEL-0: 0.75 mg/m^3

PAC-1: **2.5** mg/m^3

PAC-2: **37** mg/m^3

PAC-3: **110** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

With ethyl ether

TEEL-0: 9.34 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

Arab Republic of Egypt: TWA 1 ppm (3 mg/m^3), 1993; Australia: TWA 1 ppm (3 mg/m^3), 1993; Austria: MAK 1 ppm (3 mg/m^3), 1999; Belgium: STEL 1 ppm (2.8 mg/m^3), 1993; Denmark: TWA 1 ppm (3 mg/m^3), 1999; Finland: TWA 1 ppm (3 mg/m^3); STEL 3 ppm (8.3 mg/m^3), 1999; France: VLE 1 ppm (3 mg/m^3), 1999; the Netherlands: MAC 3 mg/m^3, 2003; Japan: 0.3 ppm (0.83 mg/m^3), 1999; Norway: TWA 1 ppm (3 mg/m^3), 1999; the Philippines: STEL 1 ppm (3 mg/m^3), 1993; Russia: TWA 0.3 ppm; STEL 1 mg/m^3, 1993; Switzerland: MAK-W 1 ppm (3 mg/m^3), KZG-W 2 ppm (6 mg/m^3), 1999; Thailand: TWA 1 ppm (3 mg/m^3), 1993; Turkey: TWA 1 ppm (3 mg/m^3), 1993; United Kingdom: STEL 1 ppm (2.8 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron trifluoride in ambient air[60] ranging from 0 μg/m^3 (Connecticut) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (North Dakota) to 71 μg/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: These compounds are corrosive. Contact may cause severe burns to skin and eyes. The boron fluoride etherates are highly toxic by inhalation. Inhalation may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can cause kidney damage.

Points of Attack: Kidneys.

Medical Surveillance: Consider chest x-ray following acute overexposure. Kidney and lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (as boron trifluoride) *10 ppm:* SA* (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Before entering confined space where these chemicals may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The DOT-required label for the dimethyl etherate [UN2965] is "DANGEROUS WHEN WET, CORROSIVE, FLAMMABLE LIQUID." The Hazard Class in 4.3 and the Packing Group is I.[19, 20]

The diethyl etherate [UN2604] requires a "CORROSIVE FLAMMABLE LIQUID" label. It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spill material. Use water spray to reduce vapors, but do not get water inside containers. For *small spills*, absorb with sand or other noncombustible absorbent material and place into containers. For *large spills*, dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires use dry chemical, carbon dioxide, water spray, or foam extinguishers. For large fires, use water spray, fog, or foam. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Boron Trifluoride Compound with Methyl Ether (1:1)*. Washington, DC: Chemical Emergency Preparedness Program

Bromacil B:0640

Molecular Formula: $C_9H_{13}BrN_2O_2$

Synonyms: Borea; Borocil extra; Bromacil 1.5; alpha-Bromacil 80 WP; Bromax; Bromazil; 5-Bromo-3-*sec*-butyl-6-methyluracil; 5-Bromo-6-methyl-3-(1-methylpropyl)-2,4-(1H,3H)-pyrimidinedione; 5-Bromo-6-methyl-3-(1-methylpropyl)-2,4(1H,3H)-pyrimidinedione; 3-*sec*-Butyl-5-bromo-6-methyluracil (German); Croptex onyx; Cynogan; Dupont herbicide 976; Eerex; Eerex granular weed killer; Eerex water soluble granular weed killer; Fenocil; Herbicide 976; Hydon; Hyvar; Hyvarex; Hyvar-EX; Hyvar X; Hyvar X-7; Hyvar X Bromacil; Hyvar X weed killer; Hyvar X-WS; Krovar II; Nalkil; 2,4(1H,3H)-Pyrimidinedione, 5-bromo-6-methyl-3-(1-methylpropyl)-; Uracil, 5-Bromo-3-*sec*-butyl-6-methyl; Uragan; Uragon; Urox; Urox B; Urox B water soluble concentrate weed killer; Urox-HX; Urox HX granular weed killer

CAS Registry Number: 314-40-9; *(alt.)* 154670-12-9

RTECS® Number: YQ9100000

UN/NA & ERG Number: NA1993 [For Domestic Bulk Shipments: Proper shipping name: Combustible liquid, n.o.s. (Ethanol, Methanol)]/128

EC Number: 206-245-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: Priority List (55FR1470).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bromacil is a noncombustible colorless, crystalline solid, that may be dissolved in a flammable liquid. Molecular weight = 261.2; Specific gravity (H_2O:1) = 1.55 at 25°C; Boiling point = (sublimes); Freezing/Melting point = 158.3°C (sublimes); Vapor pressure = 0.0008 mmHg at 25°C (NIOSH); 3.1×10^{-7} mmHg (EPA); Flash point (*in ethanol or methanol*) = 44°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0; (*in ethanol or methanol*): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water; 0.08% at 77°F/25°C. Commercial formulations use carrier solvents that may alter the physical properties shown.

Potential Exposure: Compound Description: Agricultural Chemical, Mutagen, Reproductive Effector. Used for general weed or brush control in noncrop areas and primarily for the control of annual and perennial grasses and broadleaf weeds, both nonselectively on noncrop lands and selectively for weed control in a few crops (citrus and pineapple). A limit of 0.1 mg/kg of agricultural products is set in several countries.[35] Those exposed will be those involved in manufacture, formulation, and application.

Incompatibilities: Incompatible with strong acids, oxidizers, heat. Decomposes slowly in strong acids.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.68 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/10 mg/m^3 TWA.

ACGIH 10 mg/m^3 TWA, confirmed animal carcinogen with unknown relevance to humans.

No TEEL available.

Australia: TWA 1 ppm (10 mg/m^3), 1993; Belgium: TWA 1 ppm (11 mg/m^3), 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 1 ppm (10 mg/m^3); STEL 3 ppm (30 mg/m^3), 1999; France: VME 1 ppm (10 mg/m^3), 1999; Switzerland: MAK-W 1 ppm (10 mg/m^3), 1999; United Kingdom: TWA 1 ppm (11 mg/m^3), STE; 2 ppm (22 mg/m^3), 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Some states have set guidelines or standards for bromacil in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: A no-adverse-effects-level in drinking water has been calculated by NAS/NRC as 0.086 mg/L.[46] Some states have set guidelines for Bromacil in drinking water,[61] including Maine at 25 μg/L and Kansas at 87.5 μg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.1. Fish Tox: 6485.34001000 ppb MATC (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, upper respiratory system, lungs. Inhalation can cause irritation, coughing, and wheezing.

Long Term Exposure: Has caused thyroid affects in animals. Human Tox: 90.00000 ppb Health Advisory (LOW).

Points of Attack: Eyes, skin, respiratory system, thyroid.

Medical Surveillance: Before beginning work and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. Thyroid function tests. Consider chest x-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles (depending on physical state of material) and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where potential exists for exposures *over 1 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where potential for high exposures exists*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a

NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—Green: General storage may be used. Prior to working with bromacil you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, oxidizers, heat, and open flame.

Shipping: UN 1993 IMO/IATA: Proper Shipping Name: Flammable liquid, n.o.s. (Ethanol, Methanol) Hazard Class 3. Special Information: Flash point 44°C (for ocean transport only). Packing Group: III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid containing bromacil in vermiculite, dry sand, earth, or similar material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index $K_{oc} = 32$.

Fire Extinguishing: Bromacil may burn, but does not readily ignite. Bromacil may be ignited by heat or open flame. Dust may cause an explosion. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including bromine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Bromacil should be incinerated in a unit operating at 850°C equipped with gas scrubbing equipment.[22]

Reference

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Bromacil*. Trenton, NJ

Bromadiolone B:0650

Molecular Formula: $C_{30}H_{23}BrO_4$

Synonyms: 2H-1-Benzopyran-2-one, 3-(3-[4′-Bromo(1,1′-biphenyl)-4-yl]-3-hydroxy-1-phenylpropyl)-4-hydroxy-; Bromadialone; 3-(3-[4′-Bromo(1,1′-biphenyl)-4-yl]3-hydroxy-1-phenylpropyl)-4-hydroxy-2H-1-benzopyran-2-one; 3-[3-(4′-Bromobiphenyl)-4-yl]3-hydroxy-1-phenylpropyl)-4-hydroxy-coumarin; 3-(α-[*p*-(*p*-Bromophenyl)-β-hydroxyphenethyl]benzyl)-4-hydroxy- coumarin; Canadien2000; Contrac; Coumarin, 3-(3-(4′-bromo-1,1′-biphenyl-4-yl)-3-hydroxy-1-phenylpropyl)-4-hydroxy-; Coumarin, 3-(α-[*p*-(*p*-bromophenyl)-β-hydroxyphenethyl) benzyl]-4-hydroxy-; (Hydroxy-4-coumarinyl 3)-3 phenyl-3 (bromo-4 biphenyl-4)-1 propanol-1 (French); LM-637; MAKI; Ratimus; Rentokil Deadline; Slaymor; Supercaid; Super-Caid; Super-Rozol; Sup'orats; Temus

CAS Registry Number: 28772-56-7

RTECS® Number: GN4934700

UN/NA & ERG Number: UN3027 (coumarin derivative pesticides, solid, toxic)/151; UN2811 (Poisonous solid, organic, n.o.s.)/154

EC Number: 249-205-9

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 (45.4).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bromadiolone is white to off-white (yellowish) powder. Molecular weight = 527.41; Freezing/Melting point = 200−210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0.

Potential Exposure: Bromadiolone is used as an anticoagulant rodenticide. It is bait for rodent control used against house mice, roof rats, warfarin-resistant Norway rats. It is also authorized by USDA for use in official establishments operating under the federal meat, poultry, shell egg grading, and egg products inspection program.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

Routes of Entry: Ingestion, inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

The compound is toxic by oral exposure, the oral LD_{50} rabbit is 1.0 mg/kg and LD_{50} = (oral-rat) 1.125 mg/kg (Extremely toxic).[9]

Short Term Exposure: Very toxic if ingested by skin and eye contact. May cause eye irritation. Bromadiolone has an acute oral toxicity $LD_{50} = 1-3$ mg/kg, rodents/nonrodents (HIGH). Dermal toxicity $LD_{50} = 9.4$ mg/kg, rabbits (HIGH).

Long Term Exposure: Studies of mutagenicity and teratogenicity have not shown any mutagenic, embryotoxic, or teratogenic effects. Coumarin and its derivatives may be carcinogenic to humans.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with bromadiolone you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Coumarin derivatives, solid, toxic, n.o.s., have a DOT label requirement of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is I, II.[19, 20]

Toxic solids, organic, n.o.s., requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal.

Fire Extinguishing: This material may burn but does not ignite readily. *Small fires:* dry chemicals, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Bromadiolone*. Washington, DC: Chemical Emergency Preparedness Program

Bromine B:0660

Molecular Formula: Br

Synonyms: Brom (German); Brome (French); Bromo (Spanish)

CAS Registry Number: 7726-95-6

RTECS® Number: EF9100000

UN/NA & ERG Number: UN1744/154

EC Number: 231-778-1 [*Annex I Index No.:* 035-001-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥ 1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances [Section 112(r)], TQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, C, N; Risk phrases: R26, R35, R50; Safety phrases: S1/2, S7/9, S26, S45, S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Bromine is a fuming red to dark reddish-brown, nonflammable, volatile liquid with a suffocating odor. Soluble in water and alcohol. Molecular weight = 159.8; Specific gravity = (H_2O:1) = 3.12; Boiling point = 58.8°C; Freezing/Melting point = −7.2°C; Relative density of the vapor/air-mixture at 20°C (air = 1) = 2.12; Vapor pressure = 172 mmHg at 20°C. The Odor threshold is 3.5 ppm.[41] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2.

Potential Exposure: Compound Description: Human Data. Bromine is primarily used in the manufacture of gasoline antiknock compounds (1,2-dibromoethane). Other uses are for gold extraction; in brominating hydrocarbons; in bleaching fibers and silk; in the manufacture of military gas, dyestuffs; and as an oxidizing agent. It is used in the manufacture of many pharmaceuticals and pesticides.

Incompatibilities: A powerful oxidizer. May cause fire and explosions in contact with organic or other readily oxidizable materials. Contact with aqueous ammonia, acetaldehyde, acetylene, acrylonitrile, or with metals, may cause violent reactions. Anhydrous Br_2 reacts with aluminum, titanium, mercury, potassium; wet Br_2 with other metals. Also incompatible with alcohols, antimony, alkali hydroxides, arsenites, boron, calcium nitrite, cesium monoxide, carbonyls, dimethyl formamide, ethyl phosphine, fluorine, ferrous and mercurous salts, germanium, hypophosphites, iron carbide, isobutyronphenone, magnesium phosphide, methanol, nickel carbonyl, olefins, ozone, sodium, and many other substances. Attacks some coatings and some forms of plastic and rubber. Corrodes iron, steel, stainless steel, and copper.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.54 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.7 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.7 mg/m^3 TWA; 0.3 ppm/ 0.8 mg/m^3 STEL.

ACGIH TLV®[1]: 0.1 ppm/0.66 mg/m^3 TWA; 0.1 ppm TWA; 0.2 ppm STEL.

NIOSH IDLH: 3 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.033 ppm

PAC-1: **0.033** ppm

PAC-2: **0.24** ppm

PAC-3: **8.5** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: No numerical value established. Data may be available.

Europe OEL: 0.1 ppm/0.7 mg/m^3 TWA

Arab Republic of Egypt: TWA 0.1 ppm (0.7 mg/m^3), 1993; Australia: TWA 0.1 ppm (0.7 mg/m^3); STEL 0.3 ppm (2 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.7 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.66 mg/m^3); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.7 mg/m^3), 1999; Finland: STEL 0.1 ppm (0.7 mg/m^3) [skin] 1999; France: VLE 0.1 ppm (0.7 mg/m^3), 1999; the Netherlands: MAC-TGG 0.7 mg/m^3, 2003; India: TWA 0.1 ppm (0.7 mg/m^3); STEL 0.3 ppm (2 mg/m^3), 1993; Japan: 0.1 ppm (0.65 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.7 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.7 mg/m^3), 1999; Poland: MAC (TWA) 0.7 mg/m^3, MAC (STEL) 2 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 0.5 mg/m^3, 1993; Sweden: NGV 0.1 ppm (0.7 mg/m^3), KTV 0.3 ppm (2 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.7 mg/m^3), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.7 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.66 mg/m^3); STEL 0.3 ppm (2.0 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm; STEL 0.2 ppm. Several States have set guidelines or standards for bromine in ambient air[60] ranging from 2.33 μg/m^3 (New York) to 7.0 μg/m^3 (Florida and North Dakota) to 11.0 μg/m^3 (Connecticut) to 17 μg/m^3 (Nevada) to 200 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #6011, OSHA Analytical Method ID-108.

Permissible Concentration in Water: Russia has set a MAC value of 0.2 mg/L in water bodies used for domestic purposes. Maine has set a guideline[61] for drinking water of 660 μg/L.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

The majority of exposures to bromine occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory irritation. A corrosive liquid, bromine can cause severe eye and skin irritation and burns that may cause permanent damage and scarring. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Short Term Exposure

Symptoms of exposure can include dizziness, headache, lacrimation (discharge of tears), epistaxis (nosebleed); cough, feeling of oppression; abdominal pain; diarrhea. Signs and symptoms of poisoning include eye redness and lacrimation, nose and throat irritation, cough, and dyspnea. Ingestion of liquid bromine can cause abdominal pain and hemorrhagic gastroenteritis with secondary shock. Signs and symptoms might also include brown discoloration of mucous membranes and the tongue.

Inhalation: Small amount will cause coughing, nosebleed, dizziness, and headache followed by abdominal pain and diarrhea and sometimes measles-like eruption on trunk and extremities. *Skin contact:* causes pustules and painful nodules in exposed areas of skin; if not removed will cause deep, painful ulcers. *Ingestion (of liquid):* causes burning pain in mouth and esophagus, lips and mucous membranes stained brown; severe gastroenteritis evidenced by abdominal pain and diarrhea; cyanosis, and shock. Regular exposure to concentrations approaching the permissible exposure level causes irritability, loss of appetite, joint pains, and dyspepsia. Other symptoms include loss of cornea reflexes, inflammation of the throat, thyroid dysfunction, cardiovascular disorders, disorders of digestive tract. Inhalation exposure to 11−23 mg/m^3 produces severe choking. 30−60 mg/m^3 is extremely dangerous. 200 mg/m^3 is fatal in a short time. Vapors can cause acute as well as chronic poisoning. It has cumulative properties. It is irritating to the eyes and respiratory tract. Poisoning is due to the corrosive action on the gastrointestinal tract. Nervous, circulatory, and renal disturbances occur after ingestion. Ingestion of liquid can cause death due to circulatory collapse and asphyxiation from swelling of the respiratory tract. The lowest oral lethal dose reported for humans is 14 mg/kg. The lowest lethal inhalation concentration reported for humans is 1000 ppm.

Long Term Exposure: May cause acne-like eruptions on the skin. Repeated exposure may cause headache, chest pain; joint pain, and indigestion. Bronchitis or pneumonia may develop with cough, shortness of breath, and phlegm.

Points of Attack: Respiratory system, eyes, lungs, central nervous system.

Medical Surveillance: The skin, eyes, and respiratory tract should be given special emphasis during preplacement and periodic examinations. Chest x-rays as well as general health, lung, blood, liver, and kidney function should be considered. Exposure to other irritants or bromine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **4 h:** (At least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *2.5 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS*† (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *3 ppm:* CcrFS† (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s); or GmFS† (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprTS† (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS† (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE [any appropriate escape-type, self-contained breathing apparatus(es)].

*Substance causes eye irritation or damage; eye protection needed.

†Only *nonoxidizable sorbents* are allowed (not charcoal).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Store in a cool, dry room with ventilation along the floor. Keep sealed or glass stoppered. Protect against physical damage. Keep out of direct sunlight. Separate from combustibles, organics, or other readily oxidizable materials. Store above −7°C/20°F to prevent freezing but avoid heating above room temperature to prevent pressure increase which could rupture containers.

Shipping: Bromine requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." The Hazard Class is 8 and the Packing Group is I.[19, 20] A plus sign (+) symbol indicates that the designated proper shipping name (bromine or bromine solutions) and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wear eye protection. Wear positive pressure breathing apparatus and special protective clothing. Ventilate area of spill or leak. Collect for reclamation by absorbing it in vermiculite, dry sand, earth, or a similar material and deposit it in sealed containers in secured sanitary landfill. Potassium carbonate, sodium carbonate, sodium bicarbonate, lime, and sodium hydroxide solutions are neutralizing agents for liquid bromine spills. Do not touch material, stop leak if possible without risk. Use water spray to reduce vapors. *Do not* absorb in saw-dust or other combustible absorbents; avoid contact with metal implements. *Small spills:* absorb with sand or other noncombustible absorbent material and place in container. *Large spills:* dike spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

Bromine

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6.3
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.9/3.1
Night 4.1/6.6

Bromine solution and Bromine, solution (Inhalation Hazard Zone A)

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.9/3.1
Night 4.1/6.6

Small spills (From a small package or a small leak from a large package)

Bromine, solution (Inhalation Hazard Zone B)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.2/1.9
Night 2.1/3.3

Fire Extinguishing: Bromine is not combustible but enhances combustion of other substances. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Large volumes of concentrated solutions of reducing agents (bisulfites or ferrous salts) may be added.[24] The mixture is neutralized with soda ash or dilute HCl and flushed to the sewer with large volumes of water.

References

US Environmental Protection Agency. (November 1, 1976). *Chemical Hazard Information Profile: Bromine and Bromine Compounds*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 41–43 (1981) and 3, No. 5, 67–69 (1983)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Bromine*. Washington, DC: Chemical Emergency Preparedness Program

Shannon, M. W. (1998). Bromine and iodine compounds. In L. M. Haddad, M. W. Shannon, & J. F. Winchester (Eds.), *Clinical Management of Poisoning and Drug Overdose* (3rd ed.). Philadelphia, PA: W.B. Saunders

Morabia, A., Selleger, C., Landry, J. C., Conne, P., Urban, P., & Fabre, J. (1988). Accidental bromine exposure in an urban population: An acute epidemiological assessment. *International Journal of Epidemiology*, *17*, 148–152

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Bromine*. Trenton, NJ

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Bromine*. Albany, NY: Bureau of Toxic Substance Assessment

Bromine pentafluoride B:0670

Molecular Formula: BrF_5

Synonyms: Bromine fluoride; Pentafluoruro de bromo (Spanish)

CAS Registry Number: 7789-30-2

RTECS® Number: EF9350000

UN/NA & ERG Number: UN1745/144

EC Number: 232-157-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 (≥ 6007% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bromine pentafluoride is colorless to pale yellow liquid, with pungent odor. At temperatures above boiling point this chemical is a colorless gas. Molecular weight = 174.92; Specific gravity (H_2O:1) = 2.48; Relative vapor density (air = 1) = 6.1; Boiling point = 40.5°C; Freezing/Melting point = − 61°C; Vapor pressure = 328 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3₩. Reacts explosively with water.

Potential Exposure: Bromine pentafluoride is used as an oxidizer in liquid rocket propellant combinations; it may be used in chemical synthesis.

Incompatibilities: A powerful oxidizer. Bromine pentafluoride reacts with every known element except inert gases, nitrogen, and oxygen. It reacts violently with water, acids, acid fumes (releasing highly toxic fumes of bromine and fluorine). Incompatible with halogens, arsenic, selenium, alkaline halides, sulfur, iodine, glass, metallic halides, metal oxides, and metals (except copper, stainless steel, nickel and Monel®). Fire may result from contact with combustibles or organic matter at room temperature, and contact of this substance with water produces an explosion. Even under mild conditions this substance attacks organic compounds vigorously, often causing explosion. Decomposes in heat above 460°C.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 ppm/0.7 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm/0.72 mg/m^3 TWA.

OSHA PEL: (Shipyards) 0.1 ppm/0.7 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: 0.15 ppm

PAC-2: **1.0** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Australia: TWA 0.1 ppm (0.7 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.7 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.72 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.7 mg/m^3), 1999; Finland: STEL 0.1 ppm (0.7 mg/m^3) [skin] 1999; France: VME 0.1 ppm (0.7 mg/m^3), 1999; Norway: TWA 0.6 mg[F]/m^3, 1999; the Netherlands: MAC-TGG 0.7 mg/m^3, 2003; Sweden: TWA 2 mg[F]/m^3, 1999; Switzerland: MAK-W 0.1 ppm (0.7 mg/m^3), 1999; United Kingdom: TWA 0.1 ppm (0.73 mg/m^3); STEL 0.3 ppm (2.2 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH Threshold Limit Value: TWA 0.1 ppm. Several states have set guidelines or standards for bromine pentafluoride in ambient air[60] ranging from 7.0 μg/m^3 (North Dakota) to 11.0 μg/m^3 (Virginia) to 14.0 μg/m^3 (Connecticut) to 17.0 μg/m^3 (Nevada).

Determination in Air: Sample collection by impinger or fritted bubbler, analysis by ion-specific electrode.

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Respiratory irritation is noted. See also "Fluorine" and "Chlorine trifluoride."

Short Term Exposure: Can cause severe irritation and burns of the eyes and skin. Inhalation can irritate the nose and throat; higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can cause kidney, liver, and lung damage.

Points of Attack: Eyes, skin, and mucous membranes.

Medical Surveillance: Kidney, liver, and lung function tests. Consider chest x-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use of self-contained breathing apparatus is recommended.[24] Where there is potential exists for exposures over 0.1 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with bromine pentafluoride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, acids, acid fumes, and combustibles. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Bromine pentafluoride requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 5.1 and Packing Group I. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Gas:* Ventilate area of spill or leak to disperse gas. If this is a gas leak, stop flow of gas. If the leak from a cylinder cannot be stopped, remove the container to a safe place in the open air, and repair leak, or allow cylinder to empty. *Liquid:* Cover spill with dry lime, sand, or soda ash and deposit in closed and sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.6/1.4

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.9/1.5
Night 2.0/3.2

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 2.6/4.1

Fire Extinguishing: Not combustible but enhances combustion of other substances. May spontaneously ignite combustible and organic materials. *Do not* use water or water-based extinguishers to fight fire; reacts explosively with steam or water. An exception is when large amounts of combustible material are involved and firefighters can protect themselves by distance or barrier from the violent reaction with water. Use carbon dioxide or dry chemical on small fires.[17] Poisonous gases are produced in fire, including bromine and fluorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Allow gas to flow into mixed caustic soda and slaked lime solution.[24] Return unwanted cylinders to supplier if possible.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides*. NIOSH Document No. 76−103

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Bromine Pentafluoride*. Trenton, NJ

Bromine trifluoride B:0680

Molecular Formula: BrF_3

Synonyms: Boron fluoride; Bromine fluoride; Trifluoroborane; Triflururo de bromo (Spanish)

CAS Registry Number: 7787-71-5

RTECS® Number: ED2275000

UN/NA & ERG Number: UN1746/144

EC Number: 232-132-1

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 (≥6.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 15,000 lb (6810 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bromine trifluoride is a noncombustible, colorless to gray-yellow fuming liquid with an extremely irritating odor. Molecular weight = 136.9. Specific gravity (H_2O:1) = 2.8 at 20°C; Boiling point = 135°C; Freezing/Melting point = 8.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3₩. Reacts with water, forming corrosive gas.

Potential Exposure: Bromine trifluoride is used as a fluorinating agent and an electrolytic solvent.

Incompatibilities: A powerful oxidizer, highly reactive and a dangerous explosion hazard. Contact with water or other hydrogen containing materials forms hydrogen fluoride gas. Reacts with almost all elements except for inert gases. Violent reaction with reducing agents; organic materials; strong acids; strong bases; halogens, salts (antimony salts), metal oxides; and many other materials. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

NIOSH IDLH: 250 mg[F]/m^3.

Protective Action Criteria (PAC)*
TEEL-0: 0.04 ppm
PAC-1: **0.12** ppm
PAC-2: **2.0** ppm
PAC-3: **21** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland:

TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Bromine trifluoride can affect you when breathed in and passing through your skin. This substance is a corrosive chemical and contact can severely irritate and burn the skin and eyes (causing possible blindness). Exposure can severely irritate the nose, throat, and lungs. Higher exposures can cause a buildup of fluid in the lungs which can cause death.

Long Term Exposure: Repeated exposure can cause skin rash, lung irritation, and bronchitis; and may cause a buildup of bromine and fluorine in the body.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest x-ray after acute overexposure. Blood fluorine and bromine levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min without stopping, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: *Clothing:* Avoid skin contact with bromine trifluoride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Bromine trifluoride must be stored to avoid contact with water (which releases hydrogen fluoride gas), ammonium halides, antimony trioxide, antimony chloride, and solvents (such as ether, acetone, acetic acid, toluene, and so on), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from organic and/or combustible materials (such as wood, cotton, and straw), chloride and bromide salts, and many metals. Whenever bromine trifluoride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Bromine trifluoride requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 5.1 and Packing Group I. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 0.3/0.5

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 2.4/3.8

Fire Extinguishing: Bromine trifluoride does not burn but may ignite combustible materials. Do not use water or foam. Use dry chemical or CO_2 extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Bromine Trifluoride*. Trenton, NJ

Bromobenzene B:0690

Molecular Formula: C_6H_5Br

Synonyms: Bromobenceno (Spanish); Bromobenzol; Monobromobenzene; Phenyl bromide

CAS Registry Number: 108-86-1

RTECS$^{®}$ Number: CY9000000

UN/NA & ERG Number: UN2514/130

EC Number: 203-623-8 [*Annex I Index No.:* 602-060-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act, 55FR1470 Priority List; 40CFR 141.40(e), re: community and noncommunity water systems.

TSCA 40CFR766.38 precursor chemical substances reporting.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R38; R51/53; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Bromobenzene is a flammable, clear, colorless mobile liquid with a pleasant odor. Molecular weight = 157.02. Specific gravity (H_2O:1) = 1.48; Boiling point = 156°C; Freezing/Melting point = −31°C; Flash point = 51°C; Autoignition temperature = 565°C. Explosive limits in air: LEL = 6%; UEL = 36.5%[icsc]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Very slightly soluble in water; solubility = 0.04% at 25°C.

Potential Exposure: Compound Description: Mutagen. Bromobenzene is used as an intermediate in organic synthesis, and as an additive in motor oil and fuels. During chlorination water treatment, bromobenzene can be formed in small quantities.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, alkaline earth metals (barium, calcium, magnesium, strontium, etc.), metallic salts; with risk of violent reactions. May accumulate static electrical charges; may cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.25 ppm
PAC-1: 4 ppm
PAC-2: 25 ppm
PAC-3: 350 ppm

Hungary: TWA 3 mg/m^3; STEL 6 mg/m^3 [skin] 1993; Russia: STEL 3 mg/m^3, 1993.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.1$.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Observations in humans: Bromobenzene irritates the skin and is a central nervous system depressant in humans. In view of the relative paucity of data on the carcinogenicity, teratogenicity, and long-term oral toxicity of bromobenzene, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It is recommended that studies to produce such information be conducted before limits in drinking water can be established. Since bromobenzene was negative on the *Salmonella*/microsome mutagenicity test, there should be less concern than with those substances that are positive. LD_{50} = (oral-rat) 2699 mg/kg (slightly toxic).[9]

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Exposure can cause dizziness, lightheadedness, and unconsciousness.

Long Term Exposure: May cause liver and kidney damage.

Points of Attack: Skin, liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. ACGIH recommends polyvinyl alcohol or Viton as protective materials. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with bromobenzene you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerated area away from incompatible materials listed above. Protect from light.[52] Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Bromobenzene requires a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Follow by washing spill area with alcohol then with soap and water. Do not flush spilled material into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and hydrogen bromide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[24]

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Brominated Aromatic Compounds* (pp. 76−85) including Report PB-276, 378, Rockville, MD

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Bromobenzene*. Trenton, NJ

Bromodichloromethane B:0700

Molecular Formula: $CHBrCl_2$

Common Formula: $BrCHCl_2$

Synonyms: BDCM; Dichlorobromomethane; Methane, bromodichloro-; Monobromodichloromethane; NCI-C55243

CAS Registry Number: 75-27-4

UN/NA & ERG Number: UN2810/153

RTECS® Number: PA5310000

EC Number: 200-856-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999.

Listed on TSCA inventory.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.35; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Safe Drinking Water Act: Priority List (55FR1470) as bromodichloromethane.

Safe Drinking Water Act: MCL 0.10 mg/L, as trihalomethanes.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

TSCA 40CFR716.120(a); SNUR (PMN, P-90-299) Halomethanes.

Mexico Wastewater Pollutant.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; listed on Canada's NDSL List.

Description: Bromodichloromethane is a liquid. Molecular weight = 163.8; Specific gravity (H_2O:1) = 1.98; Boiling point = 90°C. Odor threshold = about 1675 mg/m^3. Soluble in water.

Potential Exposure: This compound may find application in organic synthesis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 150 mg/m^3

DFG MAK: [skin]; Carcinogen Category 3B

Permissible Concentration in Water: The Maximum Contaminant Level (MCL) for total trihalomethanes (including bromodichloromethane) in drinking water has been set by the US EPA at 0.10 mg/L (44 RF 68624). Illinois and Vermont have set guidelines for Bromodichloromethane in drinking water.[61] Illinois at 1.0 μg/L and Vermont at 100 μg/L.

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = <2.0.

Harmful Effects and Symptoms

Bromodichloromethane is acutely toxic to mice. It was mutagenic in the *Salmonella typhimurium* TA 100 bacterial test system and carcinogenic in mice with the same qualification for result significance as for dichloromethane noted. Positive correlations between cancer mortality rates and levels of brominated trihalomethanes in drinking water in epidemiological studies have been reported. LD_{50} = (oral-rat) 916 mg/kg (slightly toxic).[9]

Short Term Exposure: This material irritates the eyes, nose, and mucous membranes.[52]

Long Term Exposure: May cause cancer in humans.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerated space in a tightly closed container. Protect from light.[52] A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic, liquids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Contain and isolate spill to limit spread. Construct clay-bentonite dams to isolate the spill. Treatment alternatives for contaminated waste include activated charcoal treatment. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not combustible. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Package in epoxy-lined drums. Destroy by high-temperature incinerator equipped with an HCl scrubber.

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 6, No. 3, 39−41

US Public Health Service. (December 1988). *Toxicological Profile for Bromodichloromethane*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

Bromoform B:0710

Molecular Formula: $CHBr_3$

Synonyms: Bromoforme (French); Bromoformo (Spanish); Methane, tribromo-; Methenyl tribromide; Methyl tribromide; NCI-C55130; Tribrommethan (German); Tribromomethane

CAS Registry Number: 75-25-2

RTECS® Number: PB5600000

UN/NA & ERG Number: UN2515/159

EC Number: 200-854-6 [*Annex I Index No.:* 602-007-00-x]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis studies (gavage); clear evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollutant Standard Set (EPA), (Mexico).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U225.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.63; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8240 (5).

Safe Drinking Water Act: Priority List (55FR1470).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Mexico Wastewater Pollutant, Drinking Water Pollutant.

TSCA 40CFR716.120(a); 40CFR712.30(e)10 dermal absorption testing; 40CFR799.5055(c), (d)2, hazardous waste constituents subject to testing; Section 12(b) export notification requirement.

California Proposition 65 Chemical: Cancer 4/1/91.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R22; R23; R36/38; R51/53; Safety phrases: S1/2; S28; S45; S63; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Bromoform is a colorless (turns yellow on exposure to air) with a sweet-smelling, chloroform-like odor. Odor threshold = 0.447 ppm. Molecular weight = 252.8; Specific gravity (H_2O:1) = 2.9; Boiling point = 149.5°C; Freezing/Melting point = 8.3°C (to hexagonal crystals); Vapor pressure = 5 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 0.1% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Bromoform is used in pharmaceutical manufacturing; as an ingredient in fire-resistant chemicals and gauge fluids; and as a solvent for waxes, greases, and oils.

Incompatibilities: Heat causes bromoform to decompose forming toxic and corrosive hydrogen bromide and bromine. Bromoform is a weak acid. Reacts violently with oxidants, bases in powdered form. Reacts with chemically active metals (alkaline metals), powdered aluminum, potassium, sodium, zinc, and magnesium and acetone under basic conditions, causing fire and explosion hazard. Attacks some forms of plastic, rubber, and coating. Corrosive to most metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.34 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.5 ppm/5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 ppm/5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 ppm/5.2 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.5 ppm

PAC-1: 25 ppm

PAC-2: 200 ppm

PAC-3: 850 ppm

DFG MAK: Carcinogen Category 3B.

NIOSH IDLH: 850 ppm.

Australia: TWA 0.5 ppm (5 mg/m^3) [skin] 1993; Austria: MAK 0.5 ppm (5 mg/m^3), 1999; Belgium: TWA 0.5 ppm (5.2 mg/m^3) [skin] 1993; Denmark: TWA 0.5 ppm (5 mg/m^3) [skin] 1999; Finland: TWA 0.5 ppm (5 mg/m^3); STEL 1.5 ppm (15 mg/m^3) [skin] 1999; France: VME 0.5 ppm (5 mg/m^3) [skin] 1999; the Netherlands: MAC-TGG 5 mg/m^3 [skin] 2003; the Philippines: TWA 0.5 ppm (5 mg/m^3) [skin] 1993; Poland: TWA 5 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (5600 mg/m^3), 1999; United Kingdom: TWA 0.5 ppm (5.3 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for bromoform in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 110 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated, or[18] OSHA Analytical Method #7, Organic Vapors.

Permissible Concentration in Water: See Regulatory Authority and Advisory Bodies above. Mexico's drinking water criteria is 0.002 mg/L. This substance is highly persistent; bioaccumulation or risk of cancer, reduce exposure by humans to minimum. Two states have set guidelines for bromoform in drinking water: 1.0 μg/L in Illinois and 40 μg/L in Maryland.[61]

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = 2.4.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Can cause irritation to the nose and throat, tearing, reddening of the face, dizziness, and death. Exposure of dogs to 7000 ppm for 8 min causes death. *Skin:* Can be absorbed. Large quantities can lead to symptoms listed under ingestion. *Eyes:* Can cause irritation and tearing. *Ingestion:* Causes burning of mouth and throat. Can cause headache, dizziness, disorientation, slurred speech; troubled breathing; tremors and unconsciousness. The estimated lethal dose is 1/3 ounce for a 150-pound adult. However, LD_{50} = (oral-rat) 1147 mg/kg (slightly toxic).[9]

Long Term Exposure: Bromoform can cause liver damage. May have an effect on the nervous system. Repeated exposure can cause skin rash. Has caused cancer in laboratory animals; whether it does so in humans is unknown. Very irritating substances, such as bromoform may affect the lungs.

Points of Attack: Skin, liver, kidneys, respiratory system, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$)*:* polyvinyl alcohol gloves; Viton™ gloves, suits. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: OSHA: *12.5 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *850 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Bromoform must be stored to avoid contact with incompatible materials listed above. Store in tightly closed containers in a cool well-ventilated area away from heat and light.

Shipping: Bromoform requires a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Bromoform itself does not burn. Poisonous gases are produced in fire, including bromine and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound

increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Purify by distillation and return to suppliers.[22] Alternatively, incinerate with excess fuel.

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bromoform: Health and Environmental Effects Profile No. 28*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 30−35

New Jersey Department of Health and Senior Services. (January 1986). *Hazardous Substances Fact Sheet: Bromoform*. Trenton, NJ

New York State Department of Health. (June 2000). *Chemical Fact Sheet: Bromoform*. Albany, NY: Bureau of Toxic Substance Assessment

4-Bromophenyl phenyl ether B:0720

Molecular Formula: $C_{12}H_9BrO$

Synonyms: Benzene, 1-bromo-4-phenoxy-; Benzene, 2-bromo-4-phenoxy-; *p*-Bromodiphenyl ether; HSDB 2747; MBDE; Monobromodiphenyl ether; Mono bromodiphenyl oxide

CAS Registry Number: 101-55-3

UN/NA & ERG Number: UN3082/171

EC Number: 202-952-4

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U030.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4-Bromophenyl phenyl ether is a brominated diphenylether and a liquid at common ambient temperatures. Molecular weight = 249.10; Boiling point = 310.14°C; Specific gravity (H_2O:1) = 1.449 (1.4208 at 20°C); Freezing/Melting point = 18.72°C; Vapor pressure = 0.0015 mmHg at 20°C; Flash point = >110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Poor solubility in water; solubility = 4.8 mg/L at 25°C.

Potential Exposure: Very little information on 4-bromophenyl phenyl ether exists. It is prepared by brominating diphenyl ether with Br_2 at 95−100°C in carbon tetrachloride.[US EPA, 1986] 4-Bromophenyl phenyl ether has been identified in raw water, in drinking water, and in river water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 200 mg/m^3

Permissible Concentration in Water: *Freshwater Aquatic Life:* For 4-bromophenyl phenyl ether the criterion to protect freshwater aquatic life as derived using the guidelines is 6.2 μg/L as a 24-h average and the concentration should not exceed 14 μg/L at any time. *Saltwater Aquatic Life:* For saltwater aquatic life, no criterion for 4-bromophenyl phenyl ether can be derived using the guidelines, and there is insufficient data to estimate a criterion using other procedures. *Human Health:* Because of a lack of adequate toxicological data on nonhuman mammals and humans, protective criteria cannot be derived at this time for this compound.

Determination in Water: *p*-Monobromodiphenyl ether (MBDE) can be determined by the standard US EPA Method 611-Haloethers. Chromatographic conditions are described in US EPA (1986). The limit of determination in municipal and industrial waste waters is 2.3 μg/L. Octanol−water coefficient: Log K_{ow} = 4.28 (4.08−4.94) [US EPA (1984, 1986)]. According to US EPA (1986), there are monitoring data for *p*-monobromodiphenyl ether in water in the USA. The mean concentration was 0.2 mg/L (range 0−202.7 mg/L, 2193 listings) in water.

Harmful Effects and Symptoms

4-Bromophenyl phenyl ether has been tested in the pulmonary adenoma assay, a short-termed carcinogenicity assay. Although the results were negative, several known carcinogens also gave negative results. No other health effects were available. Skin contact can cause tissue defatting and dehydration leading to dermatitis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color Code—Green: General storage may be used. Store away from heat, flames, or oxidizing materials; ethers tend to peroxidize when exposed to air forming unstable peroxides that may detonate with extreme violence.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire including hydrogen bromide gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with alkaline flue gas scrubbing.

References

US Environmental Protection Agency. (April 30, 1980). *4-Bromophenyl Phenyl Ether: Health and Environmental Effects*. Profile No. 30. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Haloethers: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 2, 43−45

Bromopropanes B:0730

Molecular Formula: C_4H_6

Synonyms: Propane, bromo-; *n*-Propylbromide; Propyl bromide

CAS Registry Number: 106-94-5 (1-bromopropane); 75-26-3 (2-bromopropane); 26446-77-5 (mixed isomers)

UN/NA & ERG Number: UN2344/129

EC Number: 203-445-0 [*Annex I Index No.:* 602-019-00-5] (1-bromopropane); 200-855-1 [*Annex I Index No.:* 602-085-00-5] (2-bromopropane)

Regulatory Authority and Advisory Bodies

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin (male, female) (1-bromopropane) 12/7/04; (female, male) (2-bromopropane) 5/31/05.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (*n*-propyl bromide).

European/International Regulations:

(*1-bromopropane*) Hazard Symbol: F+, T; Risk phrases: R60; R11; R36/37/38; R48/20; R63; R67; Safety phrases: S53; S45; (*2-bromopropane*) Hazard Symbol: F + , T; Risk phrases: R60; R11; R48/20; R66; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*2-bromopropane*): 2—Water polluting (1-bromopropane); 1.

Description: Bromopropane is a toxic and highly flammable, colorless liquid; Flash point ≤22°C. Molecular weight = 123.0 (1-bromopropane); 123.0 (2-bromopropane); Boiling point = 71°C (1-bromopropane); 59.4°C (2-bromopropane); Freezing/Melting point = − 110°C (1-bromopropane); − 89°C (2-bromopropane); Specific gravity (H_2O:1): 1.35 (1-bromopropane); Flash point = − 10°C (cc) (1-bromopropane); Autoignition temperature = 490°C (1-bromopropane). Explosive Limits in air: LEL = 4.6%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): (as *n*-propyl bromide): Health 2, Flammability 3, Reactivity 0; (2-bromopropane) Health 2, Flammability 3, Reactivity 3. Soluble in water; solubility = 0.25% at 20°C (1-bromopropane).

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector. Used for making other chemicals.

Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers may cause fire and explosion.

Permissible Exposure Limits in Air

1-Bromopropane

ACGIH TLV®[1]: 10 ppm/50 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 30 ppm

PAC-2: 2500 ppm

PAC-3: 2500 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.12.

Routes of Entry: Inhalation, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Exposure can cause dizziness, lightheadedness, and unconsciousness. Very high exposures can cause death.

Long Term Exposure: Repeated or high exposures may cause liver and lung damage. May be a developmental toxicant.

Points of Attack: Liver, lungs.

Medical Surveillance: Lung and liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Outside or detached storage is preferred. Prior to working with Bromopropane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: 2-Bromopropane requires a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3, Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand, earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen bromide, are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling

streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Bromopropane*. Trenton, NJ

Brucine B:0740

Molecular Formula: $C_{23}H_{26}O_4 \cdot 4H_2O$

Common Formula: $C_{23}H_{26}O_4 \cdot 4H_2O$

Synonyms: Brucina (Spanish); (−)Brucine; (−)Brucine dihydrate; Brucine hydrate; 2,3-Dimethoxystrichnidin-10-one; 10,11-Dimethoxystrychnine; 2,3-Dimethoxystrychnine; Dimethoxystrychnine; 10,11-Dimethylstrychnine; Strychnidin-10-one, 2,3-Dimethoxy-; Strychnine, 2,3-dimethoxy-

CAS Registry Number: 357-57-3 (anhydrous); 5892-11-5 (hydrate)

RTECS® Number: EH8925000

UN/NA & ERG Number: UN1570/152

EC Number: 206-614-7 [*Annex I Index No.:* 614-006-00-1] (*anhydrous*)

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P018.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: (*anhydrous*) Hazard Symbol: T+, N; Risk phrases: R26/28; R52/53; Safety phrases: S1/2; S13; S45; S61; European/International Regulations (*hydrate*): Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Brucine is a colorless to white, odorless, crystalline solid with a very bitter taste. Molecular weight = 394.46; Boiling point = 470°C; Freezing/Melting point = 178°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Poor solubility in water; solubility = 1 gm/1320 mL.

Potential Exposure: Compound Description: Drug, Natural Product. Brucine is used as denaturant for Ethanol, also resolving agent for isomer separation; in the manufacture of other chemicals, in perfumes, as a medication for animals, and as a poison for rodents. It is an alkaloid, produced from strychnos seeds.

Incompatibilities: Reacts with strong oxidizers. Finely dispersed material in air can cause dust explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Anhydrous

TEEL-0: 0.3 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 40 mg/m^3

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1.0$ (0.9).

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Exposure can cause headache, nausea, vomiting, ringing in the ears; disturbed vision; restlessness, excitement, twitching and convulsions, seizures; breathing difficulties. Severe poisoning can cause paralysis, unconsciousness, and death. The probable fatal dose in adult is estimated at 1 g.[Gosselin, 1984]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Protect against physical damage. Outside or detached storage is preferred. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with brucine you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers.

Shipping: Label: "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Brucine may burn but does not readily ignite. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Brucine*. Trenton, NJ

Gosselin, R. E., Smith, R. P., & Hodge, H. C. (1984). *Clinical Toxicology of Commercial Products*. (5th ed., [II-249, III-375−379]). Baltimore/London: Williams & Wilkins

Busulfan B:0750

Molecular Formula: $C_6H_{14}O_6S_2$

Common Formula: $CH_3SO_2O(CH_2)_4OSO_2CH_3$

Synonyms: 1,4-Bis(methanesulfonoxy)butane; [1,4-Bis (methanesulfonyloxy)butane]; Bisulfan; Bisulphane; 1,4-Butanediol dimethanesulphonate; 1,4-Butanediol dimethyl sulfonate; Buzulfan; C.B.2041; Citosulfan; 1,4-Dimesyloxybutane; 1,4-Dimethanesulfonoxbutane; 1,4-Di (methanesulfonyloxy)buane; 1,4-Dimethanesulphonyloxybutan; 1,4-Dimethylsulfonoxybutane; GT2041; GT41; Leucosulfan; Mablin®; Methanesulfonic acid tetramethylene ester; Mielucin®; Misulban®; Mitostan®; Myeloleukon; Myleran®; NCI-C01592; NSC-750; Sulphabutin; Tetramethylene bis(methanesulfonate); Tetramethylene dimethane sulfonate; X 149

CAS Registry Number: 55-98-1

RTECS® Number: EK1750000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-250-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998; NTP (K) NTP: Known to be a human carcinogen.

California Proposition 65 Chemical: Cancer 2/27/87.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Busulfan is a white crystalline powder. Molecular weight = 246.3; Freezing/Melting point = 114−118°C. Decomposes in water.

Potential Exposure: Those involved in the manufacture, formulation, or use of this compound which finds application as an insect sterilant, and as a chemotherapeutic agent taken orally to treat some kinds of leukemia.

Incompatibilities: Oxidizers, moist air, and water.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin causing rash. Exposure can cause nausea, vomiting, diarrhea, and seizures.

Long Term Exposure: A carcinogen in humans causes leukemia, kidney, and uterine cancer. A probable teratogen in humans. May damage the developing fetus. May cause testes damage in males (decrease sperm count, cause impotence), and decrease fertility in females. Long-term exposure may result in cataracts, lung irritation, permanent lung scarring, bone marrow damage, liver damage. Symptoms of exposure include bleeding tendencies, decreased leukocyte count, or depressed bone marrow activity.[52]

Points of Attack: See above.

Medical Surveillance: Completed blood count, chest x-ray, lung function tests, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately with water or normal saline for 20−30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a refrigerator and protect from exposure to oxidizers or moisture.[52] A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The label requirement for medicine, solid, toxic, n.o.s. is "POISONOUS/TOXIC MATERIALS." Medicine, solid, toxic, n.o.s., fall in Hazard Class 6.1 and busulfan falls in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Busulfan*. Trenton, NJ

1,3-Butadiene B:0760

Molecular Formula: C_4H_6

Common Formula: $H_2C{=}CH{-}CH{=}CH_2$

Synonyms: Biethylene; Bivinyl; Buta-1,3-dien (German); α-γ-Butadiene; Buta-1,3-diene; Butadiene; 1,3-Butadieno (Spanish); Divinyl; Erythrene; NCI-C50602; Pyrrolylene; Vinylethylene

CAS Registry Number: 106-99-0

RTECS® Number: EI9275000

UN/NA & ERG Number: UN1010 (stabilized)/116P

EC Number: 203-450-8 [*Annex I Index No.:* 601-013-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; NTP: 11th Report on Carcinogens, 2004: Known human carcinogen; IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1; NTP (K) NTP: Known to be a human carcinogen; EPA: (when inhaled) Carcinogenic to humans; strong evidence of human carcinogenicity; combinations of evidence.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical; Carcinogen 4/1/88; Developmental, female, male 4/16/04.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R45; R46; R12; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 1,3-Butadiene is a toxic and extremely flammable, colorless, liquefied gas with a gasoline-like odor. Molecular weight = 54.1; Specific gravity (H_2O:1) = 0.6; Boiling point = −4°C; Freezing/Melting point = −109°C; Vapor pressure = 2.4 mmHg at 20°C; Flash point = −76°C (liquid); Autoignition temperature = 420°C. The explosive limits are: LEL = 2.0%; UEL = 11.5%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. The Odor threshold is 0.45 ppm. Floats and boils on water; practically insoluble; solubility = 0.1%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. 1,3-Butadiene is used chiefly as the principal monomer in the manufacture of many types of synthetic rubber and other chemicals. Butadiene is finding increasing usage in the formation of rocket fuels, plastics, and resins.

Incompatibilities: Self-reactive. May form explosive peroxides on exposure to air. High heat can cause a violent chemical reaction that will cause container rupture. Fires, explosions, or hazardous polymerization may result from contact with air, strong oxidizers, strong acids, ozone, rust, nitrogen dioxide, phenol, chlorine dioxide, crotonaldehyde, or a free radical polymerization initiator, such as hydroquinone. Unsafe in contact with acetylide-forming materials, such as monel, copper, and copper alloys (piping material for this gas must not contain more than 63% copper). Add inhibitor (such as tributylcatechol) to prevent self-polymerization and monitor to insure effective levels are maintained at all times. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.21 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/2.21 mg/m^3 TWA; 5 ppm/11.05 mg/m^3 STEL (see CFR291910.1061 & CFR291910.19).

NIOSH REL: Potential occupational carcinogen. Reduce exposures to the lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/4.4 mg/m^3 TWA; Suspected Human Carcinogen.

NIOSH IDLH: 2000 ppm [LEL].

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **670** ppm

PAC-2: **5300** ppm

PAC-3: **2200** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 2

Australia: TWA 10 ppm (22 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (22 mg/m^3), carcinogen, 1993; Denmark: TWA 10 ppm (22 mg/m^3), 1999; Finland: TWA 50 ppm (73 mg/m^3), carcinogen, 1999; France: VME 10 ppm (36 mg/m^3), 1993; Hungary: STEL 10 mg/m^3, carcinogen, 1993; the Netherlands: MAC-TGG 46.2 mg/m^3, 2003; Norway: TWA 1 ppm (2.2 mg/m^3), 1999; the Philippines: TWA 1000 ppm (2200 mg/m^3), 1993; Poland: MAC (TWA) 10 mg/m^3; STEL 40 mg/m^3, 1999; Russia: STEL 100 mg/m^3, 1993; Sweden: NGV 10 ppm (20 mg/m^3), KTV 20 ppm (40 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 5 ppm (11 mg/m^3), carcinogen, 1999; Turkey: TWA 1000 ppm (2200 mg/m^3), 1993: United Kingdom: TWA 10 ppm (22 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. The Czech Republic[35] has set a very stringent TWA of 20 mg/m^3 with a ceiling value of 40 mg/m^3. Several states have set guidelines or standards for butadiene in ambient air[60] ranging from 0 μg/m^3 (North Dakota) to 0.003 μg/m^3 (Michigan) to 0.035 μg/m^3 (Massachusetts and North Carolina) to 220 μg/m^3 (Virginia) to 22,000 μg/m^3 (Connecticut) to 52,400 μg/m^3 (Nevada).

Determination in Air: Adsorption by charcoal tube[2]; workup with CH_2C_{12}; analysis by gas chromatography/flame ionization detection. Use NIOSH Analytical Method #1024[18] or OSHA Analytical Method ID-56.

Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/^{3} in water bodies used for domestic purposes.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <2.0.

Routes of Entry: Inhalation of gas or vapor, eye, and/or skin contact.

Harmful Effects and Symptoms

Initial signs and symptoms of exposure include blurred vision, nausea, prickling and dryness of the mouth, throat, and nose, followed by fatigue, headache, vertigo, decreased blood pressure and pulse rate, unconsciousness, and respiratory paralysis. Concentrations above 8000 ppm may cause narcotic effects, dizziness, headache, drowsiness, and loss of consciousness. Death can result 23 min after inhaling air containing 25% butadiene. It is a central nervous system depressant in high concentrations. It may be irritating and cause burns to skin, mucous membranes, and eyes. Contact with the liquid may cause frostbite. It can asphyxiate by the displacement of air.

Short Term Exposure: 1,3 Butadiene irritates the eyes, skin, and respiratory tract. Rapid evaporation of the liquid may cause frostbite. Inhalation of the vapors may cause effects on the central nervous system, sleepiness, and loss of consciousness. Very high exposures may cause death.

Long Term Exposure: This chemical is a probable carcinogen in humans; it may have effects on the bone marrow and liver. There is limited evidence that this chemical is a teratogen in animals, and that it may also damage the testes and ovaries. It may cause heritable genetic damage in humans. Animal tests show that this substance may cause toxic effects upon human reproduction. See also NIOSH Profile (Alkenes), SRI, 2/77. NIOSH Current Intelligence Bulletin 41, 1984.

Points of Attack: Eyes, respiratory system, central nervous system, reproductive system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Viton™ gloves, suits, Saranex™, Barricade™ coated suits; CPF3® suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h:** (At least 4 h but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

From [1910.1051] $\leq$ *5 ppm:* Air-purifying half-mask or full-face-piece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 4 h. $\leq$ *10 ppm:* Air-purifying half-mask or full-face-piece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 3 h. $\leq$ *25 ppm:* (1) Air-purifying half-mask or full-face-piece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 2 h; (2) Any powered air-purifying respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 1 h; or (3) Continuous-flow supplied-air respirator equipped with a hood or helmet. $\leq$ *50 ppm:* (1) Air-purifying full-face-piece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 1 h; or (2) Powered air-purifying respirator (PAPR) equipped with a tight-fitting face-piece and approved butadiene or organic vapor cartridges. PAPR cartridges shall be replaced every 1 h. $\leq$ *1000 ppm:* Supplied-air respirator equipped with a half-mask or full face-piece and operated in a pressure-demand or other positive-pressure mode. *>1000 ppm, unknown concentration, or firefighting*: (1) Self-contained breathing apparatus equipped with a full face-piece and operated in a pressure-demand or other positive-pressure mode; or (2) Any supplied-air respirator equipped with a full face-piece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode. *Escape from IDLH conditions (IDLH = 2000 ppm):* (1) Any positive-pressure self-contained breathing apparatus with an appropriate service life; or (2) Any air-purifying full-face-piece respirator equipped with a front- or back-mounted butadiene or organic vapor canister.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Outdoor or detached storage is preferred. Store cylinders upright. Prior to working with 1,3-butadiene, you should be trained on its proper handling and storage. Do not store uninhibited 1,3-butadiene. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, heat and sunlight. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Butadiene, inhibited, requires a shipping label of "FLAMMABLE GAS." This material falls in Hazard Class 2.1 and does not have an assigned Packing Group.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse gas. Attempt to stop leak if without hazard. Use water spray to knock down vapors. Avoid breathing vapors. Keep upwind. Do not handle broken packages without protective equipment. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: See respirator selection for *>1000 ppm, unknown concentration, or firefighting*. This chemical is an extremely flammable liquid. Let tank car, tank truck, or storage tank burn unless leak can be stopped; with smaller tanks or cylinders, extinguish/isolate from other flammables. Stop flow of gas before extinguishing fire. *Small fires:* dry chemical or carbon dioxide. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Stay away from ends of tanks. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Cool container with water using unmanned device until well after fire is out. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Butadiene vapors are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in stoppage of vents. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

National Institute for Occupational Safety and Health. (February 9, 1984). *1,3-Butadiene. Current Intelligence Bulletin* 41, DHHS (NIOSH), Publication No. 84−105. Cincinnati, OH

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Butadiene*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: 1,3-Butadiene*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Butadiene*. Albany, NY: Bureau of Toxic Substance Assessment

Butanes B:0770

Molecular Formula: C_4H_{10}
Common Formula: $CH_3CH_2CH_2CH_3$
Synonyms: A-17; Bu-gas; *n*-Butane; Butano (Spanish); Butyl hydride; Diethyl; Diethyl, liquefied petroleum gas; Methyl ethyl methane; Methylethylmethane; Twinkle stainless steel cleaner
Iso-isomer: 1,1-Dimethylethane; Isobutane; Isobutano (Spanish); 2-Methylpropane; Propane, 2-methyl; Trimethylmethane
CAS Registry Number: 106-97-8; 75-28-5 *(iso-)*
RTECS® Number: EJ4200000; TZ4300000 (*iso-*)
UN/NA & ERG Number: UN1011/115; UN1969 (*iso-*)/115; UN1075 (Petroleum gases, liquefied or liquefied petroleum gas)/115
EC Number: 203-448-7 [*Annex I Index No.:* 601-004-00-0] (*n-*); 200-857-2 [*Annex I Index No.:* 601-004-00-0] (*iso-*); 203-450-8 [*Annex I Index No.:* 601-004-01-8] (*butane containing ≥ 0.1% butadiene*)
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥ 1.00% concentration).
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations (*n- & isobutane*): Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16.
Iso-isomer: Clean Air Act: Accidental Release Prevention/Flammable Substances [Section 112(r), Table 3], TQ = 10,000 lb (4540 kg).
European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16 (see Appendix 4).
WGK (German Aquatic Hazard Class): Nonwater polluting agent.
Butane containing ≥ 0.1% butadiene: European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R45; R46; R12; Safety phrases: S53; S45.
Description: Butane is a colorless, extremely flammable, liquefied, compressed gas. A liquid below 30°F/−1.1°C. Natural gas-like odor. Odor threshold: 204 ppm. Molecular weight = 58.12; Specific gravity (H_2O:1) = 0.6; Relative vapor density (air = 1) = 2.11; Boiling point = −0.5°C; Freezing/Melting point = −138°C; Vapor pressure = 2.05 atm at 19°C. The explosive limits are: LEL = 1.9%; UEL = 8.4%; Flash point = −60°C (flammable gas); Autoignition temperature = 287°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Practically insoluble in water; solubility = 6×10^{-3} at 20°C.
Isobutane is a colorless, extremely flammable, liquefied, compressed gas. A liquid below 11°F/−11°C. Gasoline-like odor. Molecular weight = 58.1; Specific gravity (H_2O:1) = 0.6 (liquid); Boiling point = −12°C; Freezing/Melting point = −159°C; Vapor pressure = 3.1 mmHg at 20°C; Relative vapor density (air = 1) = 2.06. The explosive limits are: LEL = 1.8%; UEL = 8.4%; Flash point = flammable gas; Autoignition temperature = 460°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.
Potential Exposure: Compound Description: Human Data. It is used as a raw material for butadiene, as a fuel for household or industrial purposes (alone or in admixture with propane). It is also used as an extractant, solvent, and aerosol propellant. It is used in plastic foam production as a replacement for fluorocarbons.
Incompatibilities: Strong bases, strong oxidizers (e.g., nitrates & perchlorates), chlorine, fluorine, (nickel carbonyl + oxygen).
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.38 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 800 ppm/1900 mg/m^3 TWA.
ACGIH TLV®[1]: 800 ppm TWA.
Protective Action Criteria (PAC)*
TEEL-0: 1000 ppm
PAC-1: **5500** ppm
PAC-2: **17,000** ppm
PAC-3: **53,000** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.
Iso-isomer
TEEL-0: 800 ppm
PAC-1: 2400 ppm
PAC-2: 4000 ppm
PAC-3: 15,000 ppm
DFG MAK: 1000 ppm (2400 mg/m^3) (both isomers).
Australia: TWA 800 ppm (1900 mg/m^3), 1993; Austria: MAK 800 ppm (1900 mg/m^3) (all isomers), 1999; Belgium: TWA 800 ppm (1900 mg/m^3), 1993; Denmark: TWA 500 ppm (1200 mg/m^3), 1999; Finland: TWA 800 ppm (1900 mg/m^3); STEL 1000 ppm (2350 mg/m^3), 1999; France: VME 800 ppm (1900 mg/m^3), 1999; Hungary: TWA 300 mg/m^3; STEL 900 mg/m^3, 1993; the Netherlands: MAC-TGG 1430 mg/m^3, 2003; Japan: 500 ppm (1200 mg/m^3), 1999; Norway: TWA 250 ppm (600 mg/m^3), 1999; Poland: TWA 1900 mg/m^3; STEL 3000 mg/m^3, 1999; Russia: TWA 500 ppm; STEL 300 mg/m^3, 1993; Switzerland: MAK-week 800 ppm (1900 mg/m^3), 1999; United Kingdom: TWA 600 ppm (1450 mg/m^3); STEL 750 ppm (1810 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New

Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 800. Several states have set forth guidelines or standards for butane in ambient air[60] ranging from 19 mg/m^3 (North Dakota) to 32 mg/m^3 (Virginia) to 38 mg/m^3 (Connecticut) to 45.2 mg/m^3 (Nevada).

Determination in Air: OSHA Analytical Method 56.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of 19,000 μg/L based on health effects.

Determination in water: Octanol−water coefficient: Log $K_{ow} = 2.9$.

Routes of Entry: Inhalation, skin, and/or eye contact (liquid).

Harmful Effects and Symptoms

Butane is not characterized by its toxicity but rather by its narcosis-producing potential at high exposure levels.

Short Term Exposure: Can cause headache, lightheadedness, drowsiness, and unconsciousness from lack of oxygen. Contact with the liquid can cause frostbite.

First Aid: Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Clothing frozen to the skin should be thawed before being removed. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **8 h** (At least 4 h but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Butyl, Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; CPF3® suits; Trychem 1000™ suits; **4 h:** (At least 4 h but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Large amounts of butane (800 ppm and above) will replace the amount of available oxygen and lead to suffocation. Oxygen content should never be below 19%. Use NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode; or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with butane you should be trained on its proper handling and storage. All appropriate sections of the OSHA Standard 1910.111, Storage, Handling, of Liquefied Petroleum Gases must be followed. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above and heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Butane requires a shipping label of "FLAMMABLE GAS." Butane falls in Hazard Class 2.1 with no Packing Group specified.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep the gas concentration below the explosive limit range by forced ventilation.[24] Stop the flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air. Repair leak or allow cylinder to dissipate to the atmosphere. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butane is a flammable gas. In case of fire, stop the flow of gas if it can be done safely. Use dry chemical, carbon dioxide; or halon extinguishers. Use water to keep fire-exposed containers cool and to protect personnel doing the shut off. If a leak or spill has caught fire, use water spray to disperse gas and to protect personnel shutting off leak. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Butane*. Trenton, NJ

Butanedione B:0780

Molecular Formula: $C_4H_6O_2$
Common Formula: $CH_3COCOCH_3$
Synonyms: Biacetyl; Butadione; 2,3-Butanedione; Butanodiona (Spanish); Diacetyl; 2,3-Diketobutane; Dimethyl diketone; Dimethylglyoxal; Glyoxal dimethyl; Glyoxal, dimethyl-
CAS Registry Number: 431-03-8
RTECS® Number: EK2625000
UN/NA & ERG Number: UN2346/127
EC Number: 207-069-8
Regulatory Authority and Advisory Bodies
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Butanedione is a yellow-green, mobile liquid with a chlorine-like odor. Molecular weight = 86.1. Boiling point = 88°C; Freezing/Melting point = − 2.4°C; Flash point = 27°C; Autoignition temperature = 365°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Highly soluble in water.
Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen, Primary Irritant. Butanedione is used as an aroma carrier food additive in butter, vinegar, coffee, and other foods.
Incompatibilities: Contact with oxidizers may cause fire and explosions. High heat may cause violent combustion or explosion.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 20 mg/m^3
PAC-1: 60 mg/m^3
PAC-2: 400 mg/m^3
PAC-3: 400 mg/m^3
Determination in water: Octanol−water coefficient: Log $K_{ow} = -1.32$.
Routes of Entry: Inhalation, skin contact, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Butanedione can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Contact can irritate the skin. May have a narcotic effect on the nervous system.
Long Term Exposure: Repeated exposure may affect the blood count and nervous system. Repeated or prolonged contact may cause skin sensitization.
Points of Attack: Skin, eyes, respiratory system, blood, nervous system.
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: complete blood count. Consider nerve conductions studies. Examination by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: *Clothing:* Avoid skin contact with Butanedione. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn.
Respirator Selection: Where there is potential for exposures to butanedione exists, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butanedione is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of butanedione should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butanedione. Wherever butanedione is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Shipping: Butanedione must be labeled "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep Butanedione out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butanedione is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Butanedione*. Trenton, NJ

N-Butoxyethanol B:0790

Molecular Formula: $C_6H_{14}O_2$

Common Formula: $C_4H_9OCH_2CH_2OH$

Synonyms: BUCS; 2-Butoxy-ethanol (German); 2-Butoxyethanol; Butyl cellosolve; Butyl oxitol; Dowanol EB; EGBE; Ektasolve EB solvent; Ethyleneglycol monobutyl ether; Glycol butyl ether; Jeffersol EB; Poly-Solv EB

CAS Registry Number: 111-76-2

RTECS® Number: KJ8575000

UN/NA & ERG Number: UN 2369 (Ethylene glycol monobutyl ether)/152

EC Number: 203-905-0 [*Annex I Index No.:* 603-014-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies (inhalation): some evidence: mouse, 2000; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse, rat; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

TSCA 40CFR716.120(a).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/21/22; R36/38; Safety phrases: S2; S36/37; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

As glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol R—$(OCH_2CH_2)_n$—OR′ where $n = 12$, or 3; R = alkyl or aryl groups; R′ = R, H, or groups which when removed yield glycol ethers with the structure: R—$(OCH_2CH)_n$—OH. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. R—$(OCH_2CH_2)_n$—OR′; where $n = 12$ or 3; R = alkyl C_7 or less; or R = phenyl or alkyl-substituted phenyl; R′ + H, or alkyl C_7 or less; or OR′ consisting of carboxylic ester, sulfate, phosphate, nitrate, or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

Description: 2-Butoxy ethanol is a colorless liquid with a mild, ether-like odor. Molecular weight = 118.20; Boiling point = 171°C; Freezing/Melting point = −75°C; Specific gravity (H_2O:1) = 0.90; Vapor pressure = 0.8 mmHg at 20°C; Relative vapor density (air = 1) = 4.1; Flash point = 61°C (cc); Autoignition temperature = 238°C. Explosive limits = LEL 1.1% at 93°C; UEL 12.7% at 135°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. This material is used as a solvent for resins in protective coatings, lacquers, varnishes, and enamels. It is also used in varnish removers and in dry cleaning compounds.

Incompatibilities: Forms explosive mixture with air. Can form unstable and explosive peroxides; check for peroxides prior to distillation; render harmless if positive. Decomposes, producing toxic fumes. Violent reaction with strong caustics and strong oxidizers. Attacks some coatings, plastics, and rubber. Attacks metallic aluminum at high temperatures.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.83 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/240 mg/m^3 TWA [skin].

NIOSH REL: 5 ppm/24 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 20 ppm/97 mg/m^3 TWA; Confirmed animal carcinogen with unknown relevance to humans; BEI assigned.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 50 ppm

PAC-2: 100 ppm

PAC-3: 700 ppm

DFG MAK: 10 ppm (sum of all concentrations)/49 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 50 mg [Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long term).

NIOSH IDLH: 700 ppm.

Australia: TWA 25 ppm (120 mg/m^3), [skin], 1993; Austria: MAK 20 ppm (100 mg/m^3), [skin], 1999; Belgium: TWA 25 ppm (121 mg/m^3), [skin], 1993; Denmark: TWA 25 ppm (120 mg/m^3), [skin], 1999; Finland: TWA 25 ppm (120 mg/m^3); STEL 75 ppm (350 mg/m^3), [skin], 1999; France: VME 25 ppm (120 mg/m^3), [skin], 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 100 mg/m^3, [skin], 2003; Norway: TWA 20 ppm (100 mg/m^3), 1999; the Philippines: TWA 50 ppm (240 mg/m^3), [skin], 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 360 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Sweden: NGV 10 ppm (50 mg/m^3), KTV 20 ppm (100 mg/m^3), [skin], 1999; Switzerland: MAK-W 20 ppm (100 mg/m^3), KZG-W 40 ppm (200 mg/m^3), [skin], 1999; Turkey: TWA 50 ppm (240 mg/m^3), 1993; United Kingdom: TWA 25 ppm (123 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Use NIOSH Analytical Method #1403,[18] OSHA Analytical Method 83.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.830$. EC_{50} [*Daphnia magna* (water flea), 24 h] = 1.815 mg/L.

Routes of Entry: Inhalation, skin absorption, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Irritation of eyes, nose, and throat, hemolysis, hemoglobinuria. LD_{50} = (oral-rat) 1480 mg/kg (slightly toxic).

Short Term Exposure: This chemical irritates the eyes, skin, and respiratory tract. High exposure caused dizziness, lightheadedness, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure could cause central nervous system depression and liver and kidney damage.

Long Term Exposure: The liquid defats the skin. This chemical can break down red blood cells and cause anemia, effects the hematopoietic system, resulting in blood disorders. It can also damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, central nervous system, hematopoietic system, blood, kidneys, liver, lymphoid system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests, urinalysis, and kidney function tests. Complete blood count (CBC) with reticulocyte count. Liver function tests. Consider chest x-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Butyl, Viton™ gloves, suits, Saranex™. **4 h:** (At least 4 h but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)]; or Sa* (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area. Keep in dark due to possible formation of explosive peroxides. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic, liquids, organic, n.o.s., or Ethylene glycol monobutyl ether require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Enter spill area from upwind side. Establish forced ventilation to keep levels below explosive limit. Use absorbent material to permit spill removal to vapor-tight plastic bags for eventual disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (February 1989). *Hazardous Substances Fact Sheet: 2-Butoxyethanol*. Trenton, NJ

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 58−61

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Butoxyl B:0800

Molecular Formula: $C_7H_{14}O_3$

Common Formula: $CH_3COOCH_2CH_2CH(OCH_3)CH_3$

Synonyms: Acetic acid 3-methoxybutyl ester; 3-Methoxybutyl acetate; Methyl-1,3-butylene glycol acetate

CAS Registry Number: 4435-53-4

RTECS® Number: EL4725000

UN/NA & ERG Number: UN2708/127

EC Number: 224-644-9

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butoxyl is a colorless liquid with a sharp odor. Molecular weight = 146.19; Specific gravity (H_2O:1) = 0.96; Boiling point = 169−173°C; Melting/Freezing point = < -80°C; Flash point = 62°C (cc); 77°C.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 1. Slightly soluble in water; solubility = 30 g/L.

Potential Exposure: Those involved in the use of this material as a cleaning solvent and as a component in varnishes and casting molds.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No TEEL available.

Routes of Entry: Inhalation, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Butoxyl can be an eye irritant. High vapor levels can cause dizziness. LD_{50} = (oral-rat) 4210 mg/kg (slightly toxic).[9]

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to Butoxyl and at the end of the work shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Butoxyl to potentially exposed workers.

Respirator Selection: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Butoxyl must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butoxyl is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butoxyl requires a shipping label of "FLAMMABLE LIQUID." The Hazard Class is 3 and the Packing Group is III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Butoxyl*. Trenton, NJ

Butyl acetates B:0810

Molecular Formula: $C_6H_{12}O_2$
Common Formula: $C_4H_9OCOCH_3$
Synonyms: *n*-Isomer*:* Acetate de butyle (French); *n*-Acetato de butilo (Spanish); Acetato de butilo (Spanish); Acetic acid, *n*-butyl ester; Acetic acid, butyl ester; Aristoline (+); AZ1470 (+); AZ4140 (+); AZ4210 (+); AZ4330 (+); AZ4620 (+); AZ 1310-SF (+); AZ 1312-SFD (+); AZ 1350J (+); AZ 1370 (+); AZ 1370-SF (+); AZ 1375 (+); AZ thinner; Butylacetat (German); *n*-Butyl acetate; *normal* Butyl acetate; 1-Butyl acetate; Butyle (acetate de) (French); *n*-Butyl ester of acetic acid; Butyl ethanoate; 6-6 Epoxy chem resin finish, clear curing agent; Goodrite Nr-R; KTI 1470 (+); KTI 1300 thinner; KTI 1350 J (+); KTI 1370/1375 (+); KTI II (+); Microposit 111S (+); Microposit 119S (+); Microposit 119 thinner; Microposit 1375 (+); Microposit 1400-33 (+); Microposit 1400S (+); Microposit 1470 (+); Microposit 6009 (+); Microposit Sal 601-ER7 (+); Microposit XP-6012 (+); TSMR 8800 (+); TSMR 8800 BE; Ultramac PR-1024 MB-628 resin; Ultramac solvent EPA; Waycoat 204 (+); Waycoat HPR 205/207 (+); Waycoat RX 507 (+); Xanthochrome (+); XIR-3000-T resin
iso-isomer: Acetate d'isobutyle (French); Acetato de isobutilo (Spanish); Acetic acid, isobutyl ester; Acetic acid, 2-methylpropyl ester; Isobutyl acetate (DOT); 2-Methyl-1-propyl acetate; 2-Methylpropyl acetate; β-Methylpropyl ethanoate
sec-isomer: Acetate de butyle secondaire (French); Acetato de butilo-*sec* (Spanish); Acetic acid, 2-butoxy ester; Acetic acid, 1-methylpropyl ester; *s*-Butyl acetate; *sec*-Butyl acetate; *secondary* Butyl acetate; 2-Butyl acetate; *sec*-Butyl alcohol acetate; 1-Methyl propyl acetate
tert-isomer: Acetato de *tert*-butilo (Spanish); Acetic acid *t*-butyl ester; Acetic acid *tert*-butyl ester; Acetic acid, 1,1-dimethylethyl ester; Acetic acid, *tert*-butyl ester; *t*-Butyl acetate; Texaco lead appreciator; TLA
CAS Registry Number: 123-86-4 (*n*-); 105-46-4 (*sec*-); 540-88-5 (*tert*-); 110-19-0 (*iso*-)
RTECS® Number: AF7350000 (*n*-); AF380000 (*sec*-); AF7400000 (*tert*-); AI4025000 (*iso*-)
UN/NA & ERG Number: UN1123 (butyl acetates)/129; UN1213 (*iso*-)/129
EC Number: 204-658-1 [*Annex I Index No.:* 607-025-00-1] (*n*-); 203-300-1 [*Annex I Index No.:* 607-026-00-7] (*sec*-); 208-760-7 [*Annex I Index No.:* 607-026-00-7] (*tert*-); 203-745-1 [*Annex I Index No.:* 607-026-00-7] (*iso*-)
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 5000 lb (2270 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% for all isomers.
n-isomer
European/International Regulations: Hazard Symbol: F; Risk phrases: R10; R66; R67; Safety phrases: S2; S25.
sec-, iso-, & tert-isomers
European/International Regulations: Hazard Symbol: F+; Risk phrases: R11; R66; Safety phrases: S2; S16; S23; S25; S29; S33 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*n-, iso-, tert-*)
Description: Butyl acetates are colorless or yellowish liquids with pleasant, fruity odors. There are 4 isomers. Molecular weight = 116.16 (all isomers).
n-isomer
Specific gravity (H_2O:1) = 0.87; Boiling point = 126−127°C; Freezing/Melting point = −77°C; Vapor pressure = 6 mmHg at 20°C; Flash point = 22°C; Autoignition temperature = 370°C. Flammable Limits in Air: LEL = 1.7%, UEL = 7.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water; solubility in water = 0.9% at 20°C.
sec-isomer
Specific gravity (H_2O:1) = 0.87; Boiling point = 112°C; Freezing/Melting point = −99.4°C; Vapor pressure = 10 mmHg at 20°C; Relative vapor density (air = 1) = 4.0; Flash point = 19°C (cc); Flammable Limits in Air: LEL = 1.7%, UEL = 9.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility in water = 0.8% at 20°C.
iso-isomer
Specific gravity (H_2O:1) = 0.87; Boiling point = 117°C; Freezing/Melting point = −99°C; Vapor pressure = 13 mmHg at 20°C; Flash point = 18°C (cc); Autoignition temperature = 421°C; Flammable Limits in Air: LEL = 1.3%, UEL = 10.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 0.6% at 20°C.
tert-isomer
Specific gravity (H_2O:1) = 0.87; Boiling point = 97−98°C. Flammable Limits in Air: LEL = 1.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.
Potential Exposure: Compound Description (*n*-): Reproductive Effector; Human Data; Primary Irritant; (*tert*- and *iso*-) Primary Irritant. *n*-Butyl acetate is an important solvent in the production of lacquers, leather, and airplane dopes, and perfumes. It is used as a solvent and gasoline additive. *sec*-Butyl acetate is used as a widely used solvent for nitrocellulose, nail enamels, and many different purposes. *tert*-Butyl acetate is common industrial solvent used in the making of lacquers, artificial

leather, airplane dope, perfume, and as a food additive. Isobutyl acetate is used as a solvent and in perfumes and artificial flavoring materials.

Incompatibilities: All butyl acetates are incompatible with nitrates, strong oxidizers, strong alkalies, strong acids. Butyl acetates form explosive mixtures with air, reacts with water—on standing—to form acetic acid and *n*-butyl alcohol. Violent reaction with strong oxidizers and potassium-*tert*-butoxide. Dissolves rubber, many plastics, resins, and some coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.03 mg/m^3 (*n*-isomer); 1 ppm = 4.75 mg/m^3 (all other at 25°C & 1 atm isomers).

n-isomer

OSHA PEL: 150 ppm/710 mg/m^3 TWA.

NIOSH REL: 150 ppm/710 mg/m^3 TWA; 200 ppm/950 mg/m^3 STEL.

ACGIH TLV®[1]: 150 ppm/713 mg/m^3 TWA; 200 ppm/950 mg/m^3 STEL.

NIOSH IDLHs = 1700 ppm [LEL].

Protective Action Criteria (PAC)*

TEEL-0: 5 ppm

PAC-1: **5** ppm

PAC-2: **200** ppm

PAC-3: **3000** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: 100 ppm/480 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Compound Description: Reproductive Effector; Human Data; Primary Irritant.

Australia: TWA 150 ppm (710 mg/m^3); STEL 200 ppm, 1993; Austria: MAK 150 ppm (700 mg/m^3), 1999; Belgium: TWA 150 ppm (713 mg/m^3); STEL 200 ppm (950 mg/m^3), 1993; Denmark: TWA 150 ppm (710 mg/m^3), 1999; Finland: TWA 150 ppm (710 mg/m^3); STEL 200 ppm (950 mg/m^3), 1993; France: VME 150 ppm (710 mg/m^3), VLE 200 ppm (940 mg/m^3), 1999; Hungary: TWA 200 mg/m^3; STEL 600 mg/m^3, 1993; the Netherlands: MAC-TGG 710 mg/m^3, 2003; Japan: 100 ppm (475 mg/m^3), 1999; Norway: TWA 75 ppm (355 mg/m^3), 1999; the Philippines: TWA 150 ppm (710 mg/m^3), 1993; Poland: MAC (TWA) 200 mg/m^3, MAC (STEL) 950 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 200 mg/m^3, 1993; Sweden: NGV 100 ppm (500 mg/m^3), KTV 150 ppm (700 mg/m^3), 1999; Switzerland: MAK-W 150 ppm (700 mg/m^3), KZG-W 300 ppm, 1999; Turkey: TWA 150 ppm (710 mg/m^3), 1993; United Kingdom: TWA 150 ppm (724 mg/m^3); STEL 200 ppm (966 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 200 ppm.

sec-isomer

OSHA PEL: 200 ppm/950 mg/m^3 TWA.

NIOSH REL: 200 ppm/950 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm/950 mg/m^3 TWA.

NIOSH IDLHs = 1700 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 200 ppm

PAC-2: 350 ppm

PAC-3: 1700 ppm

Australia: TWA 200 ppm (950 mg/m^3), 1993; Austria: MAK 150 ppm (700 mg/m^3), 1999; Belgium: TWA 200 ppm (950 mg/m^3), 1993; Denmark: TWA 150 ppm (710 mg/m^3), 1999; France: VME 200 ppm (950 mg/m^3), 1999; India: TWA 200 ppm (950 mg/m^3), 1993; Norway: TWA 75 ppm (355 mg/m^3), 1999; the Philippines: TWA 200 ppm (950 mg/m^3), 1993; the Netherlands: MAC-TGG 950 mg/m^3, 2003; Sweden: NGV 100 ppm (500 mg/m^3), KTV 150 ppm (700 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (950 mg/m^3), KZG-W 400 ppm (1900 mg/m^3), 1999; United Kingdom: TWA 200 ppm (966 mg/m^3); STEL 250 ppm (1210 mg/m^3), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 200 ppm.

tert-isomer

OSHA PEL: 200 ppm/950 mg/m^3 TWA.

NIOSH REL: 200 ppm/950 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm/950 mg/m^3 TWA.

NIOSH IDLHs = 1500 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 600 ppm

PAC-2: 1000 ppm

PAC-3: 1500 ppm

DFG MAK: 20 ppm/96 mg/m^3.

Australia: TWA 200 ppm (950 mg/m^3), 1993; Austria: MAK 150 ppm (700 mg/m^3), 1999; Belgium: TWA 200 ppm (950 mg/m^3), 1993; Denmark: TWA 150 ppm (710 mg/m^3), 1999; France: VME 200 ppm (950 mg/m^3), 1999; India: TWA 200 ppm (950 mg/m^3), 1993; the Netherlands: MAC-TGG 950 mg/m^3, 2003; the Philippines: TWA 200 ppm (950 mg/m^3), 1993; Poland: MAC (TWA) 900 mg/m^3, MAC (STEL) 900 mg/m^3, 1999; Sweden: NGV 100 ppm (500 mg/m^3), KTV 150 ppm (700 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (950 mg/m^3), KZG-W 400 ppm (1900 mg/m^3), 1999; United Kingdom: TWA 200 ppm (966 mg/m^3); STEL 250 ppm (1210 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 200 ppm.

iso-isomer

OSHA PEL: 150 ppm/700 mg/m^3 TWA.

NIOSH REL: 150 ppm/700 mg/m^3 TWA.

ACGIH TLV®[1]: 150 ppm/713 mg/m^3 TWA.

NIOSH IDLHs = 1300 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 150 ppm
PAC-1: 150 ppm
PAC-2: 250 ppm
PAC-3: 1300 ppm
DFG MAK: 100 ppm/480 mg/m^3; Pregnancy Risk Group C.
Australia: TWA 150 ppm (700 mg/m^3); STEL 187 ppm, 1993; Austria: MAK 150 ppm (700 mg/m^3), 1999; Belgium: TWA 150 ppm (713 mg/m^3); STEL 187 ppm (888 mg/m^3), 1993; Denmark: TWA 150 ppm (710 mg/m^3), 1999; France: VME 150 ppm (710 mg/m^3), VLE 200 ppm (940 mg/m^3), 1999; the Philippines: TWA 150 ppm (700 mg/m^3), 1993; the Netherlands: MAC-TGG 700 mg/m^3, 2003; United Kingdom: TWA 150 ppm (724 mg/m^3); STEL 187 ppm (903 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 150 ppm.

Several states have set guidelines or standards for butyl acetates in ambient air[60] as follows (all values in mg/m^3):

State	***n-***	***sec-***	***tert-***	***iso-***
Connecticut	14.2	19.0	19.0	14.0
Florida	14.2	–	–	14.0
Massachusetts	–	–	–	0.97
Nevada	16.9	22.6	22.6	16.67
New York	14.2	–	–	14.0
South Dakota	14.2	–	–	–

Determination in Air: Adsorption of charcoal, workup with CS_2, analysis by gas chromatography. Use NIOSH Analytical Method #1450 (Esters I), #1405, #2549 Volatile Organic Compounds[18] (screening), and OSHA Analytical Method 7 Organic Vapors.

Permissible Concentration in Water: Russia[43] cites a MAC of 0.1 mg/L (for any isomer) in water used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.60 (*n*-); 1.5 (*sec*-).

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact. Passes through the unbroken skin.

Harmful Effects and Symptoms

Headaches, drowsiness, eye irritation, irritation of skin and upper respiratory system. Humans and animals that inhale comparatively low doses of *n*-butyl acetate experience irritation of the nasal and respiratory passages and of the eyes. At higher concentrations narcosis takes place, and repeated exposures have resulted in renal and blood changes in experimental animals.

Short Term Exposure: The substance irritates the eyes, skin, and respiratory tract. High exposures, above the occupational exposure levels, can cause weakness, headache, and drowsiness, and may cause unconsciousness.

Long Term Exposure: *n*-Butyl acetate may cause skin allergy. *n*-Butyl acetate has been shown to damage the developing fetus in animals. Prolonged and repeated exposure to butyl acetates can cause defatting, drying, and cracking of the skin. Although many solvents and petroleum-based products cause lung, brain and disturbed sleep, butyl acetates have not been adequately evaluated to determine these effects. See also NIOSH Profiles: Acetates, SRI, 2/77; *n*-Butyl acetate, SRC, 12/79; Paint and allied products manufacturing, FIRL, 4/78 and SRI, 2/7; Spray painting, FIRL, 4/78.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider initial effects on skin and respiratory tract in any preplacement or periodical examinations, as well as liver, lung, and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of saltwater and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** (At least 4 h but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. **4 h:** (At least 4 h but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n-isomer:* OSHA: *1500 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator). *1700 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

sec-isomer: 1700 ppm: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

tert-isomer: 1500 ppm: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

iso-isomer: 1300 ppm: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrOv (APF = 10) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl acetates you should be trained on its proper handling and storage. Before entering confined space where these chemicals may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl acetates require shipping label of "FLAMMABLE LIQUID." They fall in Hazard Group 3 and Packing Group II and III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Vapor buildup may cause suffocation. For small quantities absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for the evaporated vapors to completely clear the hood duct work. Burn the paper in a suitable location away from combustible materials. Or, absorb liquids in activated carbon, vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are flammable liquids. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be used as a fog to control heat and to dilute vapors and wash them from the air. Use water fog in conjunction with alcohol foam, dry chemical, or carbon dioxide as extinguishing agents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Container may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. See also "Spill Handling" section above.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: n-Butyl Acetate*, Report TR 79-607. Rockville, MD, pp. 19−27

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 41−43 (Isobutyl Acetate)

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 35−37 (*t*-Butyl Acetate)

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 38−41 (*n*-Butyl Acetate)

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 6, 82−83 (*sec*-Butyl Acetate)

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: n-Butyl Acetate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: sec-Butyl Acetate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: tert-Butyl Acetate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Isobutyl Acetate*. Trenton, NJ

Butyl acid phosphate B:0820

Molecular Formula: $C_8H_{21}O_4P$

Common Formula: $(C_4H_9O)_2PH(OH)_2$

Synonyms: Acid butyl phosphate; *n*-Butyl acid phosphate; Butyl phosphoric acid; Phosphoric acid, dibutyl ester

CAS Registry Number: 12788-93-1

RTECS® Number: TB8490000

UN/NA & ERG Number: UN1718/153

EC Number: 235-826-2

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Butyl acid phosphate is a clear white liquid. Molecular weight = 153.08; Flash point = 110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: It is used in industrial chemicals manufacture.

Incompatibilities: Strong oxidizers, strong acids.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Butyl acid phosphate can affect you when breathed in. Contact can severely irritate the eyes, skin, and respiratory tract. Can cause permanent eye damage. Inhalation can irritate the nose, throat, and lungs, causing difficult breathing and shortness of breath.

Long Term Exposure: Repeated or prolonged contact can cause skin rash. Very irritating substances, such as butyl acid phosphate, may affect the lungs.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. If pulmonary edema develops from high exposure, medical observation is recommended for 24–48 h.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Butyl acid phosphate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Store in tightly closed containers is a cool, well-ventilated area away from potentially high-heat sources.

Shipping: Butyl acid phosphate requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Butyl Acid Phosphate*. Trenton, NJ

n-Butyl acrylate B:0830

Molecular Formula: $C_7H_{12}O_2$

Common Formula: $CH_2{=}CHCOOC_4H_9$

Synonyms: Acrilato de *n*-butilo (Spanish); Acrylic acid *n*-butyl ester; Acrylic acid, butyl ester; *n*-Butyl acrylate; *normal* Butyl acrylate; Butylacrylate, inhibited; Butyl 2-propenoate; 2-Propenoic acid, butyl ester

CAS Registry Number: 141-32-2

RTECS® Number: UD3150000

UN/NA & ERG Number: UN2348/129P

EC Number: 205-480-7 [*Annex I Index No.:* 607-062-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R36/37/38; R43; Safety phrases: S2; S9 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyl acrylate is a colorless liquid. Molecular weight = 128.2; Specific gravity (H_2O:1) = 0.89; Boiling point = 146−148°C; Freezing/Melting point = − 64°C; Vapor pressure = 4 mmHg at 20°C; Relative vapor density (air = 1) = 4.4; Flash point = 29°C; Autoignition temperature = 292°C. Explosive limits in air: LEL = 1.3%; UEL = 9.9%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2. Slightly soluble in water; solubility in water = 0.14%.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Primary Irritant. This material is used as a monomer in the production of polymers, copolymers, and resins; solvent for coatings; adhesives, paints and binders.

Incompatibilities: Forms explosive mixture with air. Heat, sparks, open flame, light, reducing agents, or peroxides may cause explosive polymerization. Incompatible with strong acids, amines, halogens, hydrogen compounds, oxidizers, sunlight, or other catalysts.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.24 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 10 ppm/55 mg/m^3 TWA.

ACGIH TLV®[1]: 2 ppm; 11 mg/m^3 TWA [sensitizer]; not classified as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **8.3** ppm

PAC-2: **130** ppm

PAC-3: **480** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/11 mg/m^3 TWA; Peak Limitation Category I(2) *as acrylic acid*, *n-butyl ester*.

Australia: TWA 10 ppm (55 mg/m^3), 1993; Austria: MAK 10 ppm (55 mg/m^3), 1999; Belgium: TWA 10 ppm (52 mg/m^3), 1993; Denmark: TWA 10 ppm (55 mg/m^3), 1999; Finland: TWA 10 ppm (55 mg/m^3); STEL 20 ppm (110 mg/m^3) [skin] 1999; France: VME 10 ppm (55 mg/m^3), 1999; Hungary: TWA 20 mg/m^3; STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 11 mg/m^3, 2003; Norway: TWA 10 ppm (55 mg/m^3), 1999; Poland: TWA 20 mg/m^3; STEL 70 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Sweden: NGV 10 ppm (50 mg/m^3), KTV 15 ppm (80 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (55 mg/m^3), KZG-W 20 ppm (110 mg/m^3), 1999; United Kingdom: TWA 10 ppm (53 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Some states have set guidelines or standards for Butyl acrylate in ambient air[60] ranging from 900 μg/m^3 (Virginia) to 1100 μg/m^3 (Connecticut) to 1310 μg/m^3 (Nevada).

Determination in Air: See OSHA Analytical Method PV2011, butyl acrylate.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4.

Routes of Entry: Ingestion, skin and eye contact.

Harmful Effects and Symptoms

n-Butyl acrylate was found to be but moderately irritating to the skin. As an eye irritant it produced corneal necrosis in an unwashed rabbit eye, similar to that produced by ethyl alcohol. Exposure of rats at 1000 ppm for 4 h proved lethal to 5 of 6 rats exposed; however, rats survived a 30-min exposure to 7000 ppm. There is a close similarity in toxic response by inhalation, skin and eye to methyl acrylate. LD_{50} = (oral-rat) 900 mg/kg (slightly toxic).

Short Term Exposure: This chemical can pass through the skin. The substance severely irritates the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposure may cause liver damage.

Long Term Exposure: May cause liver and lung damage. May cause skin sensitization and allergy. Similar solvents and petroleum-based chemicals have been shown to cause brain and nerve damage.

Points of Attack: Skin, eyes.

Medical Surveillance: Liver and lung function tests. Examination by a qualified allergist. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves, Responder™ suits; Trychem 1000™ suits; **4 h:** (At least 4 but <8 h of resistance to breakthrough

>0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the *NIOSH/NPPTL Certified Equipment List*, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Butyl acrylate you should be trained on its proper handling and storage. Do not store unless stabilized. Before entering confined space where Butyl acrylate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated, fireproof area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl acrylate, inhibited, requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover liquids with dry lime or soda ash; or absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible and highly reactive liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 3, 61–75

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Butyl Acrylate*. Trenton, NJ

Butyl alcohols B:0840

Molecular Formula: $C_4H_{10}O$

Common Formula: C_4H_9OH

Synonyms: *iso-isomer:* 197 rosin flux; 4282 flux; Alcohol isobutilico (Spanish); Alcool isobutylique (French); Alcowipe; Alpha 100 flux; Alpha 850-33 flux; Aqua-Sol flux; Avantine; Boron B-30; Boron B-40; Boron B-50; Boron B-60; Burmar Lab Clean; C-589; Chemtranic flux stripper; Copper 2 reagent; CP290B activator; DAG 154; Dazzlens cleaner; ENTAC 349 biocide; ENTEC 327 surfactant; Epoxy cure agent; FC-95;

Fermentation butyl alcohol; Film remover; Glid-Guard epoxy safety blue; Hardness 2 test solution; High Grade 1086; 1-Hydroxymethylpropane; IBA; Isobutanol; Isopropylcarbinol; Kester 103 thinner; Kester 108 thinner; Kester 145 rosin flux; Kester 1585 rosin flux; Kester 185 rosin flux; KTI Cop Rinse I/II; KTI mask protective coating; KTI NMD-25(+); KTI PBS rinse; KTI PMMA rinse; Lens cleaner M6015; Magic glass cleaner and antifogging fluid; Markem 320 cleaner; 2-Methyl-1-propanol; 2-Methylpropyl alcohol; Microposit NPE-210 solution; Omega meter solution; Opti Skan scan cleaner; Organo flux 3355-11; PBS developer; PBS rinse; PC-96 solvent soluble resist; Primer 910-S; 1-Propanol, 2-methyl-; RCRA No. U140; RN-10 E-Beam negative resist rinse; RN-11 developer; RN-11 E-beam negative resist rinse; Rosin flux; Rosin flux Kester 135/1544 Mil; RP-10 E-beam positive resist rinse; Scan Kleen; Solder flux; Solder flux 2163 organic; Solder flux thinner; Sterets preinjection swabs; Surfynol 104PA surfactant; True blue glass cleaner; Uvex primer 910S; Vandalex 124; Vandalex 20; VWR glass cleaner; Whirlwind glass cleaner; WRS200S solution; Xerox cleaner, Formulka A; Xerox film remover, Tip Wipes

n-isomer: Alcohol butilico-*n* (Spanish); Alcool butylique (French); *n*-Butanol; 1-Butanol; Butan-1-ol; Butanol; *normal* Butyl alcohol; Butyl alcohol (DOT); Butyl hydroxide; Butyric alcohol; CCS 203; CEM420; DAG 154; 6-6 Epoxy chem resin finish, clear curing agent; Epoxy solvent cure agent; 1-Hydroxybutane; Isanol; Kester 5612 protecto; Methylolpropane; *normal* Primary butyl alcohol; Propyl carbinol; Propyl methanol; Protecto 5612; Tebol-88; Tebol-99

sec-isomer: Alcohol *sec*-butilico (Spanish); Alcool butylique secondaire (French); *sec*-Butanol; 2-Butanol; Butan-2-ol; Butanol-2; *secondary* Butyl alcohol; 2-Butyl alcohol; Butylene hydrate; CCS301; Ethylmethyl carbinol; 2-Hydroxybutane; Methyl ethyl carbinol; 1-Methypropyl alcohol; S.B.A.; Tanol secondaire (French)

tert-isomer: Alcohol *terc*-butilico (Spanish); Alcool butylique tertiaire (French); *tert*-Butanol; 1-Butanol; Butanol tertiaire (French); *tert*-Butyl hydroxide; 1,1-Dimethylethanol; Methanol, trimethyl-; 2-Methyl-2-propanol; NCI-C55367; 2-Propanol, 2-methyl-; TBA; Tertiary butyl alcohol; Trimethyl carbinol; Trimethyl methanol

CAS Registry Number: 71-36-3 (*n*-); *(alt.)* 42031-19-6; *(alt.)* 107569-51-7; *(alt.)* 220713-25-7; 78-92-2 (*sec*-); *(alt.)* 15892-23-6; 75-65-0 (*tert*-); 78-83-1 (*iso*-)

RTECS® Number: EO1400000 (*n*-); EO1750000 (*sec*-); EO1925000 (*tert*-); NP9625000 (*iso*-)

UN/NA & ERG Number: UN1120 (*butanols*)/129; UN1212 (isobutanol)/129

EC Number: 200-751-6 [*Annex I Index No.:* 603-004-00-6] (*n*-); 201-158-5 [*Annex I Index No.:* 603-127-00-5] (*sec*-); 200-889-7 [*Annex I Index No.:* 603-005-00-1] (*tert*-); 201-148-0 [*Annex I Index No.:* 603-108-00-1] (*iso*-)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

n-isomer

US EPA Hazardous Waste Number (RCRA No.): U031.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 2.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (50).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 2.6.

RCRA 40CFR268.48; 61FR15654, Universal Treatment.

Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 170.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R22; R37/38; R41; R67; Safety phrases: S2; S7/9; S13; S26; S37/39; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting.

sec-isomer

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R36/37; R67; Safety phrases: S2; S7/9; S13; S24/25; S26; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

iso-isomer

US EPA Hazardous Waste Number (RCRA No.): U140.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 2.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (50).

tert-isomer

Carcinogenesis Studies (*tert*-isomer) NTP: (drinking water); some evidence: mouse, rat NCI: (water); equivocal evidence: mouse, rat.

US EPA, FIFRA 1998 Status of Pesticides Canceled.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R11; R20; R36/37; Safety phrases: S2; S9; S16; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: There are four isomers. *n*- and *sec*-Butyl alcohols, are colorless liquids with strong, sweet, alcoholic odor. *tert*-Butyl alcohol is a colorless crystalline powder or liquid (above 26°C) with a camphor-like odor. It is often used in aqueous solution. Isobutyl alcohol is a colorless liquid with a mild, sweet, and musty odor. Molecular weight (all isomers) = 74.12.

n-isomer

Boiling point = 117°C; Freezing/Melting point = −90°C; Specific gravity (H_2O:1) = 0.81; Vapor pressure = 6 mmHg at 20°C; Relative vapor density (air = 1) = 2.6; Relative density of vapor/air mixture at 20°C (air = 1) = 1.01; Flash point = 35°C (cc); Autoignition temperature = 345°C. Explosive limits in air: LEL = 1.4%; UEL = 11.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water; solubility in water = 9% at 20°C.

sec-isomer

Boiling point = 100°C; Freezing/Melting point = −115°C; Specific gravity (H_2O:1) = 0.81; Vapor pressure = 12 mmHg at 20°C; Relative vapor density (air = 1) = 2.55; Relative density of vapor/air mixture at 20°C (air = 1) = 1.03; Flash point = 24°C (cc); Autoignition temperature = 406°C. Explosive limits in air: LEL = 1.7%; UEL = 9.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Solubility in water = 16% at 20°C.

tert-isomer

Boiling point = 83°C; Freezing/Melting point = 25°C; Specific gravity (H_2O:1) = 0.79 (solid); Vapor pressure = 42 mmHg at 25°C; Relative vapor density (air = 1) = 2.6; Relative density of vapor/air mixture at 20°C (air = 1) = 1.06; Flash point = 11°C (cc); Autoignition temperature = 470°C. Explosive limits in air: LEL = 2.4%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Good solubility in water; solubility in water = ∞.

iso-isomer

Boiling point = 108°C; Freezing/Melting point = −108°C; Specific gravity (H_2O:1) = 0.80; Vapor pressure = 9 mmHg at 20°C; Relative vapor density (air = 1) = 2.55; Relative density of vapor/air mixture at 20°C (air = 1) = 1.02; Flash point = 28°C (cc); Autoignition temperature = 415°C; Explosive limits in air: LEL = 1.7%; UEL = 10.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Solubility in water = 9% at 20°C.

Potential Exposure: Compound Description (*n*-isomer): Mutagen; Reproductive Effector; Human Data; Primary Irritant; (*sec*-isomer): Reproductive Effector; (*tert*-isomer): Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant; (*iso*-isomer): Tumorigen, Mutagen; Human Data. Butyl alcohols are used as solvents for paints, lacquers, varnishes, natural and synthetic resins, gums, vegetable oils, dyes, camphor, and alkaloids. They are also used as an intermediate in the manufacture of pharmaceuticals and chemicals; in the manufacture of artificial leather, safety glass; rubber and plastic cements, shellac, raincoats, photographic films, perfumes; and in plastic fabrication.

Incompatibilities: Butyl alcohols form explosive mixtures with air. In all cases they are incompatible with strong oxidizers and attack some plastics, rubber, and coatings. *n*-Butanol is incompatible with strong acids; halogens, caustics, alkali metals; aliphatic amines; isocyanates. *sec*-Butanol forms an explosive peroxide in air. Ignites with chromium trioxide. Incompatible with strong oxidizers, strong acids, aliphatic amines, isocyanates, organic peroxides. *tert*-Butanol is incompatible with strong acids (including mineral acid), strong oxidizers or caustics, aliphatic amines, isocyanates, alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium). *iso*-Butanol is incompatible with strong acids, strong oxidizers, caustics, aliphatic amines, isocyanates, alkali metals, and alkali earth. May react with aluminum at high temperatures.

Permissible Exposure Limits in Air

n-isomer

OSHA PEL: 100 ppm/300 mg/m^3 TWA [skin].

NIOSH REL: 50 ppm/150 mg/m^3 TWA.

ACGIH TLV®[1]: 20 ppm/61 mg/m^3 TWA.

sec-isomer

OSHA PEL: 150 ppm/450 mg/m^3 TWA [skin].

NIOSH REL: 100 ppm/305 mg/m^3 TWA; 150 ppm/455 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm/300 mg/m^3 TWA.

tert-isomer

OSHA PEL: 100 ppm/300 mg/m^3 TWA [skin].

NIOSH REL: 100 ppm/300 mg/m^3 TWA; 150 ppm/450 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm/303 mg/m^3 TWA.

NIOSH IDLH: 1400 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 20 ppm.

PAC-1: 20 ppm.

PAC-2: 50 ppm.

PAC-3: 1400 ppm.

DFG MAK: DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

tert-isomer

0 ppm/62 mg/m^3 TWA; Peak Limitation Category I(4).

Australia: TWA 50 ppm (150 mg/m^3), [skin], 1993; Austria: MAK 50 ppm (150 mg/m^3), 1999; Belgium: STEL 50 ppm (152 mg/m^3), [skin], 1993; Denmark: TWA 50 ppm (150 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (150 mg/m^3); STEL 75 ppm (225 mg/m^3), [skin], 1999; France: VLE 50 ppm (150 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, [skin], 1993; India: TWA 50 ppm (150 mg/m^3), [skin], 1993; Japan: 50 ppm (150 mg/m^3), [skin], 1999; Norway: TWA 25 ppm (75 mg/m^3). 1999; the Philippines: TWA 100 ppm (300 mg/m^3), 1993; Poland: TWA 50 mg/m^3; STEL 140 mg/m^3, 1999; Russia: STEL 50 ppm (10 mg/m^3), 1993; Sweden: NGV 15 ppm (45 mg/m^3), TGV 30 ppm (90 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (150 mg/m^3), KZG-W 100 ppm (300 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (300 mg/m^3), 1993; United Kingdom: STEL 50 ppm (154 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 20 ppm.

sec-isomer

OSHA PEL: 150 ppm/450 mg/m^3 TWA.

NIOSH REL: 100 ppm/305 mg/m^3 TWA; 150 ppm/455 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm TWA (2001).

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 150 ppm

PAC-2: 400 ppm

PAC-3: 2000 ppm

Australia: TWA 100 ppm (305 mg/m^3); STEL 150 ppm, 1993; Austria: MAK 50 ppm (150 mg/m^3), 1999; Belgium: TWA 100 ppm (303 mg/m^3); STEL 150 ppm (455 mg/m^3), 1993; Denmark: TWA 50 ppm (150 mg/m^3), [skin], 1999; Finland: TWA 100 ppm (300 mg/m^3), [skin], 1999; France: VME 100 ppm (300 mg/m^3), 1999; Japan: 100 ppm (300 mg/m^3), 1999; the Netherlands: MAC-TGG 450 mg/m^3, 2003; Norway: TWA 25 ppm (75 mg/m^3), 1999; the Philippines: TWA 150 ppm (450 mg/m^3), 1993; Poland: TWA 300 mg/m^3; STEL 450 mg/m^3, 1999; Russia: TWA 100 ppm; STEL 10 mg/m^3, 1993; Sweden: TWA 50 ppm (150 mg/m^3); STEL 75 ppm (250 mg/m^3), [skin], 1999; Switzerland: MAK-W 100 ppm (300 mg/m^3), KZG-W 200 ppm (600 mg/m^3), 1999; Turkey: TWA 150 ppm (450 mg/m^3), 1993; United Kingdom: TWA 100 99 m (308 mg/m^3); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm.

tert-isomer

OSHA PEL: 100 ppm/300 mg/m^3 TWA.

NIOSH REL: 100 ppm/300 mg/m^3 TWA; 150 ppm/450 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm/303 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 150 ppm

PAC-2: 1500 ppm

PAC-3: 1600 ppm

DFG MAK: 20 ppm/62 mg/m^3

NIOSH IDLH: 1600 ppm

Australia: TWA 100 ppm (300 mg/m^3); STEL 150 ppm, 1993; Austria: MAK 50 ppm (150 mg/m^3), 1999; Belgium: TWA 100 ppm (303 mg/m^3); STEL 150 ppm (455 mg/m^3), 1993; France: VME 100 ppm (300 mg/m^3), 1999; Japan: 50 ppm (150 mg/m^3), 1999; Norway: TWA 25 ppm (75 mg/m^3), 1999; the Netherlands: MAC-TGG 300 mg/m^3, 2003; Poland: MAC (TWA) 300 mg/m^3, MAC (STEL) 450 mg/m^3, 1999; Sweden: NGV 50 ppm (150 mg/m^3), KTV 75 ppm (250 mg/m^3), [skin], 1999; Switzerland: MAK-W 100 ppm (300 mg/m^3), KZG-W 200 ppm (600 mg/m^3), 1999; Turkey: TWA 100 ppm (300 mg/m^3), 1993; United Kingdom: TWA 100 ppm (308 mg/m^3); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

iso-isomer

OSHA PEL: 100 ppm/300 mg/m^3 TWA.

NIOSH REL: 50 ppm/150 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/152 mg/m^3 TWA.

NIOSH IDLH: 1600 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 100 ppm

PAC-3: 1600 ppm

DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

Australia: TWA 50 ppm (150 mg/m^3), 1993; Austria: MAK 50 ppm (150 mg/m^3), 1999; Belgium: TWA 50 ppm (152 mg/m^3), 1993; Denmark: TWA 50 ppm (150 mg/m^3), [skin], 1999; France: VME 50 ppm (150 mg/m^3), 1999; Japan: 50 ppm (150 mg/m^3), 1999; the Netherlands: MAC-TGG 150 mg/m^3, 2003; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 200 mg/m^3, 1999; Russia: TWA 50 ppm; STEL 10 mg/m^3, [skin], 1993; Switzerland: MAK-W 50 ppm (150 mg/m^3), KZG-W 100 ppm (300 mg/m^3), 1999; United Kingdom: TWA 50 ppm (154 mg/m^3); STEL 75 ppm, 2000; IN Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm.

Russia set a MAC of 0.1 mg/m^3 on either a momentary or a daily average basis for ambient air in residential areas.[43]

Several states have set guidelines or standards for butyl alcohols in ambient air[60] as follows (all values in mg/m^3):

State	***n-***	***sec-***	***tert-***	***iso-***
Connecticut	6.0	6.1	–	–
Massachusetts	0.021	–	–	0.021
Nevada	3.57	7.26	–	–
New York	3.0	–	–	–
South Dakota	3.0	–	–	–
Virginia	1.25	3.05	–	2.5

Determination in Air:

NIOSH 1405, 1450; OSHA 7 (*n*-, *sec*-, and *iso*-isomers); NIOSH 1450; OSHA 7 (tert-isomer).[18]

Permissible Concentration in Water: No criteria set, but EPA has suggested[32] ambient limits as follows based on health effects: *n*-isomer 2070 μg/L; *sec*- 6200 μg/L; *iso*- 2070 μg/L; *tert*- 4140 μg/L. Russia[43] set a MAC of 1.0 mg/mL for butyl alcohol in water bodies used for domestic purposes and 0.03 mg/L in water bodies used for fishery purposes.[35]

Determination in Water: Octanol–water coefficient: Log K_{ow} = All isomers are <1.0 as follows: 0.9 (*n*-isomer); 0.6 (*sec*-isomer); 0.4 (*tert*-isomer); 0.8 (*iso*-isomer).

Routes of Entry: Ingestion, inhalation, skin and/or eye contact. Passes through the unbroken skin (*n*-, *iso*-isomer).

Harmful Effects and Symptoms

Short Term Exposure: The vapors of butyl alcohols irritates the eyes and respiratory tract. They can irritate the skin and cause rash or burning feeling on contact. May affect the central nervous system. Exposure to high concentrations could cause headache, nausea, vomiting, and dizziness. Exposure to high levels of the *n*-isomer may cause unconsciousness and may lead to irregular heartbeat. The oral LD_{50} value for rats for the various isomers are as follows: (*n*-isomer) 790 mg/kg; (*sec*-isomer) 6480 mg/kg; (*iso*-isomer) 2460 mg/kg; (*tert*-isomer) 3500 mg/kg.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis, drying, and cracking of the skin. Exposure to the *n*-isomer can damage the liver, heart, and kidneys; cause hearing loss; and affect sense of balance.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: *n-isomer*: whole blood (chemical/metabolite). Expired air, liver and kidney function tests, hearing test (audiogram) and test for balance, EKG test. *tert-isomer:* Liver and kidney function tests. *iso-isomer:* Evaluate for brain effects and possible neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact.

n-isomer: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Butyl, Teflon™ gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; CPF3® suits; Responder™ suits. **4 h:** (At least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Neoprene™ rubber gloves, suits, boots. *sec-isomer*: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): 4H™ and Silver Shield™ gloves. **4 h:** (At least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Butyl, Nitrile.

iso-isomer: Prevent skin contact. **8 h:** butyl rubber gloves, suits, boots; Neoprene™ rubber gloves, suits, boots; Viton™ gloves, suits; Responder™ suits. **4 h:** nitrile rubber gloves, suits, boots; 4H™; and Silver Shield™ gloves.

tert-isomer: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Butyl; 4H™ and Silver Shield™ gloves, Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n-isomer: 1250 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)]. *1400 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv* [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

sec-isomer: NIOSH: *1000 ppm:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)] or SA* (any supplied-air respirator). *2000 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp

(APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

iso-isomer: 500 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *1250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *1600 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

tert-isomer: 1600 ppm: Sa:Cf* (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Green: General storage may be used. Prior to working with butyl alcohols you should be trained on its proper handling and storage. Before entering confined space where these may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butanols require "FLAMMABLE LIQUID" labels. They fall in Hazard Class 3 and Packing Group II and III. Isobutanol falls in Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in activated charcoal, vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. The *tert*-isomer may be in powdered form; collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butyl alcohols are flammable liquids (*tert*-isomer may also be a flammable solid). Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers (recommended). Water may be ineffective because of low flash point. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration or bury absorbed waste in an approved landfill.[22]

References

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New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: tert-Butyl Alcohol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 1997). *Hazardous Substances Fact Sheet: Isobutyl Alcohol*. Trenton, NJ

Butyl amines B:0850

Molecular Formula: $C_4H_{11}N$

Common Formula: $C_4H_9NH_2$

Synonyms: *iso-isomer:* 1-Amino-2-methylpropane; Isobutilamina (Spanish); Isobutylamine; 2-Methylpropylamine; Monoisobutylamine; 1-Propanamine, 2-methyl-; Valamine

n-isomer: 1-Aminobutan (German); 1-Aminobutane; 1-Butanamine; *n*-Butilamina (Spanish); *n*-Butylamin (German); *n*-Butylamine; *normal* Butylamine; Mono-*n*-butylamine; Monobutylamine; Norvalamine

sec-isomer: 2-AB; 2-Aminobutane; 2-Aminobutane base; Butafume; 2-Butanamine; *sec*-Butilamina (Spanish); Butilamina-*sec* (Spanish); *sec*-Butylamine, (*s*)-; *sec*-Butyl amine; Butyl 2-aminobutane; CSC 2-aminobutane; Deccotane; Decotane; Frucote; 1-Methylpropylamine; Propylamine, 1-methyl; Tutane

tert-isomer: 2-Aminoisobutane; 2-Amino-2-methylpropane; Butilamina-*terc* (Spanish); *tert*-Butylamine; Butylamine, *tert*-; 1,1-Dimethylethylamine; 2-Methyl-2-propanamine; Trimethylaminomethane; Trimethylcarbinylamine

CAS Registry Number: 109-73-9 (*n*-); 13952-84-6 (*sec*-); 513-49-5 (*sec*-2-); 75-64-9 (*tert*-); 78-81-9 (*iso*-); 102-82-9 (*tri-n*-; *tri*-butylamine); 110-68-9 (Methylbutylamine, *N*-)

RTECS® Number: EO2975000 (*n*-); EO3325000 (*sec*-); EO3327000 (*sec*-2-); EO3330000 (*tert*-); NP9900000 (*iso*-)

UN/NA & ERG Number: UN1125 (*N*-Butylamine)/132; UN1214 (Isobutylamine)/132

EC Number: 203-699-2 [*Annex I Index No.:* 612-005-00-0] (*n*-); 237-732-7 [*Annex I Index No.:* 612-052-00-7] (*sec*-); 208-164-7 [*Annex I Index No.:* 612-052-00-7] (*sec*-2-); 200-888-1 (*tert*-); 201-145-4 (*iso*-)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*n*-).

n-isomer

European/International Regulations: Hazard Symbol: F+; C; Risk phrases: R11; R20/21/22; R35; Safety phrases: S1/2; S3; S16; S26; S29; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

sec- & sec-2-isomers

European/International Regulations: Hazard Symbol: F+, C, N; Risk phrases: R11; R20/22; R35; R50; Safety phrases: S1/2; S9; S16; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): (*sec*-) 2—Hazard to waters.

tert- & iso-isomer

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Tributylamine

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Butylamines are highly flammable, colorless liquids (*n*- turns yellow on standing) with ammoniacal or fishlike odors. Odor threshold (*n*-) = 0.24−13.9 ppm.

n-isomer
Molecular weight = 73.14; Boiling point = 78°C; Specific gravity (H_2O:1) = 0.76; Freezing/Melting point = − 43.9°C; Relative vapor density (air = 1) = 2.5; Vapor pressure = 82 mmHg at 20°C; Relative density of vapor/air mixture at 20°C (air = 1) = 1.2; Flash point = − 12°C (cc); Autoignition temperature = 312°C. Explosive limits in air: LEL = 1.7%; UEL = 9.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

sec-isomer
Molecular weight = 73.14; Boiling point = 63°C; Specific gravity (H_2O:1) = 0.72; Relative vapor density (air = 1) = 2.5; Flash point = − 9°C (cc); Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

tert-isomer
Molecular weight = 73.14; Boiling point = 46°C; Specific gravity (H_2O:1) = 0.73; Freezing/Melting point = −67.3°C; Relative vapor density (air = 1) = 2.5; Vapor pressure = 292 mmHg at 20°C; Relative density of vapor/air mixture at 20°C (air = 1) = 1.6; Flash point = − 9°C (cc); Autoignition temperature = 380°C. Explosive limits in air: LEL = 1.7% at 100°C; UEL = 8.9% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Soluble in water.

iso-isomer
Molecular weight = 73.14; Boiling point = 66°C; Specific gravity (H_2O:1) = 0.72; Relative vapor density (air = 1) = 2.5; Flash point = − 9°C (cc); Autoignition temperature = 377.8°C. Explosive limits in air: LEL = 3.4%; UEL = 9.0% Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description (*n*-isomer): Tumorigen, Mutagen; Reproductive Effector; Primary Irritant; (*sec*-isomer): Agricultural Chemical; Drug. *n*-Butylamine is used in pharmaceuticals; dyestuffs, rubber, chemicals, emulsifying agents; photography, desizing agents for textiles; pesticides, and synthetic agents. *sec*-Butylamine is used as a fungistat. *tert*-Butylamine is used as a chemical intermediate in the production of *tert*-Butylaminoethyl methacrylate (a lube oil additive), as an intermediate in the production of rubber, and in rust preventatives and emulsion deterrents in petroleum products. It is used in the manufacture of several drugs.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. *n*-Butylamine is a weak base; reacts with strong oxidizers and acids, causing fire and explosion hazard. Incompatible with organic anhydrides; isocyanates, vinyl acetate; acrylates, substituted allyls; alkylene oxides; epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks some metals in presence of moisture.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.99 mg/m^3 at 25°C & 1 atm.

n-isomer
OSHA PEL: 5 ppm/15 mg/m^3, Ceiling Concentration [skin].
NIOSH REL: 5 ppm/15 mg/m^3, Ceiling Concentration [skin].
ACGIH TLV®[1]: 5 ppm/15 mg/m^3, Ceiling Concentration [skin].
NIOSH IDLH: 300 ppm.
Protective Action Criteria (PAC)
TEEL-0: 2 ppm
PAC-1: 2 ppm
PAC-2: 5 ppm
PAC-3: 300 ppm
DFG MAK: 2 ppm/6.1 mg/m^3 TWA; Peak Limitation Category I(2), a momentary value of 10 ppm/30 mg/m^3 should not be exceeded; Pregnancy Risk Group C.
Australia: TWA 5 ppm (15 mg/m^3), [skin], 1999; Austria: MAK 5 ppm (15 mg/m^3), [skin], 1993; Belgium: STEL 5 ppm (15 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (15 mg/m^3), [skin], 1999; Finland: STEL 5 ppm (15 mg/m^3), [skin], 1999; France: VLE 5 ppm (15 mg/m^3), [skin], 1999; Japan: 5 ppm (15 mg/m^3), 1999; the Netherlands: MAC 15 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (15 mg/m^3), 1999; the Philippines: TWA 5 ppm (15 mg/m^3), [skin], 1993; Russia: STEL 5 ppm (10 mg/m^3), [skin], 1993; Sweden: ceiling 5 ppm (15 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (15 mg/m^3); STEL 25 ppm (75 mg/m^3), [skin], 1999; Thailand: TWA 5 ppm (15 mg/m^3), 1993; Turkey: TWA 5 ppm (15 mg/m^3), [skin], 1993; United Kingdom: STEL 5 ppm (15 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: ceiling 5 ppm [skin].

all isomers
DFG MAK: 5 ppm/15 mg/m^3.

sec-isomer
TEEL-0: 2 ppm
PAC-1: 2 ppm
PAC-2: 10 ppm
PAC-3: 20 ppm
DFG MAK: 2 ppm/6.1 mg/m^3 TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/30 mg/m^3 should not be exceeded; Pregnancy Risk Group C.
Austria: MAK 5 ppm (15 mg/m^3), [skin], 1999; Denmark: TWA 5 ppm (15 mg/m^3), [skin], 1999; Norway: TWA 5 ppm (15 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (15 mg/m^3); STEL 25 ppm (75 mg/m^3), 1999.
Protective Action Criteria (PAC)

(s)-sec- or sec-2-isomer
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: 10 ppm
PAC-3: 50 ppm

iso-isomer
Protective Action Criteria (PAC)
TEEL-0: 2 ppm

PAC-1: 2 ppm
PAC-2: 10 ppm
PAC-3: 35 ppm
DFG MAK: 2 ppm/6.1 mg/m^3 TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/30 mg/m^3 should not be exceeded [Ceiling Concentration]; Pregnancy Risk Group C.
Austria: MAK 5 ppm (15 mg/m^3), [skin], 1999; Denmark: TWA 5 ppm (15 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (15 mg/m^3); STEL 25 ppm (75 mg/m^3), 1999.
Several states have set guidelines or standards for *n*-butylamine in ambient air[60] ranging from 50.0 μg/m^3 (New York) to 75 μg/m^3 (South Carolina) to 80 μg/m^3 (Virginia) to 150 μg/m^3 (North Dakota) to 357 μg/m^3 (Nevada).
tert-isomer
Protective Action Criteria (PAC)
TEEL-0: 0.35 ppm
PAC-1: 1 ppm
PAC-2: 7.5 ppm
PAC-3: 125 ppm
DFG MAK: No numerical value established. Data may be available.
102-82-9 (tri-n-)
Protective Action Criteria (PAC)
TEEL-0: 0.02 ppm
PAC-1: 0.06 ppm
PAC-2: 0.4 ppm
PAC-3: 7.5 ppm
Methylbutylamine, *N*- (CAS: 110-68-9)
TEEL-0: 2 ppm
PAC-1: 6 ppm
PAC-2: 40 ppm
PAC-3: 200 ppm

Determination in Air: Adsorption on H_2SO_4-treated silica gel, desorption with 50% methanol, analysis by gas chromatography/flame ionization detection, see NIOSH (IV) #2012.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested ambient water limits for butylamines (*n*-, *iso*-, or *tert*-isomer) as 207 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} (*n*-isomer) = 0.9; (*tert*-isomer) = 0.4.

Routes of Entry: Inhalation and percutaneous absorption, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact with butylamine can irritate and burn the eyes with possible permanent damage. Skin contact can cause irritation, burns, and blisters. Inhalation can cause nose and throat irritation, "flushed" feeling, headache, dizziness, coughing, shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The LD_{50} rat value ranges from 78 mg/kg (*tert*-) to 366 mg/kg (*n*-butyl) and all 4 are designated moderately toxic.

Long Term Exposure: Repeated exposure may cause itching and skin rash. May cause bronchitis to develop with phlegm and/or shortness of breath. Exposure to high levels of isobutylamine can affect the heart.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Rinse out mouth and *do not* induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. *n-isomer:* **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Responder™ suits; Trychem 1000™ suits; **4 h:** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Trellchem HPS™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n*-isomer: *50 ppm:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa* (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *250 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *300 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Store in a refrigerator. Keep under an inert atmosphere for long-term storage.[52]

Shipping: *n*-Butylamine and isobutylamine[19] require "FLAMMABLE LIQUID, CORROSIVE" labels. They fall in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Incineration*: incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.[22]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 68−70 (1982) and 6, No. 2, 45−48 (1986) (*n*-Butylamine)

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 40−42 (*sec*-Butylamine)

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 40−43 (1985) (t-Butylamine)

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Exposures—Single Chemicals: tert-Butylamine*, Report TR79-607. Rockville, MD, pp. 28−33

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Butylamine*. Trenton, NJ

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Isobutylamine*. Trenton, NJ

Butylate B:0860

Molecular Formula: $C_{11}H_{23}NOS$

Common Formula: $CH_3CH_2SCON[CH_2CH(CH_3)_2]_2$

Synonyms: Bis(2-methylpropyl)carbamothioic acid *S*-ethyl ester; Butilate; Diisobutylthiocarbamic acid *S*-ethyl ester; Diisocarb; *S*-Ethyl bis(2-methylpropyl)carbamothioate; *S*-Ethyl *N*,*N*-diisobutylthiocarbamate; *S*-Ethyldiisobutyl thiocarbamate; Ethyl *N*,*N*-diisobutylthiocarbamate; Ethyl-*N*,*N*-diisobutylthiolcarbamate; R-1910; Stauffer R-1910; Sutan

CAS Registry Number: 2008-41-5

RTECS® Number: EZ7525000

UN/NA & ERG Number: UN3082/171 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 217-916-3

Regulatory Authority and Advisory Bodies

Water Pollution Standard Proposed (EPA) (See "References" below).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.003; Nonwastewater (mg/kg), 1.4.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Butylate is a clear liquid with an aromatic odor. Molecular weight = 217.4; Specific gravity = 0.94; Boiling point = 130°C at 10 mmHg at 20°C; Vapor pressure = 1×10^{-3} mmHg. Low solubility in water; solubility = 44 mg/L.

Potential Exposure: Those involved in the manufacture, formulation or application of this carbamate herbicide which is used to control weed seeds in the soil prior to sowing a crop.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: A no-adverse-effects-level (NOAEL) in the range of 24−40 mg/kg body weight/day has been determined by US EPA. This leads to derivation of a 10-day health advisory for Butylate of 2.4 mg/L and a lifetime health advisory of 0.05 mg/L for a 70-kg man. Wisconsin has set a guideline for Butylate in drinking water of 200 μg/L.[61]

Determination in Water: Analysis of Butylate is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen- and phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen−phosphorus detector. The method detection limit has not been determined for Butylate, but it is estimated that the detection limits for analytes included in this method are in the range of 0.1−2 μg/L. Fish Tox: 22.61732000 ppb MATC (INTERMEDIATE).

Harmful Effects and Symptoms

LD_{50} (rat) = 4000 mg/kg (slightly toxic). Applying the criteria described in EPA's guidelines for assessment of carcinogenic risk, butylate may be placed in Group C: a possible human carcinogen. This category is for substances that show limited evidence of carcinogenicity in animals and inadequate evidence in humans.

Long Term Exposure: Human Tox = 400.00000 ppb. Health Advisory (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 400.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory: Butylate*. Washington, DC: Office of Drinking Water

Butyl benzyl phthalate B:0870

Molecular Formula: $C_{19}H_{20}O_4$
Common Formula: $C_6H_4(OCOC_4H_9)(OCOCH_2C_6H_5)$; 1,2-$C_6H_4(COOCH_2C_6H_5)(COOC_4H_9)$
Synonyms: Ashland butyl benzyl phthalate; BBP; 1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester; *n*-Benzyl butyl phthalate; Benzyl butyl phthalate; *normal* Butyl benzyl phthalate; Ftalato de butilbencilo (Spanish); Monsanto butyl benzyl phthalate; NCI-C54375; Palatinol BB; Santicizer 160; Sicol; Unimoll BB
CAS Registry Number: 85-68-7; *(alt.)* 58128-78-2
RTECS® Number: TH9990000
UN/NA & ERG Number: UN3082/171
EC Number: 201-622-7 [*Annex I Index No.:* 607-430-00-3]
Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited evidence; Human No Adequate Data, Group 3, 1999; NTP: Carcinogenesis Studies (feed); some evidence: rat; NCI: Carcinogenesis Studies (feed); clear evidence: rat; no evidence: mouse[54]; EPA: Possible Human Carcinogen.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9016; 8EHQ-0892-9174; 8EHQ-0892-8845.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Developmental/Reproductive toxin. 12/2/05.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollution Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R61; R62; R50/53; R50; Safety phrases: S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Butyl benzyl phthalate is a clear, oily liquid with a slight odor. Molecular weight = 312.39; Specific gravity (H_2O:1): 1.1; Boiling point = 370°; Freezing/Melting point = −34.7°C; Relative vapor density (air = 1): 10.8; Vapor pressure = very low; Flash point = 199°C; Autoignition temperature = 422°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Butyl benzyl phthalate is used as a plasticizer for polyvinyl and cellulosic resins. It is also used as an organic intermediate.

Incompatibilities: Incompatible with strong acids, nitrates, oxidizers. Destructive to rubber and paint.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 100 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

Denmark: TWA 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: NGV 3 mg/m^3, KTV 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000. Two states have set guidelines or standards for butyl benzyl phthalate in ambient air[60]: New York and Florida: 100 $\mu g/m^3$.

Permissible Concentration in Water: No criteria set. Butyl phthalate esters in general are classified as priority toxic pollutants by EPA.[6] Listed by Mexico for wastewater as phthalate esters.

Determination in Water: No criteria set. Octanol–water coefficient: Log $K_{ow} = 4.77$.

Routes of Entry: Inhalation; can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and the respiratory tract. Skin contact may cause a burning sensation. High levels of this chemical may cause dizziness and lightheadedness. LD_{50} = (oral-rat) 2330 mg/kg (slightly toxic).

Long Term Exposure: May affect liver and kidney function. Repeated exposure may damage the nervous system; causing weakness, “pins and needles,” and poor coordination in arms and legs. May affect the endocrine system.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system, including nerve conduction tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for 20–30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where there is potential for exposure, the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place, or refrigerator away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, or foam extinguishers. Water may cause frothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atomize into an incinerator together with a flammable solvent.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 15−17

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Butyl Benzyl Phthalate*. Trenton, NJ

N-Butyl bromide B:0880

Molecular Formula: $C_4H_{12}Br$

Common Formula: $CH_6(CH_2)_3Br$

Synonyms: 1-Bromobutane; Bromuro de *n*-butilo (Spanish); Butane, 1-bromo-; Butyl bromide; Methyl ethyl bromomethane

CAS Registry Number: 109-65-9. Much of the same information in this record may apply to *sec*-Butyl Bromide [2-Bromobutane (78-76-2)]

RTECS® Number: EJ6225000

UN/NA & ERG Number: UN1126 (*n*-isomer)/130; UN2339 (*sec*-isomer)/130

EC Number: 203-691-9 (109-65-9); 201-140-7 (78-76-2)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Butyl bromide is a highly flammable, colorless liquid with a pleasant odor. Molecular weight = 137.04. Boiling point = 101.6°C; Specific gravity (H_2O:1) = 1.276 at 20°C; Freezing/Melting point = − 112.4; Vapor density (air = 1) = 4.68; Flash point = 18°C (21°C for *sec*-isomer). Autoigniton temperature = 265°C. Explosive limits: LEL = 2.6% at 100°C; UEL = 6.6% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Butyl bromide is used to make other chemicals and in making pharmaceuticals.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion. Forms explosive mixture with air. Incompatible with strong acids. May accumulate static electrical charges and cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 15 ppm
PAC-1: 50 ppm
PAC-2: 350 ppm
PAC-3: 1500 ppm

The former-USSR/UNEP Joint Project[43] has set limits in the ambient air of residential areas. The momentary MAC is 0.7 mg/m^3. The average daily MAC is 0.03 mg/m^3.

Routes of Entry: Inhalation, ingestion (*sec*-butyl bromide passes through the skin).

Harmful Effects and Symptoms

Short Term Exposure: Causes eye, skin, and respiratory tract irritation. Inhalation can cause coughing, wheezing, and/or shortness of breath. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause death.

Long Term Exposure: Repeated exposure may cause liver and kidney damage. There is limited evidence that Butyl bromide may damage the developing fetus.

Points of Attack: Liver, kidney.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: liver function tests; kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Butyl bromide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA approve self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Butyl bromide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butyl bromide is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of Butyl bromide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butyl bromide.

Shipping: 1- and 2-Bromobutane must be labeled "FLAMMABLE LIQUID." Both 1- and 2-Bromobutane fall in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including bromine, are produced in fire.

Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (July 1996). *Hazardous Substances Fact Sheet: Butyl Bromide*. Trenton, NJ

n-Butyl chloride B:0890

Molecular Formula: C_4H_9Cl

Common Formula: $CH_3(CH_2)_3Cl$

Synonyms: Butane, 1-chloro-; *n*-Butyl chloride; 1-Chlorobutane; Chlorure de butyle (French); Cloruro de *n*-butilo (Spanish); NCI-C06155; *n*-Propylcarbinyl chloride

CAS Registry Number: 109-69-3 (*n*-); 78-86-4 (*sec*-butyl chloride)

RTECS® Number: EJ6300000

UN/NA & ERG Number: UN1127 (chlorobutanes)/130

EC Number: 203-696-6 [*Annex I Index No.*: 602-059-00-3] (*n*-); 201-151-7 (*2-chlorobutane*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; NCI: Carcinogenesis studies (gavage); no evidence: mouse, rat.

European/International Regulations: (*n-isomer*) Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S9; S16; S29; (*sec-isomer*): not listed in Annex 1.

WGK (German Aquatic Hazard Class): (*n- & sec-butyl-isomers*) 2—Hazard to waters.

Description: Butyl chloride is a highly flammable, clear, colorless liquid. Molecular weight = 92.6 (*n*- and *sec*-isomers); Boiling point = 77°C; 69°C (*sec*-isomer); Specific gravity (H_2O:1) = 0.89; Freezing/Melting point = −123°C; Flash point = −9°C; −10°C (*sec*-isomer); Relative vapor density (air = 1) = 3.2 (*n*- and *sec*-isomers); Vapor pressure = 81 mmHg at 20°C; Autoignition temperature = 240°C. Explosive limits: LEL = 1.8%; UEL = 10.1%. Insoluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0; (*sec*-) Health 2, Flammability 4, Reactivity 0. Practically insoluble in water; solubility = 0.7% at 12°C.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector. Butyl chloride is used as a solvent, as a medicine to control worms, and to make other chemicals.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Water contact slowly forms hydrochloric acid. Incompatible with strong oxidizers, alkaline earth and alkali metals, and finely divided metals. Attacks metals in presence of moisture. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 7.5 ppm
PAC-1: 25 ppm
PAC-2: 150 ppm
PAC-3: 750 ppm

(sec-)

TEEL-0: 0.4 ppm
PAC-1: 1.25 ppm
PAC-2: 7.5 ppm
PAC-3: 3500 ppm

Norway: TWA 0.5 ppm (1.5 mg/m^3), 1999; Russia: STEL 0.5 mg/m^3, [skin], 1993.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.62.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Butyl chloride can affect you when breathed in. High levels can cause you to feel dizzy, lightheaded, and pass out. Very high levels can affect the nervous system and cause death. *sec*-Butyl chloride and *tert*-butyl chloride may have similar effects.

Long Term Exposure: Unknown at this time. May affect the nervous system.

Points of Attack: Eyes, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Butyl chloride, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Butyl chloride is incompatible with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates). Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butyl chloride is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of Butyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butyl chloride.

Shipping: Chlorobutanes require a shipping label of "FLAMMABLE LIQUID." They fall in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Butyl Chloride*. Trenton, NJ

tert-Butyl chromate B:0900

Molecular Formula: $C_8H_{18}CrO_4$

Common Formula: $[(CH_3)_3CO]_2CrO_2$

Synonyms: Bis(*tert*-butyl) chromate; Chromato *terc*-butilico (Spanish); Chromic acid, di-*tert*-butyl ester of chromic acid; *tert*-Butyl chromate(VI)

CAS Registry Number: 1189-85-1

RTECS® Number: GB2900000

UN/NA & ERG Number: UN3082/171

This is an organometallic, flammable material

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1990

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As chromium compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants, as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List.

European/International Regulations: Hazard Symbol: E, T+, N; Risk phrases: R45; R46; R60; R61; R2; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: *tert*-Butyl chromate is a highly flammable, clear, colorless, hygroscopic, corrosive, flammable liquid or red crystals from petroleum ether. Solution in carbon tetrachloride is highly flammable. Molecular weight = 230.3; Freezing/Melting point = −5 to 0°C; −2.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1, (Oxidizer).[NJDHSS] Soluble in water (hydrolyzed).

Potential Exposure: Butyl chromate is used in specialty reactions as an organic source of chromium, in making catalysts, and as a curing agent for urethane foams.

Incompatibilities: *tert*-Butyl Chromate is a strong oxidizer; reacts violently with reducing agents (such as lithium, sodium, aluminum and their hydrides and hydrazine); combustible materials. Water solutions of *tert*-butyl chromate react violently with strong bases. Incompatible with strong acids (i.e., hydrochloric, sulfuric, and nitric), alcohols, and easily oxidized materials, such as paper, wood, sulfur, aluminum, and plastics.

Permissible Exposure Limits in Air

OSHA PEL: 0.005 mg[CrO_3]/m^3 [skin] see 29CFR1910.1026.

NIOSH REL: 0.001 mg[CrO_3]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See NIOSH Pocket Guide, Application A & C.

ACGIH TLV®[1]: 0.01 mg[CrO_3]/m^3 Ceiling concentration [skin], Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3

No TEEL available.

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Denmark: TWA 0.5 mg[Cr]/m^3, 1999; France: VLE 0.1 mg/m^3, [skin], 1999; Japan: 0.5 mg[Cr]/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Switzerland: TWA 0.05 mg/m^3, [skin], 1993; Thailand: TWA 0.1 mg/m^3, 1993; United Kingdom: TWA 0.5 mg[Cr]/m^3, carcinogen, 2000; the Netherlands: MAC 0.1 mg/m^3, [skin], 2003: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.1 mg/m^3 [skin]. Several states have set guidelines or standards for *t*-butyl chromate in ambient air[60] ranging from 0.5 μg/m^3 (Virginia) to 1.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause severe eye and skin irritation and acid-like burns with possible permanent damage to the eyes. Inhalation can cause irritation of the respiratory tract with coughing and wheezing. Exposure can cause headache, nausea, vomiting, diarrhea, and wheezing. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Hexavalent chromium compounds have been determined to be human carcinogens. May cause lung cancer. Breathing this chemical can cause a hole in the "bone" dividing the inner nose (septum), sometime with discharge, bleeding, and/or formation of a crust. *tert*-butyl chromate can cause allergies to the skin and lung. Prolonged skin contact can cause, burns, blisters, and deep necrotic ulcers. Can cause liver and kidney damage.

Points of Attack: Respiratory system, lungs, skin, eyes, central nervous system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Consider the points of attack in preplacement and periodic physical examinations: Examination of the skin and nose. Evaluation by a qualified allergist. Lung function tests. Liver and kidney function tests. Urine test for chromates (chemical metabolite). This test is most accurate shortly after exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: Wear appropriate clothing to prevent any possibility of skin contact. Gloves: Silver Shield®/ 4H®; Coveralls: DuPont Tychem® CSM, Responder®, and TK (for *known carcinogens*). Prevent skin contact (as chromic acid and chromates). **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated and daily at the end of each work shift. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, Chromium (VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe: Reactivity Hazard (strong oxidizer); Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with *tert*-butyl chromate you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in an explosion-proof refrigerator away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: *tert*-Butyl chromate is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, sand, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1979). *Criteria for a Recommended Standard: Occupational Exposure to Chromium*, NIOSH Document No. 76-129. Washington DC

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: tert-Butyl Chromate*. Trenton, NJ

1,2-Butylene oxide B:0910

Molecular Formula: C_4H_8O

Synonyms: 1,2-Butene oxide; α-Butylene oxide; 1,2-Epoxybutane; 2-Ethyloxirane; Oxirane, ethyl-; Propyl oxirane

CAS Registry Number: 106-88-7; much of the same information in this record may apply to 2,3-Butylene oxide: 3266-23-7

RTECS® Number: EK3675000

UN/NA & ERG Number: UN3022/127P

EC Number: 203-438-2 [*Annex I Index No.*: 603-102-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*106-88-7*): Human No Adequate Data, Animal Limited Data, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; no evidence: mouse.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

TSCA 40CFR712.30(d); 40CFR716.120 (a).

Canada, National Pollutant Release Inventory (NPRI).

European/International Regulations: (106-88-7) Hazard Symbol: F, Xn, N; Risk phrases: R11; R20/21/22; R36/37/38; R40; R52/53; Safety phrases: S2; S9; S16; S29; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Butylene oxide is a watery white liquid with an etherial odor. Molecular weight = 72.1 (1,2- and 2,3-isomers); Specific gravity (H_2O:1) = 0.83; Boiling point = 63.3°C; Freezing/Melting point = −130°C; Vapor pressure = 142 mmHg at 20°C; 176 mmHg at 25°C; Relative vapor density (air = 1) = 2.2; Relative density of the vapor/air mixture at 20°C (air = 1) = 1.3; Flash point = −22°C; Autoignition temperature = 439°C. Explosive limits in air: LEL: 1.7%; UEL: 19%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Soluble in water; solubility = 9.5% at 25°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. It is used as a stabilizer in chlorinated solvents, and to make other chemicals, such as gasoline additives.

Incompatibilities: Forms explosive mixture with air. Unless inhibited, it can form unstable and explosive peroxides. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Polymerization will occur in the presence of acids, strong bases, and chlorides of tin, iron, and aluminum. Storage tanks and other equipment should be absolutely dry and free from air, ammonia, acetylene, hydrogen sulfide, rust, and other contaminants. Reacts with strong oxidizers. Attacks some plastics. May accumulate static electric charges that can result in ignition of its vapors. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Permissible Exposure Limits in Air

AIHA WEEL: 2 ppm TWA.

Protective Action Criteria (PAC)*

106-88-7

TEEL-0: 2 ppm

PAC-1: **72** ppm

PAC-2: **140** ppm

PAC-3: **330** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

Austria: [skin], carcinogen, 1999.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.42.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Butylene oxide can cause severe irritation of the eyes, skin, and respiratory tract, with coughing, and/or shortness of breath. High exposures can cause dizziness, lightheadedness, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: 1,2-Butylene oxide is possibly carcinogenic to humans. It may cause mutations and damage to the developing fetus. Prolonged or repeated skin contact may cause blisters or other disorders. 2,2-Butylene oxide may affect the nervous system.

Points of Attack: Skin, lungs, central nervous system, reproductive system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or

authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical acid you should be trained on its proper handling and storage. Protect against physical damage. Store only if inhibited. Outside or detached storage is preferred. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: 1,2-Butylene oxide requires a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3, Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2003). *Hazardous Substances Fact Sheet: 1,2-Butylene Oxide.* Trenton, NJ

Butyl ether B:0920

Molecular Formula: $C_8H_{18}O$

Common Formula: $C_4H_9OC_4H_9$

Synonyms: 1-Butoxybutane; Di-*n*-butyl ether; Dibutyl ether; Dibutyl oxide; Ether butylique (French); 1,1′-Oxybis (butane); 1,1-Oxybis-butane

CAS Registry Number: 142-96-1

RTECS® Number: EK5425000

UN/NA & ERG Number: UN1149/128

EC Number: 205-575-3 [*Annex I Index No.*: 603-054-00-9]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R36/37/38; R52/53; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Butyl Ether is a flammable, colorless liquid with a mild, ethereal odor. Molecular weight = 130.2. Boiling point = 142°C; Specific gravity (H_2O:1) = 0.8; Freezing/Melting point = − 95°C; Relative vapor density (air = 1) = 4.48; Flash point = 25°C; Autoignition temperature = 194°C. Explosive limits: LEL = 1.5%; UEL = 7.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. It is used as a solvent for hydrocarbons, fatty materials, as an extracting agent in metal separation; in solvent purification, and for making other chemicals.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with strong acids and oxidizers. Contact with air or light may form unstable and explosive peroxides, especially anhydrous form.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 3 ppm

PAC-2: 20 ppm

PAC-3: 400 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.08 (calc).

Routes of Entry: Inhalation of vapor, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: May be poisonous if inhaled or absorbed through skin. Inhalation of vapors may cause dizziness or suffocation. Skin or eye contact may cause irritation. Repeated or prolonged skin contact may cause rash. The vapor irritates the nose, throat, and bronchial tubes and may cause nose bleeds, hoarseness, cough, phlegm, and/or tightness in the chest. Overexposure can also cause headache and make you feel dizzy and lightheaded. Higher levels can cause unconsciousness and even death.

Points of Attack: Skin, eyes, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to butyl ether, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl ether you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Butyl ether must be stored in a cool, dark place, separated from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where Butyl ether is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of butyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butyl ether.

Shipping: Dibutyl ethers require a "FLAMMABLE LIQUID" label. They fall in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Butyl Ether*. Trenton, NJ

n-Butyl glycidyl ether B:0930

Molecular Formula: $C_7H_{14}O_2$

Common Formula: $C_4H_9OCH_2CH{-}CH_2$

Synonyms: *n*-BGE; BGE; 1-Butoxy-2,3-epoxypropane; (Butoxymethyl) oxiraine; 1,2-Epoxy-3-butoxy propane; 2,3-Epoxypropyl butyl ether; Gylcidy butyl ether

CAS Registry Number: 2426-08-6

RTECS® Number: TX4200000

UN/NA & ERG Number: UN1993/128

EC Number: 219-376-4 [*Annex I Index No.*: 603-039-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Carcinogenicity: DFG (suspected).

TSCA: 716.120(c); 40CFR712.30(d).

California Proposition 65 Chemical: Developmental/ Reproductive toxin (male) 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R20/22; R37; R40; R43; R52/53; R68; Safety phrases: S2; S24/25; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *n*-Butyl glycidyl ether is a colorless liquid with slight irritating odor. Molecular weight = 130.2; Specific gravity (H_2O:1) = 0.91; Boiling point = 164°C; Relative vapor density (air = 1) = 4.5; Vapor pressure = 3 mmHg at 25°C; Flash point = 58°C. Soluble in water; solubility 2% at 20°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Primary Irritant. NIOSH has estimated human exposures at 18,000. Used as reactive diluent for epoxy resins, flooring, laminating, and electrical; and as a stabilizer, viscosity-reducing agent, as acid acceptor for solvents; and as a chemical intermediate.

Incompatibilities: Forms explosive mixture with air. Air and light form unstable and explosive peroxides. Contact with strong oxidizers may cause fire and explosions. Contact with strong caustics may cause polymerization. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.33 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/270 mg/m^3 TWA.

NIOSH REL: 5.6 ppm/30 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 3 ppm/ 16 mg/m^3 [skin, sensitizer].

Protective Action Criteria (PAC)

TEEL-0: 3 ppm

PAC-1: 3 ppm

PAC-2: 5.6 ppm

PAC-3: 250 ppm

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 3B; Germ Cell Mutation Category 2.

NIOSH IDLH: 250 ppm.

Australia: TWA 25 ppm (135 mg/m^3), 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA 25 ppm (133 mg/m^3), 1993; Denmark: TWA 6 ppm (30 mg/m^3), 1999; Finland: STEL 25 ppm (135 mg/m^3), [skin], 1999; France: VME 25 ppm (135 mg/m^3), 1999; the Netherlands: MAC-TGG 135 mg/m^3, 2003; the Philippines: TWA 50 ppm (270 mg/m^3), 1993; Sweden: NGV 10 ppm (50 mg/m^3), TKV 15 ppm (80 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (135 mg/m^3), KZG-W 50 ppm (270 mg/m^3), [skin], 1999; Turkey: TWA 50 ppm (270 mg/m^3), 1993; United

Kingdom: TWA 25 ppm (135 mg/m^3), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. Several states have set guidelines or standards for butyl glycidyl ether in ambient air[60] ranging from 1.35 mg/m^3 (Connecticut and North Dakota) to 2.25 mg/m^3 (Virginia) to 3.21 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1616 and OSHA Analytical Method 7, Organic Vapors.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of eyes, skin, and respiratory tract with wheezing and coughing. Exposure can cause headache, lightheadedness, dizziness, lack of coordination, and fainting. High levels can cause unconsciousness and even death. LD_{50} = (oral-rat)2050 mg/kg (slightly toxic).

Long Term Exposure: There is limited evidence that this chemical can cause mutations. *n*-Butyl glycidyl ether may cause skin allergy. DFG lists danger of skin and respiratory sensitization. May cause lung and liver disorders.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Pulmonary function tests, expired air. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *56 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *140 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where *n*-butyl glycidyl ether may be present, check to make sure that an explosive concentration does not exist. Store in a fireproof refrigerator in tightly closed containers under an inert atmosphere·[52] separated from strong oxidants, strong bases, strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Based on its flash point, butyl glycidyl ether requires a “FLAMMABLE LIQUID” label. It falls into Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb spills with paper or other absorbent material. Seal in vapor-tight plastic bags or sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, alcohol, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[24]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers*, NIOSH Document No. 78-166. Washington, DC

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Clycidyl Ethers*, Report PB 276−678. Rockville, MD, pp. 116−123

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: n-Butyl Glycidyl Ether*. Trenton, NJ

Butyl isovalerate B:0940

Molecular Formula: $C_9H_{18}O_2$

Common Formula: $CH_3CH_2CH(CH_3)COOC_4H_9$

Synonyms: Butanoic acid, 3-methyl-, butyl ester; *n*-Butyl isopentanoate; *n*-Butyl isovalerate; Butyl isovalerianate; Butyl 3-methyl-butyrate; Isovaleric acid, butyl ester

CAS Registry Number: 109-19-3

RTECS® Number: NY1502000

UN/NA & ERG Number: UN1993/128

EC Number: 203-654-7 (see Appendix 4)

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Butyl Isovalerate is a clear liquid. Molecular weight = 158.27; Boiling point = 150°C; Flash point = 53°C. Hazard Identification (based on NFPA 704 M Rating System): Health 0, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: May be used as a specialty solvent; food additive.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <3.0$.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Avoid skin and eye contact. Do not inhale mists or vapors. Symptoms include headache; muscle weakness; giddiness, nausea, vomiting, confusion, delirium, coughing, labored and difficult breathing; coma and even death. This ester is a skin irritant and has a high oral toxicity; the oral LD_{50} for rabbit is 8.2 mg/kg. Toxicity information of this chemical is grouped with *n*-butyl acetate. It is classified as moderately toxic. Probable oral lethal dose for humans is 0.5−5 g/kg (between 1 oz and a pint) for a 150-lb person. It is a mild irritant and central nervous depressant. Also, it is less toxic than the parent alcohol.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where butyl isovalerate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Based on its flash point (below 60.5°C), this material requires a "FLAMMABLE LIQUID" label. It falls into Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Butyl Isovalerate*. Washington, DC: Chemical Emergency Preparedness Program

Butyl lactate B:0950

Molecular Formula: $C_6H_{11}O_3$

Common Formula: $CH_3CHOHCOO(CH_2)_3$

Synonyms: Butyl α-hydroxypropionate; Butyl lactate; 2-Hydroxypropanoic acid, butyl ester; Lactato de *n*-butilo (Spanish); Lactic acid, butyl ester

CAS Registry Number: 138-22-7

RTECS® Number: OD4025000

EC Number: 205-316-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Butyl lactate is a liquid. Molecular weight = 146.19; Boiling point = 170°C at 760 mmHg; Freezing/Melting Point = − 43°C; Flash point = 71°C (oc).[17] Autoignition temperature = 340−382°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Butyl lactate is used in making paints, inks, perfumes, dry cleaning fluids, and as a resin solvent in varnishes and lacquers.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, strong bases.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 ppm/ 25 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/30 mg/m^3 TWA.

Australia: TWA 5 ppm (25 mg/m^3), 1993; Belgium: TWA 5 ppm (30 mg/m^3), 1993; Denmark: TWA 5 ppm (25 mg/m^3), 1999; Finland: TWA 1 ppm (6 mg/m^3); STEL 3 ppm (18 mg/m^3), 1999; France: VME 5 ppm (25 mg/m^3), 1999; Norway: TWA 5 ppm (25 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 20 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation to the eyes, skin, nose, throat, and may cause headaches and cough. Symptoms may also include drowsiness, central nervous system depression, nausea, vomiting. At concentrations of 7 ppm with short peaks of 11 ppm, workers experienced headaches, upper respiratory system irritation, and coughing. Some complained of sleepiness and headache in the evening after work and occasional nausea and vomiting was experienced. When exposures were below 1.4 ppm, however, no symptoms were manifested.

Long Term Exposure: Headaches, feeling sleepy, and nausea may develop in the evening after exposure during the day.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where butyl lactate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada. No label required. Combustible liquids are in Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: n-Butyl Lactate*. Trenton, NJ

Butyl mercaptan B:0960

Molecular Formula: $C_4H_{10}S$

Common Formula: $CH_3CH_2CH_2CH_2SH$

Synonyms: *n*-Butanethiol; 1-Butanethiol; Butanethiol; Butane-thiol; *n*-Butyl mercaptan; *n*-Butyl thioalcohol; 1-Mercaptobutane; NCI-C60866; Thiobutyl alcohol

CAS Registry Number: 109-79-5

RTECS® Number: EK6300000

UN/NA & ERG Number: UN2347/130

EC Number: 203-705-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Butyl mercaptan is a flammable, colorless liquid with a strong, skunk-like odor. The Odor Threshold in air is 0.00097 ppm. Molecular weight = 90.19; Specific gravity = (H_2O:1): 0.83; Boiling point = 98°C; Freezing/Melting point = − 116°C; Vapor pressure = 35 mmHg at 20°C; Relative vapor density (air = 1) = 3.1; Flash point = 2°C (cc)[17]; Autoignition temperature ≤ 225°C. Explosive limits: LEL = 1.4%; UEL = 10.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 0.06% at 20°C.

Potential Exposure: Compound Description: Reproductive Effector; Primary Irritant. The major use is in the production of organophosphorus compounds, thiolcarbamates; more specifically insecticides, herbicides, acaricides, and defoliants.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, such as dry bleaches and nitric acid. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

OSHA PEL: 10 ppm/35 mg/m^3 TWA.

NIOSH REL: 0.5 ppm/1.8 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 0.5 ppm/1.8 mg/m^3 TWA.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC) 109-79-5

TEEL-0: 0.5 ppm

PAC-1: 7.5 ppm

PAC-2: 50 ppm

PAC-3: 500 ppm

DFG MAK: 0.5 ppm/1.9 mg/m^3 TWA; Peak limitation II(2).

Austria: MAK 0.5 ppm (1.5 mg/m^3), 1999; Denmark: TWA 0.5 ppm (1.5 mg/m^3), 1999; Finland: TWA 0.5 ppm (1.5 mg/m^3); STEL 1.5 ppm (4.5 mg/m^3), 1999; France: VME 0.5 ppm (1.5 mg/m^3), 1999; India: TWA 0.5 ppm (1.5 mg/m^3), 1993; Poland: TWA 1 mg/m^3; STEL 2 mg/m^3, 1999; the Netherlands: MAC-TGG 1.5 mg/m^3, 2003; Switzerland: MAK-W 0.5 ppm (1.9 mg/m^3), KZG-W 1 ppm (3.8 mg/m^3), 1999; Turkey: TWA 10 ppm (35 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 0.5 ppm TLV. Several states have set guidelines or standards for butyl mercaptan in ambient air[60] ranging from 5 μg/m^3 (New York) to 15 μg/m^3 (North Dakota and South Carolina) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (Connecticut) to 36 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2525 and #2542.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water limit of 21 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

In animals: narcosis, incoordination, weakness; cyanosis, pulmonary irritation, eye irritation, paralysis. LD_{50} = (oral-rat) 1500 mg/kg (slightly toxic).

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can cause a skin rash. The substance may affect the thyroid gland. High concentrations can cause weakness, nausea, dizziness, headache, and confusion. Very high concentrations (above the occupational exposure limit) exposure may affect the central nervous system and cause unconsciousness. In animals: narcosis, loss of coordination, lassitude (weakness, exhaustion), cyanosis, pulmonary irritation, and liver, kidney damage.

Long Term Exposure: Repeated exposure can cause skin rash and affect eyes, skin, respiratory system, central nervous system, liver, and kidneys,

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, or acids.

Shipping: Butyl mercaptan requires a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stop discharge if possible. Evacuate area in case of large spill. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam (preferred) extinguishers. Water may be ineffective in firefighting. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (1093°C) followed by scrubbing with a caustic solution.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards*, Report PB 276,678. Rockville, MD, pp. 169−176

New Jersey Department of Health and Senior Services. (February 2003). *Hazardous Substances Fact Sheet: Butyl Mercaptan*. Trenton, NJ

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 39−40

Butyl methacrylate B:0970

Molecular Formula: $C_8H_{14}O_2$

Synonyms: *n*-Butyl methacrylate; Butyl 2-methacrylate; *n*-Butyl α-methylacrylate; Butyl 2-methyl-2-propenoate; Metacrilato de *n*-butilo (Spanish); Methacrylate de butyle (French); Methacrylic acid, butyl ester; Methacrylsaeure butyl ester (German); 2-Methyl butylacrylate; 2-Propenic acid, 2-methyl-, butyl ester

CAS Registry Number: 97-88-1

RTECS® Number: OZ3675000

UN/NA & ERG Number: UN2227/130P

EC Number: 202-615-1 [*Annex I Index No.*: 607-033-00-5]

Regulatory Authority and Advisory Bodies

TSCA 40CFR716.120(a).

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R36/37/38; R43; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyl methacrylate is a flammable, colorless liquid with a mild odor. Molecular weight = 122.4; Boiling point = 163°C; Specific gravity (H_2O:1) = 0.9; Freezing/Melting point = −25°C; Relative vapor density (air = 1) = 4.9; Vapor pressure = 2.3 mmHg at 20; Flash point = 52°C (oc); Autoignition temperature = 294°C. Explosive limits: LEL = 2%; UEL = 8%. Hazard Identification (based on

NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.6% at 20°C.

Potential Exposure: Compound Description: Drug; Reproductive Effector; Primary Irritant. Butyl methacrylate is used in resins, solvents, coatings, adhesives, dental materials, and textile emulsions.

Incompatibilities: Forms an explosive mixture with air. Unless inhibitor is maintained at the proper level, oxidizers, heat, ultraviolet light, contamination, or moisture may cause polymerization. May accumulate static electrical charges and cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: [skin] Danger of skin sensitization.

Denmark: TWA 50 ppm (290 mg/m^3), 1999; Russia: STEL 30 mg/m^3, 1993; Sweden: NGV 50 ppm (300 mg/m^3), KTV 75 ppm (450 mg/m^3), 1999; the Netherlands: MAC-TGG 59 mg/m^3, 2003.

Determination in Air: No criteria set.

Determination in Water: No criteria set. Octanol–water coefficient: Log K_{ow} = 2.26–3.01.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate the respiratory tract with coughing, wheezing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Butyl methacrylate may cause skin allergy. There is limited evidence that this chemical is teratogen in animals.

Points of Attack: Skin, reproductive system.

Medical Surveillance: Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Outside or detached storage is preferred. Prior to working with butyl methacrylate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above and from light and heat. Butyl methacrylate should be kept refrigerated and inhibited with 10-ppm hydroquinone monomethylether. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl methacrylate requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3, Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (July 2000). *Hazardous Substances Fact Sheet: Butyl Methacrylate*. Trenton, NJ

Butylphenols B:0980

Molecular Formula: $C_{10}H_{14}O$

Common Formula: $C_4H_9C_6H_4OH$

Synonyms: *o-n*-isomer: 2-*n*-Butylphenol
o-sec-isomer: o, sec-Butylphenol; 2-*sec*-Butylphenol
o-tert-isomer: 2-*t*-Butylphenol; Phenol, *o*-(*tert*-butyl)-
p-sec-isomer: p, sec-Butylphenol; 4-*sec*-Butylphenol
p-tert-isomer: Butylphen; *p*, *ter*-Butylphenol; 4-*t*-Butylphenol; 4-*tert*-Butylphenol; 4-(1,1-Demethylethyl)phenol; 1-Hydroxy-4-*tert*-butylbenzene; UCAR butylphenol 4-*t*

CAS Registry Number: 3180-09-4 (*o*-isomer); 89-72-5 (*o-sec*-isomer); 99-71-8 (*p-sec*-isomer); 4074-43-5 (*m*-isomer); 88-18-6 (*o-tert*-isomer); 98-54-4 (*p-ter*t-isomer); 1638-22-8 (*p*-isomer); 28805-86-9 (mixed isomers)

RTECS® Number: SJ8850000 (*o-n*-isomer); SJ8920000 (*o-sec*-isomer); SJ8810000 (*m*-isomer); SJ8924000 (*p-sec*-isomer); SJ8925000 (*p-tert*-isomer); SJ8922500 (*p-n*-isomer)

UN/NA & ERG Number: UN2930 (Toxic solids, flammable, organic, n.o.s.)/131; UN2929 (Toxic liquids, flammable, organic, n.o.s.)/131

Regulatory Authority and Advisory Bodies

o-sec-isomer: Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled (*p-tert-isomer*).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*o-sec-*; *p-tert-*; *p-*; *o-*; *m-*; *p-tert*-isomers).

WGK (German Aquatic Hazard Class): 2—Water polluting (*o-*, *sec-*, and *o-tert-isomers*).

Description: The butylphenols include several isomers. The two most highly regulated are *o-sec*-butylphenol and *p-tert*-butylphenol. Their properties are as follows:

o-sec-isomer (89-72-5): Colorless liquid or solid (below 16°C). Molecular weight = 150.22; Boiling point = 108°C; Flash point = 108°C. Insoluble in water.

p-tert-isomer (98-54-4): White crystalline solid. Molecular weight = 150.24; Boiling point = 237°C; Freezing/Melting point = 97°C; Flash point = 115°C (oc); Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description (*p-tert*-isomer): Tumorigen, Mutagen, Human Data; Primary Irritant; (*o-sec-* and *o-tert*-isomers): Primary Irritant. Butylphenols may be used as intermediates in manufacturing varnish and lacquer resins; as a germicidal agent in detergent disinfectants; as a pour point depressant, in motor-oil additives; de-emulsifier for oil; soap-antioxidant, plasticizer, fumigant, and insecticide.

Incompatibilities: Incompatible with strong acids, caustics, aliphatic amines, amides, oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.14 mg/m^3 at 25°C & 1 atm.

o-sec-isomer

OSHA PEL: None.

NIOSH REL: 5 ppm/30 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/31 mg/m^3 TWA [skin].

Australia: TWA 5 ppm (30 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (30 mg/m^3), 1999; Belgium: TWA 5 ppm

(31 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (30 mg/m^3), [skin], 1999; France: VME 5 ppm (30 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (30 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (31 mg/m^3), [skin], 2000; the Netherlands: MAC-TGG 30 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam, Israel: TWA 5 ppm [skin].

p-tert-isomer

Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 0.5 mg/m^3
PAC-2: 0.75 mg/m^3
PAC-3: 500 mg/m^3

DFG MAK: 0.080 ppm/0.5 mg/m^3 TWA; Peak Limitation Category II(2); [skin] Danger of skin sensitization; Pregnancy Risk Group D.

Australia: TWA 10 ppm (60 mg/m^3); STEL 20 ppm, 1993; Austria: MAK 0.08 ppm (0.5 mg/m^3), [skin], 1999; Denmark: TWA 0.08 ppm (0.5 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.08 ppm (0.5 mg/m^3), LZG-(week) 0.4 ppm, [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2000.

Several states have set guidelines or standards for the o-*sec*-isomer in ambient air[60] ranging from 300 μg/m^3 (North Dakota) to 500 μg/m^3 (Virginia) to 600 μg/m^3 (Connecticut) to 714 μg/m^3 (Nevada).

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.4-3.4$ [icsc].

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause irritation to nose, throat, and lungs. Sensitization may occur. Skin contact studies with animals suggest that severe irritation at concentrations above 10% may occur. May cause rash, redness, and irritation, especially when skin is wet. Absorption is significant and contact may lead to allergic reaction. Eye studies with animals suggest that severe irritation may occur. Ingestion studies on animals suggest that 8 oz may be lethal to a 150-lb person.

Long Term Exposure: May cause skin color changes by contact or inhalation of levels between 10 and 100 ppm. Allergy may develop after repeated exposure. Liver damage may also occur. There is limited evidence that butylphenol causes skin cancer in animals. Repeated or prolonged skin contact can cause skin ulcers and lead to permanent loss of skin pigment in affected areas.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *No respirator listed by NIOSH for Butylphenols*. If misting or vapor occur consider using a NIOSH/MSHA- or European Standard EN149-approved organic cartridge respirator or NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with butyl phenol you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Based on flash point, solid butylphenols should have a "POISONOUS/TOXIC MATERIALS, FLAMMABLE SOLID" label. Based on flash point, liquid butylphenols should have a "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID" label. These materials fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butylphenol is combustible. Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 1986). *Hazardous Substances Fact Sheet: Butylphenol.* Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet p-tert-Butylphenol.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: o-sec-Butylphenol.* Trenton, NJ

Butyl propionate B:0990

Molecular Formula: $C_7H_{14}O_2$
Common Formula: $C_2H_5COOC_4H_9$
Synonyms: Butyl propanoate; *n*-Butyl propionate; Propanoic acid butyl ester; Propionic acid butyl ester
CAS Registry Number: 590-01-2
RTECS® Number: UE8245000
UN/NA & ERG Number: UN1914/130
EC Number: 209-669-5 [*Annex I Index No.*: 607-029-00-3]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: None; Risk phrases: R10; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyl propionate is a flammable, colorless to straw-yellow liquid with an apple-like odor. Molecular weight = 130.2; Boiling point = 146°C; Specific gravity (H_2O:1) = 0.87; Melting/Freezing point = −90°C; Vapor pressure = 2.9 mmHg at 20°C; Relative density at 20°C of the saturated vapor/air mixture (air = 1) = 1.01; Flash point = 32°C; Autoignition temperature = 426°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. It is used as a solvent or lacquer thinner and in perfumes and flavorings.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 100 mg/m^3
PAC-1: 300 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance irritates the eyes, skin, and the respiratory tract.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Outside or detached storage is preferred. Prior to working with butyl propionate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl propionate requires a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3, Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet:* Butyl Propionate. Trenton, NJ

p-tert-Butyltoluene B:1000

Molecular Formula: $C_{11}H_{16}$

Common Formula: p-$CH_3C_6H_4C_4H_9$

Synonyms: *p*-Methyl-*tert*-butylbenzene; 1-Methyl-4-*tert*-butylbenzene; TBT

CAS Registry Number: 98-51-1

RTECS$^®$ Number: XS8400000

UN/NA & ERG Number: UN2667/152

EC Number: 202-675-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: *p-tert*-Butyltoluene is a colorless liquid with an aromatic gasoline-like odor. Molecular weight = 148.18; Boiling point = 193−194°C; Boiling point = 193°C; Freezing/Melting point = −52°C; Vapor pressure = 0.68 mmHg at 20°C; Flash point = 68°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. This material is used as a solvent for resins and as an intermediate in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Reacts with strong oxidizers. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.07 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm/60 mg/m^3 TWA.
NIOSH REL: 10 ppm/60 mg/m^3 TWA; 20 ppm/120 mg/m^3 STEL.
ACGIH TLV®[1]: 1 ppm/6.1 mg/m^3 TWA.
No TEEL available.
DFG MAK: No numerical value established. Data may be available.
NIOSH IDLH: 100 ppm.

Australia: TWA 10 ppm (61 mg/m^3); STEL 20 ppm, 1993; Austria: MAK 10 ppm (60 mg/m^3), 1993; Denmark: TWA 10 ppm (60 mg/m^3), 1999; Finland: TWA 10 ppm (60 mg/m^3); STEL 20 ppm (120 mg/m^3) [skin] 1999; France: VME 10 ppm (60 mg/m^3), 1999; Norway: TWA 10 ppm (60 mg/m^3), 1999; the Netherlands: MAC-TGG 6.1 mg/m^3, 2003; Switzerland: MAK-W 10 ppm (60 mg/m^3), KZG-W 20 ppm (120 mg/m^3), 1999; Turkey: TWA 10 ppm (60 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm. The state of Virginia has set a limit in ambient air[60] of 1.0 mg/m^3. Several states have set guidelines or standards for this compound in ambient air[60] ranging from 600 to 1200 μg/m^3 (North Dakota) to 1000 μg/m^3 (Virginia) to 1200 μg/m^3 (Connecticut) to 1429 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 1501.
Aromatic hydrocarbons or OSHA Analytical Method 7, Organic Vapors.[18]

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract, causes dry nose and throat, headaches, low blood pressure, tachycardia, abnormal cardiovascular system behavior, central nervous system depression, hematopoietic depression. LD_{50} = (oral-rat) 1500 mg/kg (slightly toxic). This chemical may cause effects on the central nervous system.

Long Term Exposure: The liquid defats the skin and may have effects on the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, central nervous system, bone marrow, liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. CBC (complete blood count), electrocardiogram.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton™ gloves, suits. **4 h:** (At least 4 but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): nitrile; 4H™ and Silver Shield™ gloves. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyltoluenes require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably in admixture with a more flammable solvent.[24]

Reference

NIOSH/OSHA. (1981−1995). *Occupational Health Guidelines for Chemical Hazards*, *DHHS*. Supplements I−IV. NIOSH Publication No. 81-123; 88-118. Cincinnati, OH

Butyl trichlorosilane B:1010

Molecular Formula: $C_4H_9Cl_3S$

Common Formula: $CH_3(CH_2)_3SiCl_3$

Synonyms: *n*-Butiltriclorosilano (Spanish); Butylsilicon trichloride; *n*-Butyltrichlorosilane

CAS Registry Number: 7521-80-4

RTECS® Number: VV2080000

UN/NA & ERG Number: UN1747/155

EC Number: 231-381-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyl trichlorosilane is a colorless liquid. Molecular weight = 191.57. Boiling point = 149°C; Flash point = 45°C (cc); 54°C (oc).[17] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Insoluble in water; reacts violently.

Potential Exposure: This is a raw material for silicone resin production.

Incompatibilities: Forms explosive mixture with air. Violent reaction with water, forming hydrochloric acid and fumes. Contact with strong oxidizers may cause fire and explosions. Attacks metals in a moist environment.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.60** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, skin, eyes.

Harmful Effects and Symptoms

Short Term Exposure: Butyl trichlorosilane is a corrosive chemical and can cause severe eye burns leading to permanent damage. Contact can cause severe skin burns. Exposure to vapors can irritate the eyes, nose, and throat. Butyl trichlorosilane can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposure can cause a buildup of the fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: Repeated exposure may cause bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of butyl trichlorosilane to potentially exposed workers.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard. Store separately in a corrosion-resistant location. (2) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl trichlorosilane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl trichlorosilane requires a "CORROSIVE, FLAMMABLE LIQUID" label. It falls in Hazard Class 8 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen chloride, chlorine, and phosgene, are produced in fire. Use dry chemical or carbon dioxide. Foam extinguishers are not recommended. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Butyl Trichlorosilane*. Trenton, NJ

Butyl vinyl ether B:1020

Molecular Formula: $C_6H_{12}O$

Common Formula: $CH_2{=}CHOC_4H_9$

Synonyms: Butane, 1-(ethenyloxy)-; Butoxyethene; 1-(Ethenyloxy)butane; Ether, butyl vinyl; Vinyl *n*-butyl ether; Vinyl butyl ether

CAS Registry Number: 111-34-2

RTECS® Number: KN5900000

UN/NA & ERG Number: UN2352/127P

EC Number: 203-860-7

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Butyl vinyl ether is an extremely flammable, colorless liquid with an ether-like odor. Molecular weight = 100.2; Specific gravity (H_2O:1) = 0.8; Boiling point = 94°C; Freezing/Melting point = − 112.8°C; Vapor density (air = 1) = 3.5; Flash point = − 9.4°C (oc)[17]; Autoignition temperature = 255°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: This material may be used in organic synthesis and in copolymer manufacture.

Incompatibilities: Moderately explosive by spontaneous chemical reaction. Contact with oxidizers and strong acids may cause fire and explosions. Able to form unstable peroxides, which can cause polymerization.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May be poisonous if inhaled or absorbed through skin. Vapors may cause dizziness or suffocation. Contact may irritate or burn skin and eyes. LD_{50} = (oral-rat) 15,000 mg/kg (insignificantly toxic).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl vinyl ether you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The DOT label requirement for inhibited butyl vinyl ether is "FLAMMABLE LIQUID."[19] It falls in Hazard Class 3 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind. Remove all ignition sources. Stop leak if you can do so without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dangerous, fire risk. For small fires use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. For large fires use water spray, fog, or alcohol foam. Move containers from fire area if you can do so without risk. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Butyl Vinyl Ether*. Washington, DC: Chemical Emergency Preparedness Program

Butyraldehyde B:1030

Molecular Formula: C_4H_8O

Synonyms: Aldehyde butyrique (French); Butal; Butaldehyde; Butalyde; Butanal; Butirraldehido (Spanish); *n*-Butyl aldehyde; Butyl aldehyde; Butyral; Butyraldehyd (German); *n*-Butyraldehyde; Butyric acid; Butyric aldehyde; NCI-C56291

CAS Registry Number: 123-72-8

RTECS® Number: ES2275000

UN/NA & ERG Number: UN1129

EC Number: 204-646-6 [*Annex I Index No.*: 605-006-00-2]

Regulatory Authority and Advisory Bodies

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S9; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyraldehyde is a highly flammable, colorless liquid with a pungent odor. Odor threshold = 0.009 ppm. Molecular weight = 72.12; Specific gravity (H_2O:1) = 0.79; Boiling point = 76°C; Freezing/Melting point = −99°C; Flash point = −22°C; Relative vapor density (air = 1) = 2.5; Autoignition temperature = 218°C. Explosive limits in air: LEL = 1.9%; UEL = 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slowly mixes with water; solubility = 7%.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Used in making synthetic resins, solvents, and plasticizers.

Incompatibilities: Butyraldehyde can presumably form explosive peroxides, and may polymerize due to heat or contact with acids or alkalis. May accumulate static electrical charges, and may cause ignition of its vapors. Forms explosive mixture with air. Possible self-reaction in air; undergoes rapid oxidation to butyric acid in air. Incompatible with strong oxidizers (possible violent reaction), strong acids, caustics, ammonia, aliphatic amines, alkanolamines, aromatic amines. May corrode steel due to corrosive action of butyric acid.

Permissible Exposure Limits in Air
AIHA WEEL: 25 ppm TWA.
Protective Action Criteria (PAC)
TEEL-0: 0.02 ppm
PAC-1: 0.06 ppm
PAC-2: 0.4 ppm
PAC-3: 12.5 ppm
Russia: STEL 5 mg/m^3, [skin].

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.9-1.2$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Butyraldehyde is corrosive. Irritates the eyes, skin, and respiratory tract. Eye or skin contact may cause burns and possible permanent damage. High exposure can cause dizziness and lightheadedness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Prolonged or repeated skin exposure may cause skin disorders. Testing has not been completed to determine the carcinogenicity of butyraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, skin.

Medical Surveillance: Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Outside or detached storage is preferred. Prior to working with Butyraldehyde you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyl propionate requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3, Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand, earth or similar noncombustible absorbent material and deposit in sealed containers. *Do not* use sawdust or other combustible absorbent. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Butyraldehyde*. Trenton, NJ

Butyric acid B:1040

Molecular Formula: $C_4H_8O_2$

Common Formula: $CH_3(CH_2)_2COOH$

Synonyms: Acido butirico (Spanish); Butanic acid; *n*-Butanoic acid; Butanoic acid; Buttersaeure (German); *n*-Butyric acid; *normal* Butyric acid; Butyric acid; Ethylacetic acid; 1-Propanecarboxylic acid; Propylformic acid

CAS Registry Number: 107-92-6; Much of the following information may also apply to 79-31-2 (Isobutyric acid)

RTECS® Number: ES5425000

UN/NA & ERG Number: UN2820/153

EC Number: 203-532-3 [*Annex I Index No.:* 607-135-00-X] (107-92-6); 201-195-7 [*Annex I Index No.:* 607-063-00-9] (79-31-2)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: (*butyric acid*; *107-92-6*) Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S26; S36; S45; (*isobutyric acid*; *79-31-2*) Hazard Symbol: Xn; Risk phrases: R21/22; R36/38; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Butyric acid is a combustible, oily liquid with an unpleasant odor. The Odor Threshold is 0.0001 ppm.[41] Molecular weight = 88.12; Specific gravity (H_2O:1): 0.96; Boiling point = 163.5°C; Freezing/Melting point = − 7.87°C; Vapor pressure = 0.44 mmHg at 20°C; Flash point = 72°C; Autoignition temperature = 440°C. Flammable Limits in Air: LEL = 2%; UEL = 10%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Highly soluble in water.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. It is used in the manufacture of butyrate esters, some of which are used in artificial flavoring.

Incompatibilities: Forms explosive mixture with air. Incompatible with sulfuric acid, caustics, ammonia, aliphatic amines, isocyanates, strong oxidizers, alkylene oxides, epichlorohydrin.

Permissible Exposure Limits in Air

Temporary Emergency Exposure Limits (DOE).

TEEL-0: 15 ppm

PAC-1: 40 ppm

PAC-2: 250 ppm

PAC-3: 250 ppm

The former-USSR-UNEP/IRPTC joint project MAC value is 2.5 ppm (10 mg/m^3)[43] for work-place air. They also cite a momentary MAC value of 0.015 mg/m^3 and an allowable average daily MAC of 0.01 mg/m^3 in ambient air of residential areas.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.8.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Butyric acid is a medium strong corrosive acid. Can cause severe eye and skin irritation and burns leading to permanent damage. Inhalation can cause respiratory tract irritation, coughing, wheezing, and/or shortness of breath. LD_{50} = (oral-rat) 2940 mg/kg (slightly toxic).[9]

Long Term Exposure: Can affect the blood. Repeated exposures may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. May cause kidney damage.

Points of Attack: Skin, eyes, and respiratory system.

Medical Surveillance: Lung function tests. Kidney function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Protect against physical damage. Outside or detached storage is preferred. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with butyric acid you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Butyric acid requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group III.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand, earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a

secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 71–73

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Butyric Acid*. Trenton, NJ

C

Cacodylic acid C:0050

Molecular Formula: $C_2H_7AsO_2$
Synonyms: Acide cacodylique (French); Acide dimethylarsinique (French); Acido cacodilico (Spanish); Agent blue; Ansan; Ansar; Arsinic acid, dimethyl-; Bolls-Eye; Chexmate; Cottonaide HC; Dilic; Dimethylarsenic acid; Dimethylarsinic acid; Dimethylarsinic arsinic acid; DMAA; Erase; Hydroxydimethylarsine oxide; Monocide; Montar; Phylar; Phytar 138; Phytar 560; Phytar 600; Rad-E-Cate 25; Salvo; Silvisar 510
CAS Registry Number: 75-60-5; 124-65-2 (sodium salt)
RTECS® Number: CH7525000
UN/NA & ERG Number: UN1572/151
EC Number: 200-883-4
Regulatory Authority and Advisory Bodies
EPA: Not Classifiable as to human carcinogenicity.
Reportable Quantity (RQ): 1 lb (0.454 kg).
US EPA Hazardous Waste Number (RCRA No.): U136.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
EPCRA Section 313 Form R (as organic arsenic compound) *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as dimethylarsinic acid.
California Proposition 65 Chemical: Cancer 5/1/96.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as arsenic, water-soluble compounds, n.o.s.
Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Cacodylic acid is a colorless, odorless, crystalline solid arsenic compound. Molecular weight = 138.02; Boiling point = 200°C; Freezing/Melting point = 192°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0.[NJ] Highly soluble in water.
Potential Exposure: Used as an herbicide, soil sterilant and in timber thinning. Has been used as a chemical warfare agent.
Incompatibilities: Aqueous solution reacts violently with chemically active metals releasing toxic arsenic fumes. Incompatible with oxidizers, sulfuric acid, caustics (strong bases), reducing agents, ammonia, amines, isocyanates, alkylene oxides, epichlorohydrin.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 250 mg/m^3
Sodium salt
TEEL-0: 1.07 mg/m^3
PAC-1: 3.2 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 500 mg/m^3
Arsenic, organic compounds
OSHA PEL: 0.5 mg[As]/m^3 TWA
NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.
ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
Protective Action Criteria (PAC)
As arsenic, organic compounds
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 350 mg/m^3
124-65-2 (sodium salt)
TEEL-0: 1.07 mg/m^3
PAC-1: 1.07 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 500 mg/m^3
Determination in Air: Use NIOSH Analytical Method (IV) #5022, arsenic, organo-.
Determination in Water: The atomic absorption graphite furnace technique is often used for the measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry. Fish Tox = 2841.14769000 ppb MATC (VERY LOW).
Routes of Entry: Inhalation, ingestion, skin and/or eye contact. This chemical can be absorbed through the skin, thereby increasing exposure.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can also cause burning, itching, thickening, and color changes.
Long Term Exposure: Certain other arsenic compounds have been identified as carcinogens. Although this chemical has not been identified as a carcinogen it should be handled with extreme caution. May cause an ulcer of the “bone” dividing the inner nose. It can cause disturbed sleep; thickening of the skin with patch areas of darkening and loss of pigment, or the development of white lines in the nails. May cause liver and kidney damage. Repeated exposure can lead to a metallic or garlic taste in the mouth, loss of appetite, nausea, vomiting, difficulty in swallowing, stomach pain, diarrhea, and possible death. *In animals*: irritation skin, possible dermatitis, respiratory distress, diarrhea, kidney damage, muscle tremor, convulsions, possible gastrointestinal tract damage, reproductive effects, possible liver damage. Human Tox = 5.61798 ppb; CHCL (Chronic Human Carcinogen Level) (HIGH).

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00003-5

Points of Attack: Skin, respiratory system, kidneys, central nervous system, liver, gastrointestinal tract, reproductive system.

Medical Surveillance: Test for urine arsenic. Levels should not be greater than 100 μg/g creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cacodylic acid you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents, chemically active metals, strong bases, moisture, fertilizers, seeds, insecticides, and fungicides.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Shipping Group is II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide and arsenic oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Cacodylic Acid*. Trenton, NJ

Cadmium (and cadmium inorganic compounds) C:0100

Molecular Formula: Cd

Synonyms: Cadmio (Spanish); C.I. 77180; Colloidal cadmium; Elemental cadmium; Kadmium (German)

CAS Registry Number: 7440-43-9 (elemental)

RTECS® Number: EU9800000 (metal)

UN/NA & ERG Number: UN2570 (for cadmium compounds)/154

EC Number: 231-152-8 [*Annex I Index No.:* 048-002-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence (cadmium and cadmium compounds), Limited evidence (metal); Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA: Limited evidence of carcinogenicity based on epidemiologic studies; OSHA: Human Carcinogen.

Banned or Severely Restricted (many countries) (UN).[13, 35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): D006.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 1.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.69; Nonwastewater (mg/L), 0.19 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL mg/L): 601 (40); 7130 (50); 7131 (1).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, 0.005 mg/L; Regulated chemical (47 FR 9352); Priority List (55 FR 1470).

Reportable Quantity (RQ): 10 lb (4.54 kg). *Note:* No release report required if diameter of pieces is equal to or exceeds 0.004 in.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

Mexico Drinking Water Criteria: 0.01 mg/L.

California Proposition 65 Chemical: Cancer 10/1/87; Developmental/Reproductive toxin (male) 5/1/97.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as cadmium, elemental; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited; Drinking Water Quality: 0.005 mg/L MAC.

European/International Regulations (*cadmium*): Hazard Symbol: T + , N; Risk phrases: R45; R26; R48/23/25; R62; R63; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cadmium is a bluish-white metal. Molecular weight = 112.4; Boiling point = 765°C; Freezing/Melting point = 321°C; Autoignition temperature (*metal dust*) = 250°C. Hazard Identification (based on NFPA-704 M Rating System): (*powder*) Health 3, Flammability 2, Reactivity 0. Insoluble in water. The only cadmium mineral, greenockite (CdS), is rare; however, small amounts of cadmium are found in zinc, copper, and lead ores. It is generally produced as a by-product of these metals, particularly zinc. Cadmium is insoluble in water but is soluble in acids. "Cadmium dust" includes dust of various cadmium compounds, such as $CdCl_2$. "Cadmium fume" has the composition Cd/CdO.

Potential Exposure: Cadmium is highly corrosion resistant and is used as a protective coating for iron, steel, and copper; it is generally applied by electroplating, but hot dipping and spraying are possible. Cadmium may be alloyed with copper, nickel, gold, silver, bismuth, and aluminum to form easily fusible compounds. These alloys may be used as coatings for other materials, welding electrodes, solders, etc. It is also utilized in electrodes of alkaline storage batteries, as a neutron absorber in nuclear reactors, a stabilizer for polyvinyl chloride plastics, a deoxidizer in nickel plating, an amalgam in dentistry, in the manufacture of fluorescent lamps, semiconductors, photocells, and jewelry, in process engraving, in the automobile and aircraft industries, and to charge Jones reductors. Various cadmium compounds find use as fungicides, insecticides, nematocides, polymerization catalysts, pigments, paints, and glass; they are used in the photographic industry and in glazes. Cadmium is also a contaminant of superphosphate fertilizers. Human exposure to cadmium and certain cadmium compounds occurs through inhalation and ingestion. The entire population is exposed to low levels of cadmium in the diet because of the entry of cadmium into the food chain as a result of its natural occurrence. Tobacco smokers are exposed to an estimated 17 mg per cigarette. Cadmium is present in relatively low amounts in the earth's crust; as a component of zinc ores, cadmium may be released into the environment around smelters.

Incompatibilities: Air exposure with cadmium powder may cause self ignition. Moist air slowly oxidizes cadmium forming cadmium oxide. Cadmium dust is incompatible with strong oxidizers, ammonium nitrate, elemental sulfur, hydrazoic acid, selenium, zinc, tellurium. Contact with acids cause a violent reaction, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA [*Note:* The PEL applies to all cadmium compounds (as Cd).]

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level. [*Note:* The REL applies to all cadmium compounds (as Cd).]

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)*
TEEL-0: 0.005 mg/m^3
PAC-1: **0.10** mg/m^3
PAC-2: **0.76** mg/m^3
PAC-3: **4.7** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Cadmium and inorganic compounds

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) (*fume*) 0.02 mg/m^3, MAC (STEL) (*fume*) 0.05 mg/m^3, 1999; MAC (TWA) (*dust*): 0.04 mg/m^3, MAC (STEL) *(dust):* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen.

Several states have set guidelines or standards for cadmium in ambient air[60] ranging from zero (North Dakota) to 0.0006 mg/m^3 (Rhode Island) to 0.0055 μg/m^3 (North Carolina) to 0.0056 μg/m^3 (Massachusetts) to 0.07 (Montana) to 0.12 μg/m^3 (Pennsylvania) to 0.25 μg/m^3 (South Carolina) to 0.4 μg/m^3 (Connecticut and South Dakota) to 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (Nevada) to 2.0 μg/m^3 (New York).

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *dust* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206; *fume*: NIOSH #7048, #7300, #7301, #7303, #7200 (Welding and Brazing Fume), and OSHA ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods.

Routes of Entry: Inhalation or ingestion of fumes or dust.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Dust may cause irritation of the nose and throat. Nonfatal lung inflammation has been reported from concentrations of 0.5−2.5 mg/m^3. In 4−10 h after exposure severe chest pain with persistent cough and difficult breathing, headache, chills, muscle aches, nausea, vomiting, and diarrhea may occur. Fluid in the lungs (pulmonary edema) and dark-purple coloration of the skin may occur. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. Breathing becomes more difficult and is accompanied by wheezing or coughing of blood. Other symptoms which may occur 12−36 h after exposure in addition to those above include dizziness, irritability, gastrointestinal disturbances, shortness of breath, fever, profuse sweating, exhaustion, and inflammation of the lungs. Death may result within 7−10 days after exposure. The average concentrations of fume responsible for fatalities have been 40−50 mg/m^3 for 1 h, 9 mg/m^3 for 5 h, or 5 mg/m^3 for 8 h. *Skin:* Absorption is negligible. *Eyes:* Cadmium compound dust may cause irritation. *Ingestion:* A dose of 15−30 mg (1/1000 oz) of metal or soluble compounds may cause increased salivation, choking, vomiting, abdominal pain, anemia, kidney malfunction, diarrhea, and persistent desire to empty the bladder. Symptoms may occur within 15−30 min after ingestion. May cause heart and lung failure.

Long Term Exposure: Continued exposure to low levels of cadmium in air may cause irreversible lung injury, abnormal lung function, and kidney disease. Other consequences of cadmium exposures are inflammation of the nose and throat, open sores in the nose, soreness, bleeding and reduced nose size, loss of sense of smell, damage to the olfactory nerve, yellow cadmium stains on teeth, sleeplessness, nausea, lack of appetite, weight loss, anemia, lung distention with scar formation, and liver damage. May cause bone disease characterized by softening, bending, and reduction in bone size. Difficulty walking, pain in back and extremities, and spontaneous fractures may result. Inhalation of 0.06−0.68 mg/m^3 for 4−8 years may cause throat irritation, cough, chest pain, upset stomach, and fatigue. Exposure to levels of 3.0−15.0 mg/m^3 of fumes or dust over a period of 20 years has caused lung distention, anemia, protein in urine, and kidney dysfunction. Studies indicate that there is an increased incidence of prostatic cancer and possible kidney and respiratory cancer in cadmium workers. Cadmium causes birth defects in rats, mice, and hamsters; whether it does so in humans is not known.

Points of Attack: Respiratory system, lungs, kidneys, prostate, blood.

Medical Surveillance: In preemployment physical examinations emphasis should be given to a history of, or actual presence of: significant kidney disease, smoking history, and respiratory disease. A chest X-ray and baseline pulmonary function study is recommended. Periodic examinations should emphasize the respiratory system, including pulmonary function tests, kidneys, and blood. A low-molecular-weight proteinuria may be the earliest indication of renal toxicity. The trichloroacetic acid test may pick this up, but more specific quantitative studies would be preferable. If renal disease due to cadmium is present, there may also be increased excretion of calcium, amino acids, glucose, and phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Cadmium dust: (metal) Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Wear protective gloves and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield to prevent any possibility of eye contact, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue (*carcinogen*): Health Hazard: Store in a secure poison location. Prior to working with cadmium you should be trained on its proper handling and storage. Cadmium must be stored to avoid contact with sulfur, selenium, tellurium, ammonium nitrate, and hydrazoic acid since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Sources of ignition, such as smoking and open flames, are prohibited where cadmium is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA standard 1910.1045.

Shipping: Cadmium metal and dust are not specifically cited in DOT's Performance-Oriented Packaging Standards, but cadmium compounds are. These require a "POISONOUS/TOXIC MATERIALS" label.[19] They are in Hazard Class 6.1 and depending on other factors, may be in Packing Group I, II, or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable powder. Use dry chemicals appropriate for metal fires or dry sand. Use no other extinguishing agents. *Do not use water*. Toxic gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: With cadmium compounds in general, precipitation from solution as sulfides, drying, and return of the material to suppliers for recovery are recommended. Cadmium may be recovered from battery scrap as an alternative to disposal.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

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US Environmental Protection Agency. (March 31, 1987). *Health Advisory: Cadmium*. Washington, DC: Office of Drinking Water

US Public Health Service. (November 1987). *Toxicological Profile for Cadmium*. Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Cadmium*. Trenton, NJ

Cadmium acetate C:0110

Molecular Formula: $C_4H_6CdO_4$
Common Formula: $Cd(C_2H_3O_2)_2$
Synonyms: Acetic acid, cadmium salt; Aceto cadmio (Spanish); Bis(acetoxy)cadmium; Cadmium(II) acetate; Cadmium diacetate; C.I. 77185
CAS Registry Number: 543-90-8
RTECS*® *Number: EU9810000
UN/NA & ERG Number: UN2570/154
EC Number: 208-853-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Toxic Pollutant (Section 401.15), Hazardous Air Pollutants (Title I, Part A, Section 112). *Note:* Includes any unique chemical substance that contains cadmium as part of that chemical’s infrastructure.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as cadmium acetate; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cadmium acetate is a colorless crystalline solid; Freezing/Melting point = 130°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Cadmium acetate is used in ceramics, textile dyeing, and printing and electroplating, and to make other acetate compounds.

Incompatibilities: Sulfides, strong acids.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0103 mg/m^3
PAC-1: 0. 062 mg/m^3
PAC-2: 0.15 mg/m^3
PAC-3: 18.6 mg/m^3
DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.
Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *(dust)* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on Cadmium. North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3.

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods. See also reference.[49]

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Cadmium acetate can affect you when breathed in. Cadmium acetate is a carcinogen; handle with extreme caution. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Risk is greatest near dust or fume from heating or grinding cadmium acetate.

Long Term Exposure: Repeated lower exposure can cause permanent kidney damage, emphysema, low blood sugar, and/or lowered sense of smell. Serious damage can occur at levels below the PEL. See also entry on "Cadmium."

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: Urine test for Cadmium (levels should be less than 10 μg/L urine). Urine test for "low-molecular-weight proteins" (electrophoresis method best). Urinalysis (UA). Complete blood count (CBC). Lung function test. These should be repeated after suspected overexposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: *Clothing:* Avoid skin contact with Cadmium acetate. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium acetate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials listed above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Cadmium acetate requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Cadmium acetate itself does not burn. Poisonous gases are produced in fire, including cadmium fumes. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitation as sulfide, drying, and return to supplier.[22] Incineration is not recommended.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, No. 4, 59−70

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Cadmium Acetate*. Trenton, NJ

Cadmium bromide C:0120

Molecular Formula: Br_2Cd

Common Formula: $CdBr_2$

Synonyms: Bromuro de cadmio (Spanish); Cadmium dibromide

CAS Registry Number: 7789-42-6

RTECS® Number: EU9935000

UN/NA & ERG Number: UN2570/154

EC Number: 232-165-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: Toxic Pollutant (Section 401.15); Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as cadmium salts, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cadmium bromide is a white to yellowish crystalline powder. Molecular weight = 272.22; Boiling point = 863°C; Freezing/Melting point = 567°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Cadmium bromide is used in photography, engraving, and lithography.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0121 mg/m^3

PAC-1: 0.0727 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 21.8 mg/m^3

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *(dust)* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3.

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods. See also reference.[49]

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Cadmium bromide can affect you when breathed in. Cadmium bromide is a carcinogen; handle with extreme caution. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Risk is greatest near dust or fume from heating or grinding cadmium acetate.

Long Term Exposure: Repeated exposures can cause anemia, permanent kidney damage, emphysema, low blood count, and/or loss of sense of smell, fatigue, yellow staining of teeth. Cadmium bromide should be handled as a potential teratogenic agent and reproductive hazard since several related cadmium compounds are known teratogens and decreases fertility in males and females. Repeated low exposures (below the OSHA PEL) can cause permanent kidney damage, which can go unnoticed without testing until severe. Kidney stones can also occur. Emphysema and/or lung scarring can occur from a single high exposure or repeated lower exposures. Sax (see "References" below) states that $CdBr_2$ is a recognized carcinogen of the connective tissue, lungs, and liver.

Points of Attack: Respiratory system, kidneys, liver.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Urine test for cadmium (levels should be less than 10 μg of cadmium per liter of urine). Urine test for low-molecular-weight proteins (electrophoresis method best). Urine analysis (UA). Complete blood count (CBC). Lung function tests. These should be repeated after suspected overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: *Clothing:* Avoid skin contact with cadmium bromide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with cadmium bromide you should be trained on its proper handling and storage. Cadmium bromide must be stored to avoid contact with Potassium, since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Cadmium bromide requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Cadmium bromide itself does not burn. Poisonous gases are produced in fire, including cadmium and bromine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 76−79

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Cadmium bromide*. Trenton, NJ

Cadmium chloride C:0130

Molecular Formula: $CdCl_2$

Synonyms: Caddy; Cadmium dichloride; Cloruro de cadmio (Spanish); Dichlorocadmium; Kadmiumchlorid (Germany); VI-CAD

CAS Registry Number: 10108-64-2; 7790-78-5 (hemipentahydrate)

RTECS® Number: EV0175000

EC Number: 048-008-00-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (In pesticides in UK)[13] (other) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: Toxic Pollutant (Section 401.15); Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as cadmium chloride; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cadmium chloride is a colorless, odorless, crystalline solid or powder. Molecular weight = 183.30; Boiling point = 960°C; Freezing/Melting point = 568°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 140 g/100 mL at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical Tumorigen, Mutagen; Reproductive Effector; Human Data. Cadmium chloride is used in dyeing and printing of fabrics, in electronic component manufacture, in photography, used as a pesticide, and in nonpasture turf fungicides.

Incompatibilities: Sulfur, selenium, potassium, and strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.00815 mg/m^3
PAC-1: 0.0489 mg/m^3
PAC-2: 0.5 mg/m^3
PAC-3: 14.7 mg/m^3

Hemipentahydrate
TEEL-0: 0.0102 mg/m^3
PAC-1: 0.0609 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 18.3 mg/m^3

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *(dust)* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3. Guidelines for cadmium chloride in ambient air have been set[60] ranging from 1.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida).

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) −8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) −3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota); to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods.[49]

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. Cadmium chloride can cause severe irritation of the gastrointestinal tract and the respiratory tract. Inhalation can cause nose, throat, and lung irritation. Fumes can cause flu-like illness with chills, headache, aching muscles, and/or fever. Higher exposures can cause nausea, salivation, vomiting, cramps, diarrhea, and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Cadmium chloride is highly toxic. As little as 14.5 mg of Cd orally causes nausea and vomiting; 8.9 g has caused death. Cadmium salts cause cramps, nausea, vomiting, and diarrhea. Acute poisoning causes lung damage.

Long Term Exposure: This chemical is a probable carcinogen in humans, with some evidence that it causes prostate and kidney cancer in humans, and it has been shown to cause lung and testes cancer in animals. It may also be a reproductive hazard in humans. Repeated low exposures may cause permanent kidney and liver damage, anemia, and/or loss of the sense of smell. Chronic poisoning damages kidneys, lungs, bones, and causes blood changes (anemia).

Points of Attack: See above on harmful effects and symptoms.

Medical Surveillance: Urine test for cadmium. Urine test for "low-molecular-weight proteins" to detect kidney damage. Urinalysis. Complete blood count (CBC). Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Store in tightly closed containers. Avoid contact with strong acids and oxidizers or moisture.

Shipping: Cadmium chloride requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use agent suitable for surrounding fire. Cadmium chloride itself does not burn. Poisonous gases are produced in fire, including cadmium and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is preferred to convert the salt to the nitrate, precipitate it with H_2S, filter, wash and dry the precipitate, and return it to the supplier.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 73−76

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Cadmium Chloride*. Trenton, NJ

Cadmium oxide C:0140

Molecular Formula: CdO
Synonyms: Cadmium monoxide; Cadmium oxide brown; Cadmium oxide fume; Oxido de cadmio (Spanish)
CAS Registry Number: 1306-19-0 (*oxide and fume*)
RTECS® Number: EV1925000; EV1930000 (*fume*)
UN/NA & ERG Number: UN2570/154
EC Number: 215-146-2 [*Annex I Index No.:* 048-002-00-0]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Banned or Severely Restricted (the Czech Republic, Germany) (UN).[35]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.
Clean Water Act: Toxic Pollutant (Section 401.15), as cadmium compounds.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (045.4 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.
California Proposition 65 Chemical: Cancer 10/1/87.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as cadmium oxide; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R26; R48/23/25; R62; R63; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Cadmium oxide forms brownish-red crystals or a yellow to dark brown amorphous powder. Molecular weight = 128.4; Freezing/Melting point = 900°C (slow decomposition begins at 700°C); Sublimation point = 1559°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Very slightly soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; (*fume*) Tumorigen; Human Data. Cadmium oxide is used as an electroplating chemical and in the manufacture of semiconductors and cadmium electrodes; synthesis of other cadmium salts; a component of silver alloys, phosphorus, glass and ceramic glazes, semiconductors, and batteries. Used as a vermicide.
Incompatibilities: Oxides of cadmium react explosively with magnesium, especially when heated. Heating above 700°C causes slow decomposition. Not compatible with oxidizers. May ignite combustibles, such as wood, paper, oil, etc.
Permissible Exposure Limits in Air
OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.
NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.
ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.
NIOSH IDLH: 9 mg [Cd]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.00571 mg/m^3
PAC-1: 0.0343 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 10.3 mg/m^3
Dipotassium cadmium oxide
TEEL-0: 0.0099 mg/m^3
PAC-1: 0.05940 mg/m^3
PAC-2: 0.1 mg/m^3
PAC-3: 17.8 mg/m^3
Disodium cadmium oxide
TEEL-0: 0.00847 mg/m^3
PAC-1: 0.0508 mg/m^3
PAC-2: 0.0847 mg/m^3
PAC-3: 15.2 mg/m^3
DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.
Arab Republic of Egypt: TWA 0.05 mg[Cd]/m^3, (*fume*) 1993; Australia: TWA 0.05 mg/m^3, Carcinogen (*fume*), 1993; Austria: carcinogen, 1999; Belgium: STEL 0.05 mg/m^3, Carcinogen (*fume*), 1993; TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg[Cd]/m^3, 1999; Finland: TWA 0.01 mg/m^3, Carcinogen (*fume*), 1999; carcinogen, 1993; France: VLE 0.05 mg/m^3 (*fume*), carcinogen, 1999; the Netherlands: MAC-TGG 0.005 mg[Cd]/m^3, 2003; Hungary: STEL 0.05 mg/m^3, carcinogen, 1993; Japan: 0.05 mg[Cd]/m^3, *carcinogenic to humans*, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg [Cd]/m^3, 1999; the Philippines: TWA 0.1 mg/m^3 (*fume*), 1993; Poland: MAC (TWA) *(fume)* 0.02 mg[Cd]/m^3, MAC (STEL) *(fume)* 0.05 mg[Cd]/m3, 1999; MAC (TWA) *(dust):* 0.04 mg [Cd]/m^3, MAC (STEL) *(dust):* 0.2 mg[Cd]/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.05 mg/m^3 (*fume*), carcinogen, 1999; Thailand: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3 (*fume*), 1993; Turkey: TWA 0.1 mg/m^3 (*fume*), 1993; United Kingdom: TWA 0.025 mg [Cd]/m^3; STEL 0.05 mg[Cd]/m^3, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3. Several states have set guidelines or standards for cadmium oxide in

ambient air[60] ranging from 0.167 μg/m^3 (New York) to 0.25 μg/m^3 (South Carolina) to 0.40 μg/m^3 (Virginia) to 0.5 μg/m^3 (Florida) to 1.0 μg/m^3 (Nevada).

NIOSH IDLH: Carcinogen [9 mg/m^3 (as Cd)].

Determination in Air: For *(dust):* use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods.[49]

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact causes irritation. Inhalation can cause irritation of the nose and throat and irritation of the lungs with coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Cadmium oxide can cause metal fume fever with chills, headache, aching muscles, metallic taste, and/or fever. Exposure can cause nausea, salivation, vomiting, cramps, and diarrhea. Symptoms for cadmium poisoning include metallic taste in the mouth, headache, shortness of breath; chest pain, cough with foamy or bloody sputum, pulmonary rales, weakness, leg pains, and pulmonary edema. The lethal inhalation dose of cadmium oxide in humans is 2500 mg/m^3 for a minute exposure. Lethal exposure has been established at 50 mg (cadmium)/m^3 for 1 h for cadmium oxide dust and 30 min for the fume. These concentrations may be inhaled without sufficient discomfort to warn worker of exposure. Acute exposure by inhalation may cause death by anoxia. The lowest human toxic inhalation concentration is 8630 μg/m^3/5 h for the fume.

Long Term Exposure: Lungs (tracheobronchitis, pneumonitis), kidneys (possible kidney stones), and liver may be affected or damaged by repeated or prolonged exposure. Cadmium oxide is probably carcinogenic to humans; there is some evidence of lung and prostate cancer. There is limited evidence that this chemical is a teratogen in animals. Long-term exposure can cause anemia, brittle and painful bones, loss of sense of smell, fatigue, and/or yellow staining of teeth. Cancer site: prostate and lung.[NIOSH]

Medical Surveillance: Urine test for cadmium. Urine test for "low-molecular-weight proteins" to detect kidney damage. Urinalysis. Complete blood count (CBC). Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Cadmium fume: (CdO) Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots. Persons with respiratory disorders should be excluded from contact with this material. A Class I, Type B, biological safety hood should be used when mixing, handling, or preparing cadmium oxide. Wear protective gloves and clothing to prevent any skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with cadmium oxide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, away from magnesium, oxidizers, combustible materials, heat, moisture, and acids. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and Packing Group I.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind and out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid but may increase fire activity. Use any extinguishing agent. Poisonous gases are produced in fire, including toxic fumes of cadmium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Form nitrate with HNO_3, precipitate with H_2S, filter, package, and return to supplier.[22]

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 4, 77−83 (Cadmium oxide fumes)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cadmium Oxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Cadmium Oxide*. Trenton, NJ

Cadmium stearate C:0150

Molecular Formula: $C_{36}H_{72}CdO_4$

Common Formula: $Cd(C_{17}H_{36}COO)_2$

Synonyms: Alaixol II; Cadmium octadeconoate; Estearato de cadmio (Spanish); Kadmiumstearat (German); Octadecanoic acid, cadmium salt; Stearic acid, cadmium salt

CAS Registry Number: 2223-93-0

RTECS® Number: RG1050000

UN/NA & ERG Number: UN2570/154

EC Number: 218-743-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: Toxic Pollutant (Section 401.15), as cadmium compounds.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as cadmium stearate; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cadmium stearate is a crystalline solid. Molecular weight = 698.5. Hazard Identification (based on

NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Used as a lubricant and stabilizer in polyvinyl chloride plastics.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0303 mg/m^3

PAC-1: 0.182 mg/m^3

PAC-2: 13 mg/m^3

PAC-3: 54.6 mg/m^3

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *(dust)* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3.

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods.[49]

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Acute poisoning produces severe nausea, vomiting, diarrhea, and abdominal and chest pains. Dry mouth, salivation, and metallic taste have been reported. If ingested, may result in exhaustion, collapse, shock, and death within a period of 24 h. Acute toxicity most notably occurs secondary to cadmium ingestion or inhalation of cadmium fumes. Poisoning from inhalation is relatively rare but dangerous, having a mortality rate of about 15%. Toxic inhaled concentrations in humans have been reported at 147 mg/m^3/35 min and at 1800 μg/m^3/2 years. LD$_{50}$ = (oral-rat) 1125 mg/kg; the oral LD$_{50}$ for mouse is 590 mg/kg.

Long Term Exposure: Yellow rings may be seen in teeth when chronically exposed. A probable human carcinogen and teratogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium stearate you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area, away from incompatible materials. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Cadmium stearate falls under "cadmium compounds" in DOT regulations. It falls in Hazard Class 6.1 and Packing Group III.[19,20]

Spill Handling: Do not touch spilled material. Stay upwind, keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cadmium Stearate*. Washington, DC: Chemical Emergency Preparedness Program

Cadmium sulfate C:0160

Molecular Formula: $O_4S \cdot Cd$

Synonyms: Cadmium monosulfate; Cadmium sulphate; Sulfuric acid, cadmium(2+) salt; Sulfuric acid, cadmium(II) salt; Sulphuric acid, cadmium salt

CAS Registry Number: 10124-36-4; *(alt.)* 31119-53-6; *(alt.)* 62642-07-3

UN/NA & ERG Number: UN2570/154

EC Number: 233-331-6 [*Annex I Index No.*: 048-009-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganic compounds: 0.1%; organic compounds: 1.0%).

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R26; R48/23/25; R62; R63; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cadmium sulfate is a white to colorless, odorless, crystalline substance. Molecular weight = 208.48; Freezing/Melting point = 1000°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 76 g/100 mL at 0°C.

Potential Exposure: Compound Description: Agricultural Chemical Tumorigen; Mutagen; Reproductive Effector. It is used in pigments, electroplating, as a fungicide, and in synthetic and analytical chemistry. Also used in fluorescent screens and as an electrolyte.

Incompatibilities: Incompatible with strong oxidizers, sulfur, selenium, tellurium, zinc. Acts as a weak inorganic acid; neutralizes bases. May ignite combustible materials.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

Protective Action Criteria (PAC)

TEEL-0: 0.00927 mg/m^3

PAC-1: 0.0556 mg/m^3

PAC-2: 0.0927 mg/m^3

PAC-3: 16.7 mg/m^3

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

NIOSH IDLH: 9 mg [Cd]/m^3.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *dust* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3.

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total Cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved Cadmium is determined by 0.45-μ filtration followed by the previously cited methods.[49]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes on contact. Inhalation irritates the nose, throat, and lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Cadmium sulfate can cause nausea, salivation, vomiting, cramps and diarrhea, metal fume fever with flu-like symptoms, chills, headache, weakness, and metallic taste in the mouth.

Long Term Exposure: Repeated exposure can cause anemia, brittle and painful bones, diminished or loss of the sense of smell, fatigue, and/or yellow staining of the teeth. May cause lung and prostate cancer, kidney damage with kidney stones, liver damage, lung damage with bronchitis, cough, phlegm, and/or shortness of breath. There is some evidence that cadmium sulfate is a teratogen in humans.

Points of Attack: Lungs, liver, kidneys, blood.

Medical Surveillance: Urine test for Cd (levels should be less than 10 μg/L of urine). Urine test for low-molecular-weight proteins (β-2-microglobulin) to detect kidney damage. Complete blood count (CBC). Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or

authorized paramedic may consider administering a corticosteroid spray.

Note to physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4—12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium sulfate, you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and metals.

Shipping: DOT label requirement of "POISONOUS/ TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid that may ignite combustible materials. Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Cadmium Sulfate*. Trenton, NJ

Cadmium sulfide C:0170

Molecular Formula: CdS

Synonyms: Aurora yellow; Cadmium golden 366; Cadmium lemon yellow 527; Cadmium monosulfide; Cadmium orange; Cadmium primrose 819; Cadmium sulphide; Cadmium yellow; Cadmium yellow 000; Cadmium yellow 10G concentrate; Cadmium yellow 892; Cadmium yellow conc. golden; Cadmium yellow conc. lemon; Cadmium yellow conc. primrose; Cadmium yellow oz dark; Cadmium yellow primrose 47-4100; Cadmopur golden yellow N; Cadmopur yellow; Capsebon capsebon; C.I. 77199; C.I. Pigment orange 20; C.I. Pigment yellow 37; Ferro lemon yellow; Ferro orange yellow; Ferro yellow; Greenockite; NCI-C02711

CAS Registry Number: 1306-23-6

UN/NA & ERG Number: UN2570/154

EC Number: 215-147-8 [*Annex I Index No.:* 048-010-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganic compounds: 0.1%; organic compounds: 1.0%).

California Proposition 65 Chemical: Cancer 10/1/87.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; R48/23/25; R620; R63; R68; R53 Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cadmium sulfide is an odorless, crystalline, lemon yellow to orange solid. Molecular weight = 144.48; Specific gravity (H_2O:1) = 4.8; Sublimation point = 978°C. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Used in pigments; as an active ingredient in antidandruff shampoos; making photoconductors, solar cells, and other electronic components.

Incompatibilities: Contact with water or moisture releases poisonous hydrogen sulfide gas. Incompatible with oxidizers, hydrogen azide, zinc, selenium, tellurium, and other metals, iodine monochloride, strong acids.

Permissible Exposure Limits in Air

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA.

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood.

NIOSH IDLH: 9 mg [Cd]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.00643 mg/m^3

PAC-1: 0.0386 mg/m^3

PAC-2: 11.6 mg/m^3

PAC-3: 11.6 mg/m^3

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.02 mg/m^3, carcinogen, 1999; France: VME 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.005 mg/m^3, 2003; Japan: 0.05 mg/m^3, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) *(fume)* 0.02 mg/m^3, MAC (STEL) *(fume)* 0.05 mg/m^3, 1999; MAC (TWA) *(dust):* 0.04 mg/m^3, MAC (STEL) *(dust)* 0.2 mg/m^3, 1999; Russia: TWA 0.01 mg/m^3; STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3 (total *dust*), 1999; TWA 0.01 mg/m^3 (respirable *dust*), 1999; Switzerland: MAK-W 0.05 mg/m^3, carcinogen, 1999; Thailand: TWA 0.2 mg/m^3; STEL 0.5 mg/m^3, 1993; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μg/m^3.

Determination in Air: Collection of particles on a filter, workup with acid, and measurement by atomic absorption have been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* [1.05 In (hardness) − 8.53] μg/L as a 24-h average, never to exceed: e[1.05 In (hardness) − 3.73] μg/L at any time. *To protect saltwater aquatic life:* 4.5 μg/L as a 24-h average, never to exceed 59.0 μg/L at any time. EPA[62] and Canada set a limit of 0.005 mg/L in drinking water. Mexico has set a limit of 0.01 mg/L in drinking water. Effluent standards for cadmium in water have been set by Argentina, 0.1 mg/L; Japan, 0.1 mg/L. Drinking water standards have been set[35] by the Czech Republic, 0.010 mg/L; EEC, 5.0 μg/L (0.005 mg/L); Japan, <0.01 mg/L; USSR-UNEP/IRPTC, 0.01 mg/L; WHO, 0.005 mg/L. Further, guidelines for cadmium in drinking water have been set[61] ranging from 5 μg/L (Kansas and Minnesota) to 10 μg/L (Maine).

Determination in Water: Total cadmium may be determined by digestion followed by atomic absorption of colorimetric (Dithizone) analysis or by inductively coupled plasma (ICP) optical emission spectrometry. Dissolved cadmium is determined by 0.45-μ filtration followed by the previously cited methods.[49]

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes on contact. Inhalation irritates the nose, throat, and lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Cadmium sulfid can cause nausea, salivation, vomiting, cramps and diarrhea, metal fume fever with flu-like symptoms, chills, headache, weakness, and metallic taste in the mouth.

Long Term Exposure: Repeated exposure can cause anemia, brittle and painful bones, diminished or loss of the sense of smell, fatigue, and/or yellow staining of the teeth. May cause lung cancer; kidney damage with kidney stones; liver damage; lung damage with bronchitis, cough, phlegm, and/or shortness of breath; damage to the testes; and may damage the developing fetus. There is some evidence that cadmium sulfid is a teratogen in humans.

Points of Attack: Lungs, liver, kidneys, blood.

Medical Surveillance: Urine test for Cd (levels should be less than 10 μg/L of urine). Urine test for low-molecular-weight proteins (β-2-microglobulin) to detect kidney damage. Complete blood count (CBC). Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as Cd compounds): *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium sulfide, you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, dark, well-ventilated area away from oxidizers and metals, strong acids, water or moisture, and other incompatible materials listed above.

Shipping: DOT label requirement of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not* use water. Use dry chemical extinguishers appropriate for metal fires. Poisonous gases are produced in fire, including sulfur oxides and hydrogen sulfide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Cadmium Sulfide*. Trenton, NJ

Calcium C:0200

Molecular Formula: Ca
Synonyms: Calcicat; Calcium metal; Calcium metal, crystalline; Elemental calcium
CAS Registry Number: 7440-70-2
RTECS® Number: EV8040000
UN/NA & ERG Number: UN1401/138; UN1855 (Calcium, pyrophoric)/135
EC Number: 231-179-5 [*Annex I Index No.*: 020-001-00-X]
Regulatory Authority and Advisory Bodies
European/International Regulations: Hazard Symbol: F; Risk phrases: R15; Safety phrases: S2; S8; S24/25; S43 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Calcium is a silvery-white metal when freshly cut, which tarnishes to a blue-gray color in air. It can also be found as a powder. Molecular weight = 40.1; Specific gravity (H_2O:1) = 1.54; Boiling point = 1485°C; Freezing/Melting point = 849°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Reacts with water.
Potential Exposure: Calcium is used as a raw material for aluminum, copper, and lead alloys.
Incompatibilities: Forms hydrogen gas on contact with air; dust may ignite spontaneously. A strong reducing agent; reacts violently with water, acids, strong oxidizers (such as chlorine, bromine and fluorine), alkaline carbonates, dinitrogen tetroxide, halogenated hydrocarbons, lead chloride, halogens, alkaline hydroxides, oxygen, silicon, sulfur, chlorine, fluorine, chlorine trifluoride, and many other substances. Reacts with water to produce flammable hydrogen gas.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 10 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3
Determination in Air: Use NIOSH (IV) Analytical Method #7020 (Calcium).
Routes of Entry: Inhalation of dust.
Harmful Effects and Symptoms
Contact with the dust can severely irritate and burn the eyes and skin. Exposure to the dust can irritate the air passages and lungs. Calcium is a reactive chemical and is an explosion hazard.
Short Term Exposure: Eye contact can cause irritation and possible permanent damage. Skin contact can cause irritation and burns. Inhalation can irritate air passages and lungs, causing coughing and difficult breathing.
Points of Attack: Eyes, skin, and respiratory system.
Medical Surveillance: Lung function tests are recommended on a preemployment and regular postemployment basis.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear chemical goggles and face shield when working with Calcium, unless full face-piece respiratory protection is worn.
Respirator Selection: Where there is potential for exposure to calcium, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.
Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Store in tightly closed containers in a cool, well-ventilated area away from water, moisture, oxidizers, and acids. Wherever calcium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in kerosene or other neutral oil. Do not store large quantities of calcium in rooms with sprinkler systems. A detached fire-resistant building is recommended for large storage.
Shipping: Calcium or calcium alloys must be labeled (UN1401): "DANGEROUS WHEN WET" or (UN1855) "SPONTANEOUSLY COMBUSTIBLE." They fall in (UN1401) Hazard Class 4.3 and Packing Group II; (UN1855) Hazard Class 4.3 and Packing Group I.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered

material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Calcium dust may ignite spontaneously in air. In contact with water or moisture, Calcium releases Hydrogen gas which can be explosive. Containers may explode in fire. Fire may restart after it has been extinguished. Use dry graphite, soda ash, powdered salt, or appropriate metal fire extinguisher. *Do not use water*, CO_2, or dry chemical extinguishers since they are ineffective. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Calcium metal may be burned in an open furnace.[24] When burning calcium waste in a steel pan, dry steam may be directed to the waste with due care to avoid splashing.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Calcium.* Trenton, NJ

Calcium arsenate C:0210

Molecular Formula: $As_2Ca_3O_8$
Common Formula: $Ca_3(AsO_4)_2$
Synonyms: Arsenate de calcium (French); Arseniato calcico (Spanish); Arsenic acid, calcium salt (2:3); Calciumarsenat (German); Calcium orthoarsenate; Chip-Cal®; Cucumber dust; Fencal®; Flac®; Kalo®; Kalziumarseniat (German); Kilmag®; Pencal®; Protars®; Security; Spracal; Tricalciumarsenat (German); Tricalcium arsenate; Tricalcium orthoarsenate
CAS Registry Number: 7778-44-1; *(alt.)* 1333-25-1
RTECS® Number: CG0830000
UN/NA & ERG Number: UN1573
EC Number: 231-904-5 [*Annex I Index No.:* 033-002-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1987.

Banned or Severely Restricted (Thailand) Banned for import, production, having in possession and use as an agricultural pesticide. 12/12/2001.

US EPA, FIFRA, 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: List of high-risk pollutants (Section 63.74) as arsenic compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15) as arsenic compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), listed by name; also listed as calcium arsenate and calcium arsenite, mixtures, solid.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Calcium arsenate is a white flocculent powder. It is not combustible. Molecular weight = 398.1. Boiling point = (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.01% at 77°C.

Potential Exposure: Compound Description: Agricultural Chemical Tumorigen. Workers engaged in manufacture, formulation, and application of pesticides containing calcium arsenate.

Incompatibilities: None reported, according to NIOSH. When heated produces arsenic fumes.

Permissible Exposure Limits in Air

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 [15 min] Ceiling Concentration. Limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.0266 mg/m^3
PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3
PAC-3: 13.3 mg/m^3
DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301, #7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: No criteria set for calcium arsenate. See "Arsenic" entry.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Can cause poor appetite, a metallic or garlic taste, nausea, vomiting, stomach pain, diarrhea, abnormal heart rhythm, seizures, pain in extremities and muscles, weakness, flushing of skin, numbness and tingling in extremities, intense thirst, and muscular cramps, delirium, and possible death. Kidney failure may occur. Jaundice may appear within an hour. In severe poisoning, death can occur within an hour, but the usual interval is 24 h. This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. It is an irritant to eyes, respiratory tract, mouth, and stomach.

Long Term Exposure: Calcium arsenate is a carcinogen in humans and may be a reproductive hazard. Damage to kidneys, liver and the nervous system has been reported. Chronic exposure can cause bone marrow damage, often leading to aplastic anemia. Long-term exposure can cause an ulcer in the septum dividing the inner nose. High or repeated exposure may damage the nerves, causing weakness and poor coordination in the limbs. Repeated skin contact can cause thickened skin and/or patch areas of darkening and loss of pigment. Some may develop white lines on the nails. There is epidemiological evidence that chronic ingestion of arsenic compounds causes a predisposition to skin cancers. A rebuttable presumption against pesticide registration was issued on October 18, 1978 by US EPA on the basis of oncogenicity, teratogenicity, and mutagenicity.

Points of Attack: Eyes, respiratory system, liver, skin, lymphatics, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Examination of the nose, eyes, nails, and nervous system. Liver function tests. Tests for urine arsenic. NIOSH recommends urine arsenic should not exceed 100 μg/g creatine in the urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic.*"

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Calcium arsenate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The DOT label requirement[19] is "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fires. Poisonous gases are produced in fire, including arsenic. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Long-term storage in large, weatherproof, and sift-proof storage bins or silos; small amounts may be disposed in a chemical waste landfill. Alternatively, dissolve in HCl, precipitate as sulfide, with H_2S, dry, and return to supplier.[23]

References

National Institute for Occupational Safety and Health. (1974). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Arsenic*, NIOSH Document No. 74-110. Washington, DC

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 89−91

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Calcium Arsenate*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Calcium Arsenate*. Trenton, NJ

Calcium carbide C:0220

Molecular Formula: C_2Ca

Common Formula: CaC_2

Synonyms: Acetylongen; Calcium acetylide; Calcium dicarbide; Carbide, acetylenogen

CAS Registry Number: 75-20-7

RTECS® Number: EV9400000

UN/NA & ERG Number: UN1402/138

EC Number: 200-848-3 [*Annex I Index No.*: 006-004-00-9]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: F; Risk phrases: R15; Safety phrases: S2; S8; S43 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium carbide is grayish-black granules, powder, or lumps. Slight garlic odor. Molecular weight = 64.1; Specific gravity (H_2O:1) = 2.23; Boiling point ≥ 447°C; Freezing/Melting point = about 2300°C.

Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩ (water reactive).

Potential Exposure: Those involved in the manufacture and handling of carbide and the generation of acetylene.

Incompatibilities: Water contact or moist air forms calcium hydroxide and explosive acetylene gas with risk of fire and explosion. Keep away from acids, oxidizers, hydrogen chloride, methanol, copper salt solutions, lead fluoride, magnesium, selenium, silver nitrate, iron trichloride, tin dichloride, sodium peroxide, stannous chloride, sulfur.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 10 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Irritation of skin, eyes and respiratory tract. Inhalation of dust may cause lung edema.

Short Term Exposure: Corrosive. Contact with eyes or skin causes severe irritation and burns with possible permanent eye damage and ulcers to the skin. Irritates the lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can irritate the lungs. Exposure may cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, and respiratory tract.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—Green: General storage may be used. Prior to working with calcium carbide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and without sprinkler protection and avoid contact with incompatible materials. Use only nonsparking tools and equipment especially when opening and closing containers of calcium carbide. Metal containers involving the transfer of this chemical should be grounded and bonded. Use explosion-proof electrical equipment in the carbide-handling area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Calcium carbide requires a "DANGEROUS WHEN WET" label. It falls in Hazard Class 4.3 and Packing Groups I or II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Wet calcium carbide produces highly flammable acetylene gas. Dry calcium carbide itself is not flammable. *Do not use water*, foam, carbon dioxide, or halogen extinguishers on fire. Use dry chemical, sand, soda ash, or lime extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mixing with large quantity of water using pilot flame to ignite evolved acetylene. Lime residue sent to landfill.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 91−93

New Jersey Department of Health and Senior Services. (March 2003). *Hazardous Substances Fact Sheet: Calcium Carbide*. Trenton, NJ

Calcium carbonate C:0230

Molecular Formula: $CCaO_3$

Common Formula: $CaCO_3$

Synonyms: Agricultural limestone; Agstone; Aragonite; Atomit; Bell mine pulverized limestone; Calcite; Calcium (II)carbonate (1:1); Carbonic acid, calcium salt (1:1); Chalk; Dolomite; Franklin; Limestone; Lithographic stone; Marble; Portland stone; Sohnhofen stone; Vaterite. The monocarbonate is an FDA and foreign over-the-counterdrug with more than 250 registered trade names.

CAS Registry Number: 471-34-1; 1317-65-3 (dolomite; limestone)

RTECS® Number: EV9580000; FF9335000 (monocarbonate)

EC Number: 207-439-9; 215-279-6 (limestone)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Calcium carbonate is a white, odorless powder, or crystalline solid. Molecular weight = 100.09; Specific gravity (H_2O:1) = 2.7−2.95; Freezing/Melting point = 825−1339°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Very slightly soluble in water; solubility = 0.001%. In some of the literature monocarbonate (CAS 471-34-1) is listed: Freezing/Melting point = 825°C (decomposes).

Potential Exposure: Compound Description: Primary Irritant (monocarbonate). Calcium carbonate is used as a source of lime, as a neutralizing agent, in manufacturing of rubber, plastics, paint and coatings, sealants, paper, dentifrices, ceramics, putty, polishes and cleaners, insecticides, inks and cosmetics, whitewash, Portland cement, antacids, in analytical chemistry, and others.

Incompatibilities: Calcium carbonate decomposes in high temperature forming carbon dioxide and corrosive materials. Reacts with acids producing carbon dioxide gas release. Incompatible with acids, ammonium salts, fluorine. NIOSH also lists alum as incompatible but this is questionable.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (respirable fraction) TWA; 5 mg/m^3 (total dust) TWA.

NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 (respirable dust) TWA.

ACGIH TLV®[1]: Withdrawn.

Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 75 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

Dolomite; limestone
TEEL-0: 15 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 500 mg/m^3

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Poland: MAC (TWA) dust 10 mg/m^3, 1999; Russia: STEL 6 mg/m^3, 1993; Switzerland: MAK-W 6 mg/m^3 (respirable dust), 1999; United Kingdom: TWA 10 mg/m^3, total inhalable dust, 2000; TWA 4 mg/m^3, respirable dust, 2000; the Netherlands: MAC-TGG 10 mg/m^3, for regular and monocarbonate, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3.(E)

Determination in Air: NIOSH Analytical Method #7020 (Calcium), Method #7303, or OSHA Analytical Method ID-121. See also NIOSH Analytical Methods #0500 for nuisance dust, total, and 0600 for nuisance dust, respirable.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause irritation to nose. Eye contact can cause irritation. *Ingestion:* Large amounts can cause irritability, nausea, dehydration, and constipation. Estimated lethal dose is over 2 lb.

Long Term Exposure: Ingestion of more than 8 g (1/3 oz) a day can cause blood and kidney disorders.

Points of Attack: Eyes, respiratory system, digestive system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear safety glasses.

Respirator Selection: Wear dust mask.

Storage: Color Code—Green: General storage may be used. Store to avoid contact with acids.

Shipping: The DOT Performance-Oriented Packaging Standards[19] do not cite calcium carbonate.

Spill Handling: Scoop up and place in suitable container. Discard with regular trash.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding materials.

Disposal Method Suggested: Landfills.

Reference

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Calcium Carbonate*. Albany, NY: Bureau of Toxic Substance Assessment

Calcium chlorate C:0240

Molecular Formula: $CaCl_2O_6$

Common Formula: $Ca(ClO_3)_2$

Synonyms: Calcium chlorate aqueous solution; Chlorate de calcium (French); Chloric acid, calcium salt

CAS Registry Number: 10137-74-3

RTECS® Number: FN9800000

UN/NA & ERG Number: UN1452 (solid)/140; UN2429 (solution)/140

EC Number: 233-378-2

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Calcium chlorate forms white to yellow deliquescent crystals. Molecular weight = 243; Specific gravity (H_2O:1) = 2.71; Freezing/Melting point = 340° (loses H_2O of crystallization at >100°). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0; oxidizer. Highly soluble in water.

Potential Exposure: Calcium chlorate is used in making fireworks, herbicides (weed killers), and in photography.

Incompatibilities: A strong oxidizer. Reacts, possibly with risk of fire and explosion, with acids (especially organic acids), reducing agents, aluminum, arsenic, chemically active metals, combustible materials, ammonium compounds, charcoal, copper, cyanides, manganese dioxide, metal sulfides, phosphorus, sulfur.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Calcium chlorate can affect you when breathed in. Contact can irritate the skin and eyes. Inhalation can cause irritation of the respiratory tract. Calcium chlorate may damage the kidneys. Very high exposures can interfere with the ability of the blood to carry oxygen, causing headaches, dizziness, weakness, a bluish skin color, and even death. High exposures can cause death. LD_{50} = (oral-rat) 4500 mg/kg.[41]

Long Term Exposure: Can affect the kidneys, liver, heart, and blood.

Points of Attack: Eyes, skin, respiratory system, blood.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level. EKG. Kidney and liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Avoid skin contact with Calcium chlorate. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to Calcium chlorate, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European

Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric) and chemically active metals (such as potassium, sodium, magnesium and zinc). Calcium chlorate must be stored to avoid contact with organic matter, ammonium compounds, aluminum, copper, cyanides, flammable vapors, and other oxidizable materials since violent reactions occur. Avoid storage on wood floors. Friction, heat, or physical shocks may cause calcium chlorate to ignite and explode. Wherever calcium chlorate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Calcium chlorate requires an "OXIDIZER" label. It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: *For dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

For solution: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid that increases the combustion of other substances. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For barium chlorate, the UN[22] recommends using a vast volume of a reducing agent (bisulfites, ferrous salts or hypo) followed by neutralization and flushing to the sewer with abundant water. This should be applicable here as well.

Reference

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Calcium Chlorate.* Trenton, NJ

Calcium chloride C:0250

Molecular Formula: $CaCl_2$

Synonyms: Calcium chloride, anhydrous; Calplus; Caltac

CAS Registry Number: 10043-52-4; 7774-34-7 (hexahydrate); 22691-02-7 (hydrate)

RTECS® Number: EV9800000

EC Number: 233-140-8 [*Annex I Index No.:* 017-013-00-2] (*10043-52-4*)

Regulatory Authority and Advisory Bodies

European/International Regulations (*22691-02-7*): Hazard Symbol: Xi; Risk phrases: R11; R36; Safety phrases: S2; S22; S24 S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium chloride is a colorless to off-white crystalline solid which is deliquescent (absorb water). When heated, crystals lose water at 100°C. Molecular weight = 111; Specific gravity (H_2O:1) = 2.16; Boiling point = 1935°C (decomposes); Freezing/Melting point = 772°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water; solubility = 75% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Hormone. Calcium chloride is used as road salt for melting snow, a drying agent in desiccators, for dehydrating organic liquids and gases, in refrigeration brines and antifreeze, as a dust-proofing agent, food additive, concrete hardening accelerator, and others.

Incompatibilities: The solution in water is a weak base. Reacts with zinc in presence of moisture, forming highly flammable hydrogen gas. Dissolves violently in water with generation of much heat. Incompatible with water, bromine trifluoride; 2-furan, percarboxylic acid. May attack some building materials and metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 400 mg/m^3

Hexahydrate

TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 100 mg/m^3
PAC-3: 500 mg/m^3

Hydrate

TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 450 mg/m^3

Routes of Entry: Inhalation of dust; ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation of dust may cause burning, irritation of the nose, mouth and throat, nose bleeds, and breakdown of nasal tissue. Contact with dry skin may cause severe irritation. Contact with wet skin or concentrated solutions can cause more severe irritation and burns. Ingestion may cause irritation of the mouth, throat and stomach, nausea, and vomiting. Eye contact may cause irritation, burning, and some damage to the surface of the eye. LD_{50} = (oral-rat) 1000 mg/kg (slightly toxic).

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Prolonged or repeated inhalation may cause ulcerations of the nasal mucous membrane.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear goggles or face shield if eye hazard exists, coveralls and rubber gloves. Natural rubber, Neoprene™, and polyvinyl chloride are among the recommended protective materials.

Respirator Selection: Dust mask or dust respirator may be helpful in preventing inhalation exposures.

Storage: Keep tightly sealed in a cool, dry place away from incompatible materials.

Shipping: There are no label or maximum shipping quantity requirements set by DOT.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material, and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add large volumes of water. Add excess soda ash, then neutralize with HCl. Route to sewage plant or use as landfill sludge.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Calcium Chloride.* Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report,* 2, No. 1, 93−94

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Calcium chromate C:0260

Molecular Formula: $CaCrO_4$

Synonyms: Calcium chromate(IV); Calcium chrome yellow; Calcium chromium oxide; Calcium monochromate; Chromato calcico (Spanish); Chromic acid, calcium salt (1:1); C.I. 77223; C.I. Pigment yellow 33; Gelbin; Yellow ultramarine

CAS Registry Number: 13765-19-0

RTECS® Number: GB2750000

UN/NA & ERG Number: UN3288 (Toxic solids inorganic)/151

EC Number: 237-366-8 [*Annex I Index No.:* 024-008-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U032.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Calcium chromate is a yellow crystalline solid, often used in solution. Odorless. It normally occurs as the dehydrate and loses water at 200°C. Molecular weight = 192.1. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Calcium chromate is used as a pigment, as a corrosion inhibitor, in the manufacture of chromium, in oxidizing reactions, and in battery depolarization.

Incompatibilities: A strong oxidizer. Incompatible with boron (violent reaction), ethanol, combustibles, organic, or other easily oxidized materials.

Permissible Exposure Limits in Air

As chromium(VI), inorganic insoluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3

Protective Action Criteria (PAC)

TEEL-0: 0.000261 mg/m^3

PAC-1: 0.125 mg/m^3

PAC-2: 0.75 mg/m^3

PAC-3: 45 mg/m^3

DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are less than the limits listed above. Two states have set guidelines or standards for calcium chromate in ambient air[60] ranging from zero for North Carolina to 0.0008 μg/m^3 for Massachusetts.

Determination in Air: Use NIOSH Analytical Method (IV) #7024, Chromium.

Permissible Concentration in Water: See entry in "Chromium" for priority toxic pollutant limits in water.

Determination in Water: By atomic absorption (AA) using either direct aspiration into a flame or a furnace technique.[49]

Routes of Entry: Skin contact, inhalation of dust, ingestion. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Exposure to 0.18−1.4 mg/m^3 can cause irritation of nose and throat within 2 weeks, disintegration of nasal tissue, coughing, wheezing, headache, painful breathing, and fever within 8 weeks. Skin contact can cause severe irritation. Contact with damaged skin can cause deep sores known as "chrome holes." Eye contact can cause severe chemical burns and possible loss of vision. Ingestion can cause severe sore throat and irritation of the throat, stomach and intestine, which can develop into tissue damage.

Long Term Exposure: Calcium chromate is a carcinogen in humans and has been shown to cause cancer of lung, liver, bladder, etc. Inhalation can cause breakdown of nasal tissue and a hole in the septum dividing the inner nose. Exposed persons may develop skin allergy, bronchitis, lung allergy, and kidney damage.

Points of Attack: Lungs, kidneys, skin, respiratory system, eyes, gastrointestinal system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following is recommended before beginning work and at regular times after that: Urine test for chromates. This test is most accurate shortly after exposure. Examination of the skin and nose. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing; may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. (as chromic acid and chromates); **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- (if using solution) or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, Chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue (carcinogen): Health Hazard: Store in a secure poison location. Calcium chromate must be stored to avoid contact with combustible, organic, or other easily oxidized materials (such as paper, wood, sulfur, aluminum, hydrazine and plastics) since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solution: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chromium fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reduce to trivalent chromium and precipitate as chromium(III) hydroxide. Compact the sludge and dispose in single purpose special waste dumps.[22]

References

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Calcium Chromate (VI)*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency. (March 31, 1987). *Health Advisory: Chromium.* Washington, DC: Office of Drinking Water

US Public Health Service. (October 1987). *Toxicological Profile for Chromium.* Washington, DC: Agency for Toxic Substance and Disease Registry

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Calcium Chromate*. Trenton, NJ

Calcium cyanamide C:0270

Molecular Formula: $CCaN_2$

Common Formula: $CaCN_2$

Synonyms: Aero-cyanamid; Aero-cyanamid, Special grade; Alzodef; Calcium carbimide; Calcium cyanamid; CCC; Cianamida calcica (Spanish); Cyanamid; Cyanamide; Cyanamide calcique (French); Cyanamide, calcium salt (1:1); Cyanamid granular; Cyanamid special grade; Cy-L 500; Lime nitrogen; NCI-C02937; Nitrogen lime; Nitrolime; USaF Cy-2

CAS Registry Number: 156-62-7

RTECS® Number: GS6000000

UN/NA & ERG Number: UN1403 (Calcium cyanamide, with more than 0.1% Calcium carbide)/138

EC Number: 205-861-8 [*Annex I Index No.:* 615-017-00-4]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R37; R41; Safety phrases: S2; S22; S26; S36/37/S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Calcium cyanamide is a blackish-gray, shiny crystalline material or powder. Molecular weight = 80.11; Specific gravity (H_2O:1) = 2.29; Freezing/Melting point = 1340°C (sublimes >1500°C). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Insoluble in water; reaction.

Potential Exposure: Compound Description: Agricultural Chemical Tumorigen, Mutagen; Human Data. Calcium cyanamide is used in agriculture as a fertilizer, herbicide, defoliant for cotton plants, and pesticide. It is also used in the manufacture of dicyandiamide and calcium cyanide as a desulfurizer in the iron and steel industry and in steel hardening.

Incompatibilities: Commercial grades of calcium cyanamide may contain calcium carbide; contact with any form of moisture solutions may cause decomposition, liberating explosive acetylene gas and ammonia. May polymerize in water or alkaline solutions to dicyanamide. Contact with all solvents tested also causes decomposition.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg/m^3 TWA, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 75 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK 1 mg/m^3, measured as the inhalable fraction, [skin]; Peak Limitation Category II(2).

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3 [skin] 1999; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, 1999; France: VME 0.5 mg/m^3, 1999; Norway: TWA 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Switzerland: MAK-W 0.5 mg/m^3 [skin] 1999; United Kingdom: LTEL 0.5 mg/m^3; STEL 1 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

The former USSR-UNEP/IRPTC joint project[43] set a MAC of 0.02 mg/m^3 in ambient residential air either on a momentary or on a daily average basis. Several states have set guidelines or standards for calcium cyanamide in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; IV NIOSH Analytical Method #0500, Particulates NOR, total dust.

Permissible Concentration in Water: The former USSR-UNEP/IRPTC joint project[43] set a MAC of 1.0 mg/L in water for domestic purposes.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Calcium cyanamide can cause nausea, headache, dizziness, and flushing of the skin. It is a primary irritant of the mucous membranes of the respiratory tract, eyes, and skin. Drinking alcohol shortly before or within 1−2 days after exposure can cause a severe reaction. Inhalation may result in rhinitis, pharyngitis, laryngitis, and bronchitis. Conjunctivitis, keratitis, and corneal ulceration may occur. An itchy erythematous dermatitis has been reported and continued skin contact leads to the formation of slowly healing ulcerations on the palms and between the fingers. Sensitization occasionally develops. Chronic rhinitis and perforation on the nasal septum have been reported after long exposures. All local effects appear to be due to the caustic nature of cyanamide.

Long Term Exposure: Calcium cyanamide may damage the developing fetus. This chemical may damage the nervous system causing numbness and weakness in the hands and feet. Prolonged contact can cause skin ulcers. It causes a characteristic vasomotor reaction. There occurs erythema of the upper portions of the body, face, and arms accompanied by nausea, fatigue, headache, dyspnea, vomiting, oppression in the chest, and shivering. Circulatory collapse may follow in the more serious cases. The vasomotor response may be triggered or intensified by alcohol ingestion. Pneumonia or lung edema may develop. Cyanide ion is not released in the body, and the mechanism of toxic action is unknown.

Points of Attack: Eyes, skin, respiratory system, vasomotor system.

Medical Surveillance: Examination of the nervous system. Evaluation by a qualified allergist. Evaluate skin, respiratory tract, and history of alcohol intake in placement or periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. In addition to personal protective equipment, waterproof barrier creams may be used to provide additional face and skin protection.

Respirator Selection: *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with calcium cyanamide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Calcium cyanamide with more than 1% calcium carbide requires a "DANGEROUS WHEN WET" label. It falls in Hazard Class 4.3 and Packing Group III.[19]

Spill Handling: Restrict persons not wearing protective equipment from area of spill until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing calcium cyanamide in vermiculite, dry sand, earth, or similar material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Do not use foam extinguishers or water. Use dry chemical, soda ash, or lime. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report,* 2, No. 6, 38−41

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration,*

Reregistration, and Special Review (Rainbow Report). Washington, DC
New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Calcium Cyanamide*. Trenton, NJ

Calcium cyanide C:0280

Molecular Formula: C_2CaN_2
Common Formula: $Ca(CN)_2$
Synonyms: Calcid; Calcyan; Calcyanide; Cianuro calcico (Spanish); Cyanogas; Cyanure de calcium (French)
CAS Registry Number: 592-01-8
RTECS® Number: EW0700000
UN/NA & ERG Number: UN1575/157
EC Number: 209-740-0 [*Annex I Index No.:* 020-002-00-5]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): P021.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions, or cyanides, inorganic, n.o.s.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as cyanide compounds, inorganic, n.o.s.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R28; R32; R50/53; Safety phrases: S1/2; S7/8; S23; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Calcium cyanide is a white crystalline solid or powder. Odor of hydrogen cyanide. Molecular weight = 92.12; Specific gravity (H_2O:1) = 1.853 at 20°C; Freezing/Melting point $\geq$ 350°C (dangerous decomposition below MP). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; violent reaction.

Potential Exposure: Calcium cyanide is used as a fumigant, as a rodenticide, in leaching precious metal ores, in the manufacture of stainless steel, and as a stabilizer for cement. Used as raw material for production of nitrogenous compounds and in treatment of alcoholism.

Incompatibilities: Contact with water, acids, acidic salts, moist air, or carbon dioxide, forms highly toxic and flammable hydrogen cyanide. Incompatible with fluorine, magnesium. Reacts violently when heated with nitrites, nitrates, chlorates, and perchlorates. Calcium cyanide decomposes in high heat forming hydrogen cyanide and nitrous oxides fumes.

Permissible Exposure Limits in Air
OSHA PEL: 5 ppm[CN] TWA.
NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 min] Ceiling Concentration.
ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.
Protective Action Criteria (PAC)*
TEEL-0: 3.8 mg/m^3
PAC-1: **3.8** mg/m^3
PAC-2: **13** mg/m^3
PAC-3: **28** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
NIOSH IDLH: 25 mg[CN]/m^3.
DFG MAK: 2 mg[CN]/m^3 inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.
The former USSR-UNEP/IRPTC Project[43] set a MAC of 0.3 mg/m^3.

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: A limit of 0.2[CN]$^-$/L has been set by US EPA[6] as part of the priority toxic pollutant program.

Routes of Entry: Can be absorbed through the skin, inhalation, ingestion.

Harmful Effects and Symptoms
Calcium cyanide is highly toxic. The lethal human dose is 18 mg/kg. The hazard is that of hydrogen cyanide. The dust is irritating to the eyes, nose, and throat.[41] Inhalation or ingestion causes headache, nausea, vomiting, and weakness; high concentrations are rapidly fatal.

Short Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the central nervous system, blood, heart, and respiratory tract.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May be a reproductive toxin in humans.

Points of Attack: Skin, lungs.

Medical Surveillance: Lung function tests. Examination by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Do not allow water to enter nose or mouth. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Calcium cyanide you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from moisture, water, acids, and oxidizers. Protect against physical damage to containers.

Shipping: Calcium cyanide requires a “POISONOUS/TOXIC MATERIALS” label. It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep material out of drains, sewers, streams. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical or dry sand. Do not use foam, water, carbon dioxide. Poisonous gases are produced in fire, including phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add cyanide waste to strong alkaline sodium hypochlorite. Let stand 24 h and then flush to sewage plant.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 95−96

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Calcium fluoride C:0290

Molecular Formula: CaF_2

Synonyms: Calcium difluoride; Fluorite; Fluorspar; Fluospar; Met-Spar

CAS Registry Number: 7789-75-5

RTECS® Number: EW1760000

EC Number: 232-188-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium fluoride is colorless crystalline or white, powdery substance. Molecular weight = 78.08; Specific gravity (H_2O:1) = 3.18 at 20°C; Boiling point = 2495°C; Freezing/Melting point = 1423°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector. Calcium fluoride is used for production of hydrofluoric acid, as a flux in steel manufacture, in smelting, electric arc welding, making glass and ceramics, and to fluoridate drinking water.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 5.14 mg/m^3

PAC-1: 15.4 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause difficult breathing, burning of mouth, throat, and nose which may result in bleeding. These may be felt at 7.5 mg/m^3. Nausea, vomiting, profuse sweating, and excess thirst may occur at higher levels. *Skin:* May cause rash, itching, and burning. Solutions of 1% strength may cause sores if not removed promptly. *Eyes:* May cause severe irritation. *Ingestion:* Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. 5−40 mg may cause nausea, diarrhea, and vomiting. More severe symptoms of burning and painful abdomen, sores in mouth, throat and digestive tract, tremors, convulsions, and shock will occur from about 1 g. Death may result by ingestion of 2−5 g (1/6 oz).

Long Term Exposure: Repeated exposure may cause poor appetite, nausea, constipation, or diarrhea. Repeated exposure to fluoride chemicals may cause stiffness in muscles or ligaments and even crippling; this could take years to develop. Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 mg/m^3 or higher. Mottling of the teeth may occur at this level.

Points of Attack: Eyes, skin, respiratory system, bones.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Urine fluoride level (normal is less than 4 mg/L).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. A doctor or authorized paramedic may consider administering aluminum hydroxide gel, if conscious.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) *_if not present as a fume_ (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from acids and chemically active metals (such as potassium, sodium, magnesium, and zinc) because corrosive hydrogen fluoride will be produced.

Shipping: Calcium fluoride is not specifically covered by DOT[19] in its Performance-Oriented Packaging Standards.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 47−48

New Jersey Department of Health and Senior Services. (May 1986). *Hazardous Substances Fact Sheet: Calcium Fluoride*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Calcium Fluoride*. Albany, NY: Bureau of Toxic Substance Assessment

Calcium hydride C:0293

Molecular Formula: CaH_2

Synonyms: Calcium Dihydride; Hydrolith

CAS Registry Number: 7789-78-8; 57308-10-8 [calcium hydrogen (-1) ion]

RTECS$^{®}$ Number: EW2440000

UN/NA & ERG Number: UN1404/138

EC Number: 232-189-2

Description: Calcium hydride is a grayish-white crystalline solid. Molecular weight = 60.24; Freezing/Melting point = 816°C (it decomposes at about 600°C). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 3₩ (water reactive).

Potential Exposure: Calcium hydride is used as a drying and reducing agent and a cleaner for blocked up oil wells.

Incompatibilities: Reacts with water, moist air, and steam, releasing flammable hydrogen gas and may self-ignite in air. Incompatible with metal halogenates, silver fluoride, and tetrahydrofuran.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

7789-78-8

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 35 mg/m^3

PAC-3: 150 mg/m^3

Permissible Concentration in Water: No criteria set (calcium hydride reacts with water in any event).

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Calcium hydride can affect you when breathed in. Contact with skin or eyes can cause severe burns. Exposure can irritate the eyes, nose, and throat. Breathing Calcium hydride can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: Although it is unknown whether calcium hydride causes lung damage, similar very irritating substances are capable of causing lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium hydride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to Calcium hydride use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Calcium hydride must be stored to avoid contact with water or steam since violent reactions occur and flammable hydrogen gas is produced. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Calcium hydride should carry a "DANGEROUS WHEN WET" label. It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not use any hydrous (water, foam, etc.) extinguishing agents.* Fire may restart after it has been extinguished. Use dry chemical, soda ash, or lime extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Calcium Hydride.* Trenton, NJ

Calcium hydroxide C:0295

Molecular Formula: CaH_2O_2

Common Formula: $Ca(OH)_2$

Synonyms: Bell mine; Calcium hydrate; Carboxide; Hydrated kemikal; Hydrated lime; Lime water; Slaked lime
CAS Registry Number: 1305-62-0
UN/NA & ERG Number: Not regulated.
RTECS® Number: EW2800000
EC Number: 215-137-3
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium hydroxide is a soft white crystalline, odorless powder with an alkaline, bitter taste. Molecular weight = 74.11; Freezing/Melting point = 580°C (decomposes; dehydrates to calcium oxide). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2. Insoluble in water.
Note: Readily absorbs CO_2 from air to form calcium carbonate.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Primary Irritant. Calcium hydroxide is used in agriculture and in fertilizer manufacture, in the formulation of mortar, plasters and cements, and as a scrubbing and neutralizing agent in the chemical industry. It is also used for making insecticides, acaricides, and products to control arthropods.[ESIS]

Incompatibilities: May react violently with acids, maleic anhydride, nitromethane, nitroethane, nitropropane, nitroparaffins, and phosphorus.

Permissible Exposure Limits in Air
OSHA PEL: 15 mg/m^3 (total dust) TWA; 5 mg/m^3 TWA, respirable fraction.
NIOSH REL: 5 mg/m^3 TWA.
ACGIH TLV®[1]: 5 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 75 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; Poland: AC (TWA) 2 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3. Several states have set guidelines or standards for calcium hydroxide in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Filter collection followed by atomic absorption analysis. Use NIOSH Analytical Method #7020 for Calcium. See also OSHA Analytical Method ID-121.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms
Short Term Exposure: A corrosive. *Inhalation:* May cause severe irritation to mouth, throat, and lungs if dust is inhaled. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* May cause painful irritation and chemical burns on contact with open cuts or sores or on prolonged contact with intact skin. *Eyes:* Powders and slurries may cause severe chemical burns. Blindness can result. *Ingestion:* Powders, crystals, or slurries may give rise to irritation, soreness, and chemical burns. The estimated lethal dose is about 1 lb.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure to dust particles.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Prevent skin contact. Gloves, eye protection, and coveralls should be worn if contact with calcium hydroxide is likely. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): natural rubber gloves, Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots.

Respirator Selection: A dust mask or respirator with dust cartridges.

Storage: Color Code—Green: General storage may be used. Keep containers tightly closed. Store away from incompatible materials listed above.

Shipping: Calcium hydroxide is not specifically cited by DOT.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill or admixture with acid industrial wastes prior to lagooning.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 48−50

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Calcium Hydroxide*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Calcium Hydroxide*. Trenton, NJ

Calcium hypochlorite C:0300

Molecular Formula: $CaCl_2O_2$

Common Formula: $Ca(OCl)_2$

Synonyms: B-K powder; Bleaching powder; Calcium chlorohydrochlorite; Calcium hypochloride; Calcium oxychloride; Caporit; CCH; Chloride of lime; Chlorinated lime; Hipoclorito calcico (Spanish); HTH; Hy-Chlor; Hypochlorous acid, calcium; Hyporit; Induclor; Lime chloride; Lo-Bax; Losantin; Perchloron; Pittabs; Pittchlor; Pittcide; Prestochlor; Pulsar; Stellos

CAS Registry Number: 7778-54-3

RTECS® Number: NH3485000

UN/NA & ERG Number: UN1748 [mixtures dry with >39% available chlorine (8.8% available oxygen)]/140; UN2208 (with >10% but not >39% available Cl)/140; UN2880 (hydrated mixtures, with not <5.5% but not >10% water)/140

EC Number: 231-908-7 [*Annex I Index No.:* 017-012-00-7]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: O, C, N; Risk phrases: R8; R22; R31; R34; R50; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Calcium hypochlorite is a white powder, granule or pellets with a strong chlorine-like odor. Molecular weight = 142.98; Freezing/Melting point = about 100°C [decomposes (possibly explosively)]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Soluble in water; reacts slowly releasing chlorine gas; solubility = 21% at 25°C.

Potential Exposure: Calcium hypochlorite is used to kill algae and bacteria, in bleach, and in pool chemical products.

Incompatibilities: A strong oxidizer. Decomposes in heat or sunlight; becomes explosive above 100°C/212°F. Incompatible with strong acids, water and other forms of moisture, reducing agents, combustible materials, all other chemicals, especially acetylene, aniline and all other amines, anthracene, carbon tetrachloride, iron oxide, manganese oxide, mercaptans, diethylene glycol monomethyl ether, nitromethane, organic matter, organic sulfides, phenol, 1-propanethiol, propyl mercaptan, sulfur, turpentine, organic sulfur compounds.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 350 mg/m^3

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Calcium hypochlorite can affect you when breathed in. Calcium hypochlorite may cause mutations. Handle with extreme caution. Exposure can severely irritate the eyes, nose, and throat. Contact can severely irritate the skin. Exposure can severely irritate the "voice box" (larynx), bronchial tubes, and lungs. Higher levels can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: Repeated or prolonged contact can irritate the lungs; may cause bronchitis.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Avoid skin contact with Calcium hypochlorite. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene™, and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof goggles and face shield when working with powders or dust unless full-facepiece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to Calcium hypochlorite, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet, in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with Calcium hypochlorite you should be trained on its proper handling and storage. Calcium hypochlorite must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), ammonium compounds (such as ammonia and ammonium hydroxide), and amines (such as aniline) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and combustibles (such as wood, paper, or oil). When heated above 100°C, Calcium hypochlorite becomes explosive. Protect containers against physical damage. Avoid storage for long periods, particularly at summer temperatures. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Calcium hypochlorite must be labeled "OXIDIZER." They fall in DOT Hazard Class 5.1 and UN1748 and UN2880 are in Packing Group II while UN 2208 is in Packing Group III.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1748 (calcium hypochlorite, dry) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: This chemical is a strong oxidizer and will increase the intensity of any fire. Use water only. *Do not use chemical or carbon dioxide extinguishers*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve the material in water and add to a large volume of concentrated reducing agent solution, then acidify the mixture with H_2SO_4. When reduction is complete, soda ash is added to make the solution alkaline. The alkaline liquid is decanted from any sludge produced, neutralized, and diluted before discharge to a sewer or stream. The sludge is landfilled.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report,* 1, No. 8, 50−52 (1981) and 4, No. 3, 76−79 (1984)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Calcium Hypochlorite*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Calcium Hypochlorite.* Trenton, NJ

Calcium nitrate C:0310

Molecular Formula: CaN_2O_6

Common Formula: $Ca(NO_3)_2$

Synonyms: Calcium(II) nitrate (1:2); Lime saltpeter; Nitric acid, calcium salt; Nitrocalcite; Norwegian saltpeter

CAS Registry Number: 10124-37-5; 13477-34-4 (tetrahydrate)

RTECS® Number: EW2985000

UN/NA & ERG Number: UN1454/140

EC Number: 233-332-1

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium nitrate is a colorless, moisture absorbing crystalline material. Molecular weight = 164.1; Specific gravity (H_2O:1) = 2.50 at 18°C; Freezing/Melting point = 561°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3, Oxidizer. Soluble in water.

Potential Exposure: It is used to make explosives, fertilizers, matches, fireworks, and other industrial products.

Incompatibilities: A strong oxidizer. Incompatible with combustible materials, reducing agents, organics and other oxidizable materials, chemically active metals, aluminum nitrate, ammonium nitrate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 125 mg/m^3

Routes of Entry: Eyes, skin, respiratory system.

Harmful Effects and Symptoms

Short Term Exposure: Calcium nitrate can irritate the skin, eyes, nose, throat, bronchial tubes, and lungs. Overexposure may cause nausea and vomiting, headaches, flushing, weakness, faintness, and collapse. Severe overexposure can cause nausea, vomiting, flushing of the head and neck, headache, weakness, faintness, and collapse; the lips and fingernails may become bluish. There may be shortness of breath. Coma, convulsions, and death are possible.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If overexposure is suspected, also consider: complete blood count (CBC) and test for methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium nitrate. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to Calcium nitrate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with Calcium nitrate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from flammables (such as fuel) or combustibles (such as wood, paper, and oil). Calcium nitrate may explode if shocked or heated. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Calcium nitrate must be labeled "OXIDIZER."[19] It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a strong oxidizer that will increase the intensity of any fire. Use dry chemical, carbon dioxide, or water spray extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Calcium Nitrate*. Trenton, NJ

Calcium oxide C:0320

Molecular Formula: CaO

Synonyms: Burnt lime; Calcia; Calx; Fluxing lime; Lime; Lime, burned; Lime, unslaked; Oxyde de calcium (French); Pebble lime; Quicklime

CAS Registry Number: 1305-78-8

RTECS® Number: EW3100000

UN/NA & ERG Number: UN1910/157

EC Number: 215-138-9

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium oxide, CaO, occurs as white or grayish-white lumps or granular powder. The presence of iron gives it a yellowish or brownish tint. Molecular weight = 56.1; Specific gravity (H_2O:1) = 3.34; Boiling point = 2850°C; Freezing/Melting point = 2572°C; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2. Soluble in water (reactive).

Potential Exposure: Calcium oxide is used as a refractory material, a binding agent in bricks, plaster, mortar, stucco and other building materials. Used as a dehydrating agent, a flux in steel manufacturing, and a laboratory agent to absorb CO_2. Used in the manufacture of aluminum, magnesium, glass, pulp and paper, sodium carbonate, calcium hydroxide, chlorinated lime, calcium salts, and other chemicals. Used in the flotation of nonferrous ores, water and sewage treatment, oil treatment in agriculture, dehairing hides, in the clarification of cane and beet sugar juice, and in fungicides, insecticides, drilling fluids, and lubricants.

Incompatibilities: The water solution is a medium strong base. Reacts with water, forming calcium hydroxide and sufficient heat to ignite nearby combustible materials. Reacts violently with acids, halogens, metals.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 2 mg/m^3 TWA.

ACGIH TLV®[1]: 2 mg/m^3 TWA.

NIOSH IDLH: 25 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3, 1999; France: VME 2 mg/m^3, 1999; India: TWA 2 mg/m^3, 1993; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 2 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 6 mg/m^3, 1999; Sweden: NGV 2 mg/m^3, KTV 5 mg/m^3, 1999; Switzerland: MAK-W 3 mg/m^3, KZG-W 4 mg/m^3, 1999; Turkey: TWA 5 mg/m^3, 1993; United Kingdom: TWA 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3; the Czech Republic: 4 mg/m^3.

Several states have set guidelines or standards for calcium oxide in ambient air[60] ranging from 20 μg/m^3 (North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 48 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7020, Method #7303, or OSHA Analytical Method ID-121.

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Short Term Exposure: The corrosive action of calcium oxide is due primarily to its alkalinity and exothermic reaction with water. It is irritating and may be caustic to the skin, conjunctiva, cornea, and mucous membranes of the upper respiratory tract; may produce burns or dermatitis with desquamation and vesicular rash, lacrimation, spasmodic blinking, ulceration; and ocular perforation, ulceration and inflammation of the respiratory passages; ulceration of nasal and buccal mucosa and perforation of nasal septum. Bronchitis and pneumonia have been reported from inhalation of dust. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The lower respiratory tract may not be affected because irritation of upper respiratory passages is so severe that workers may be forced to leave the area.

Long Term Exposure: Repeated or prolonged contact with skin may cause brittle nails and thickening and cracking of the skin. Repeated or prolonged exposure to dust particles may cause lung problems. Calcium oxide may cause ulceration and perforation of the cartilage separating the nose (septum).

Points of Attack: Respiratory system, skin, and eyes.

Medical Surveillance: Preemployment physical examinations should be directed to significant problems of the eyes, skin, and the upper respiratory tract. Periodic examinations should evaluate the skin; changes in the eyes, especially the cornea and conjunctiva; mucosal ulcerations of the nose, mouth and nasal septum; and any pulmonary symptoms. Smoking history should be known.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash promptly when skin is contaminated and daily at the end of each work shift. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing if contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator); *20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with calcium oxide you should be trained on its proper handling and storage. Should be stored on dry flooring in a fire-resistant room, well protected from the weather. The area should be cool and adequately ventilated. Store in containers protected from physical damage, acids and oxidizing materials, such as permanganate, dichromate, or chlorine.

Shipping: Calcium oxide must bear a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group III.

The symbol "A" restricts the application of requirements of this subchapter to materials offered or intended for transportation by aircraft, unless the material is a hazardous substance or a hazardous waste.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Contact with water or moisture may generate enough heat to ignite nearby combustible materials. Avoid the use of water. Do not use carbon dioxide, foam, or halogenated fire extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves neutralization with hydrochloric acid to yield calcium chloride. The calcium chloride formed is treated with soda ash to yield the insoluble calcium carbonate. The remaining brine solution may be discharged into sewers and waterways.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report,* 2, No. 1, 98−99

New York State Department of Health. (January 1996). *Chemical Fact Sheet: Calcium Oxide*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Calcium Oxide.* Trenton, NJ

Calcium peroxide C:0330

Molecular Formula: CaO_2

Synonyms: Calcium dioxide; Calcium superoxide

CAS Registry Number: 1305-79-9

RTECS® Number: EW3865000

UN/NA & ERG Number: UN1457/140

EC Number: 215-139-4

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Calcium peroxide is a grayish-white or yellowish odorless crystalline solid. Molecular weight = 72.1; Freezing/Melting point = 275°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Insoluble in water.

Potential Exposure: Calcium peroxide is used as a seed disinfectant, an antiseptic, and a rubber stabilizer.

Incompatibilities: A strong alkali and strong oxidizer. Incompatible with reducing agents, combustible materials, polysulfide polymers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Calcium peroxide can affect you when breathed in. Contact can severely irritate and may burn the skin and eyes. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs, causing coughing and/or shortness of breath. Still higher exposures may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: Prolonged exposure can damage the skin. Very irritating substances may cause problems.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium peroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles with face shield when working with powders or dust, unless full face-piece respiratory protection is worn. ***Respirator Selection:*** Where there is potential for exposures to calcium peroxide, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with calcium peroxide you should be trained on its proper handling and storage. Calcium peroxide must be stored to avoid contact with combustible materials (such as wood, paper, oil, fuels, etc.) since violent reactions occur. Store in tightly closed containers. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Calcium peroxide must be labeled "OXIDIZER."[19] It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Calcium peroxide is an oxidizer and will greatly increase the intensity of a fire. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Calcium Peroxide*. Trenton, NJ

Calcium phosphide C:0340

Molecular Formula: Ca_3P2

Synonyms: Photophor; Tricalcium diphosphide

CAS Registry Number: 1305-99-3

RTECS® Number: EW3860000

UN/NA & ERG Number: UN1360/139

EC Number: 215-142-0 [*Annex I Index No.:* 015-003-00-2]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

European/International Regulations: Hazard Symbol: F, T+, N; Risk phrases: R15/29; R28; R50; Safety phrases: S1/2; S28; S36/37; R43; R45; R61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Calcium phosphide is a gray granular solid or reddish-brown crystalline solid. It has a musty odor, somewhat like acetylene. Molecular weight = 182.2; Specific gravity (H_2O:1) = 2.5 at 20°C; Freezing/Melting point = about 1600°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2₩ (water reactive).

Potential Exposure: Calcium phosphide is used to kill rodents; used in explosives and fireworks.

Incompatibilities: A strong reducing agent. Forms spontaneously combustible phosphine gas in moist air. Contact with water or acids releases phosphine gas and can cause explosions. Incompatible with oxidizers, acids, chlorine, chlorine monoxide, halogens, halogen acids, oxygen, sulfur.

Permissible Exposure Limits in Air

DOE Temporary Emergency Exposure Limits (TEELs)

TEEL-0: 0.05 ppm

PAC-1: 0.15 ppm

PAC-2: 1 ppm

PAC-3: 1.8 ppm

Permissible Concentration in Water: No criteria set. (Reacts violently with water as noted above.)

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Short Term Exposure: Calcium phosphide can severely irritate the eyes, skin, and respiratory tract. Phosphine (liberated from calcium phosphide) is an acute local irritant; it may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Phosphine is toxic upon inhalation, causing restlessness, tremors, fatigue, gastric pain, diarrhea, coma, and convulsions. Also, calcium phosphide is a dangerous fire and explosion hazard.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium phosphide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to Calcium phosphide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), oxygen, sulfur, or moisture since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where Calcium phosphide is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of Calcium phosphide. Wherever Calcium phosphide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Do not store large amounts of this material in a room protected by water sprinkler systems. Protect containers against physical damage.

Shipping: Calcium phosphide must carry a "DANGEROUS WHEN WET" label.[19] It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1360 (calcium phosphide) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: *Do not use water* or foam extinguishers. Contact with water forms highly toxic and flammable phosphine gas. Use dry chemical, dry sand, soda ash, or lime extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (February 1987). *Hazardous Substances Fact Sheet: Calcium Phosphide.* Trenton, NJ

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report,* 2, No. 1, 102−103

Calcium sulfate C:0350

Molecular Formula: CaO_4S
Common Formula: $CaSO_4$
Synonyms: *anhydrous:* Anhydrite; Anhydrous calcium sulfate; Anhydrous gypsum; Anhydrous sulfate of lime; Calcium salt of sulfuric acid
Dihydrate: Gypsum
Hemihydrate: Plaster of Paris
CAS Registry Number: 7778-18-9 (anhydrous); *(alt.)* 23296-15-3; 10101-41-4 (dihydrate); 10034-76-1 (hemihydrate); 13397-24-5 (hemihydrate-gypsum)
RTECS® Number: WS6920000 (anhydrous); EW4150000 (dihydrate)
EC Number: 231-900-3 (anhydrous)
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Calcium sulfate forms white to clear crystals. It is commonly encountered in the anhydrous form or as the dihydrate. Molecular weight = 136.08; Freezing/Melting point = 1560°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): (*anhydrous; dihydrate*) Health 2, Flammability 0, Reactivity 1. Practically insoluble in water; solubility = 0.3% at 20°C.
Potential Exposure: Calcium sulfate is used as a pigment, in Portland cement, in tiles and plaster, in polishing powders, a filler in paints and paper coatings, in the drying of gases and liquids, a soil conditioner, in molds and surgical casts, in wallboard and many others.
Incompatibilities: Contact with diazomethane, aluminum, phosphorus, and water may cause explosions. *Note:* Hygroscopic material (i.e., absorbs moisture from the air). Reacts with water forming gypsum and plaster of Paris.
Permissible Exposure Limits in Air
OSHA PEL: [Particulates not otherwise regulated] 15 mg/m^3 TWA total dust; TWA; 5 mg/m^3 TWA, respirable fraction.
NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.
ACGIH TLV®[1]: 10 mg/m^3 TWA inhalable fraction (2005).
Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3
DFG MAK: 1.5 mg/m^3 respirable fraction (previously "fine *dust*"); 4 mg/m^3 inhalable fraction (previously "total *dust*"); Pregnancy Risk Group: C.
Australia: TWA 10 mg/m^3, 1993; Austria: MAK 6 mg/m^3 (*dust*), 1999; Belgium: TWA 10 mg/m^3, 1993; United Kingdom: LTEL 10 mg/m^3 (total *dust*), 5 mg/m^3 (respirable dust), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/$m^{3(E)}$.
Determination in Air: By filter collection and gravimetric means. Particulates NOR: NIOSH #0500, total dust or #0600 (respirable).
Routes of Entry: Inhalation of dust, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: *Inhalation:* May cause irritation of mouth, throat, nose, and lungs. Senses of smell and taste may be lessened. Nose irritation may lead to bleeding. *Skin:* May cause irritation in open sores. The harsh washing and abrasive action necessary to remove this material may also lead to irritation. *Eyes:* Dust may irritate eyes. *Ingestion:* May cause blockage of digestive system if material hardens.
Long Term Exposure: May cause nose irritation accompanied by sneezing, tear formation, and excessive fluid secretion. Animal studies suggest that pneumonia and other more serious lung disorders may occur.
Points of Attack: Eyes, skin, respiratory system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear loose-fitting clothing of dust-tight material and safety goggles.
Respirator Selection: A dust mask should be worn if irritation effects become apparent.
Storage: Color Code—Green: General storage may be used. The hemihydrate and anhydrous forms should be stored in tightly sealed containers.
Shipping: Calcium sulfate is a "NONREGULATED MATERIAL."[19]
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Clean up using methods that do not raise dust, such as vacuum and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a

hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguisher suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

This chemical is a combustible liquid. Poisonous gases, including sulfuroxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Nonflammable, so it imposes no particular extinguisher requirements.

Disposal Method Suggested: Landfilling.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Calcium Sulfate*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Camphene C:0360

Molecular Formula: $C_{10}H_{10}$

Synonyms: Bicyclo-(2.2.1)heptane; 3,3-Dimethylenenorcamphene; 2,2-Dimethyl-3-methylene-; 2-2-Dimethyl-3-methylene norborane; 3,3-Dimethyl-2-methylene norcamphone

CAS Registry Number: 79-92-5

RTECS® Number: EX1055000

UN/NA & ERG Number: UN2319 [terpene hydrocarbons, n.o.s. (Camphene)]/128

EC Number: 201-234-8

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Camphene is a colorless to white crystalline solid with camphor-like odor. It may be shipped as a liquid. Freezing/Melting point = 50°C. Molecular weight = 136.24; Boiling point = 159°C; Melting point = 37°C; Flash point = 42°C (oc); 33°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Camphene is used for mothproofing and in the cosmetics, perfume, and food-flavoring industries.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. Emulsions in xylene may violently decompose on contact with iron or aluminum above 70°C. Contact with reducing agents may cause exothermic reaction, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.1$.

Routes of Entry: Inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Camphene can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. Exposure can irritate the eyes, nose, and throat. Higher levels can cause you to feel dizzy, excited, sweaty, and have a headache. At very high levels, confusion, nausea, drowsiness, coma, and kidney damage can occur. LD_{50} = (oral-rat) >5000 mg/kg (slightly toxic).

Long Term Exposure: Similar chemicals also can cause skin allergy. It is not known if camphene can cause the same problem.

Points of Attack: Eyes, skin, respiratory system, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with camphene. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: Where there is potential for exposure to camphene, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with camphene you should be trained on its proper handling and storage. Camphene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Camphene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of camphene.

Shipping: Terpene hydrocarbons, n.o.s. require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II. If shipped as a solid, based on a flash point [less than 60.5°C/141°F] it may be described as "FLAMMABLE SOLIDS, ORGANIC, N.O.S." It requires a shipping label of "FLAMMABLE SOLID." Based on this description, it would fall in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner, using nonsparking tools, and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. The crystals do not easily ignite, but they release flammable vapor at room temperature. Heating greatly increases the release of these flammable vapors. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Camphene*. Trenton, NJ

Camphor C:0370

Molecular Formula: $C_{10}H_{16}O$

Synonyms: Bicyclo-(2.2.1.)-heptanone; Bicyclo 2.2.1 heptan-2-one,1,7,7-trimethyl-; Bornane, 2-oxo-; 2-Bornanone; 2-Camphanone; Camphor, natural; 2-Camphorone; DL-Camphor; Formosa camphor; Gum camphor; Huile de camphre (French); Japan camphor; Kampfer (German); 2-Keto-1,7,7-trimethylnorcamphane; Laurel camphor; Matricaria camphor; Norcamphor, synthetic camphor; 1,7,7-Trimethyl-; 1,7,7-Trimethylbicyclo(2.2.1)-2-heptanone; 1,7,7-Trimethylnorcamphor

CAS Registry Number: 76-22-2; 8008-51-3 (camphor oil)
RTECS® Number: EX1225000
UN/NA & ERG Number: UN2717/133
EC Number: 200-945-0

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in juvenile drugs) (UN).[13]
FDA—over-the-counter drug.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Camphor is a colorless glassy solid with a penetrating, characteristic odor. Odor threshold = 0.079 mg/m^3. Molecular weight = 152.24; Freezing/Melting point = 180°C (natural); 165°C (synthetic); Flash point = 66°C (solid); 47°C (oil); Autoignition temperature = 460°C. Explosive limits: LEL = 0.6%, UEL = 3.5%. Hazard Identification (based on NFPA-704 M Rating System) (*solid*): Health 3, Flammability 2, Reactivity 0. Insoluble in water; (*oil):* Health 2, Flammability 2, Reactivity 0.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen, Human Data; Natural Product. Camphor is used as a plasticizer for cellulose esters and ethers, in lacquers and varnishes, and in explosives and pyrotechnics formulations. It is used as a moth repellent and as a medicine.

Incompatibilities: Forms explosive mixture with air. Violent, possibly explosive, reaction with strong oxidizers, especially chromic anhydride, potassium permanganate. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 2 mg/m^3 TWA.
NIOSH REL: 2 mg/m^3 TWA.
ACGIH TLV®[1]: 2 ppm/12 mg/m^3 TWA; 3 ppm/19 mg/m^3 STEL, not classifiable as a human carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 19 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 200 mg/m^3
DFG MAK: 2 ppm/13 mg/m^3 TWA; Peak Limitation Category II(2).
NIOSH IDLH: 200 mg/m^3
Australia: TWA 2 ppm (12 mg/m^3); STEL 3 ppm (18 mg/m^3), 1993; Austria: MAK 2 ppm (13 mg/m^3), 1999; Belgium: TWA 2 ppm (12 mg/m^3); STEL 3 ppm (19 mg/m^3), 1993; Denmark: TWA 2 ppm (12 mg/m^3), 1999; Finland: TWA 0.3 ppm (2 mg/m^3); STEL 0.9 ppm (6 mg/m^3), 1993; France: VME 2 ppm (12 mg/m^3), 1999; Norway: TWA 2 ppm (12 mg/m^3), 1999; the Netherlands: MAC-TGG 12 mg/m^3, 2003; the Philippines: TWA 2 ppm, 1999; Russia: STEL 3 mg/m^3, 1993; Switzerland: MAK-W 2 ppm (13 mg/m^3), 1999; United Kingdom: TWA 2 ppm (13 mg/m^3); STEL 3 ppm (19 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 ppm. Several states have set guidelines or standards for camphor in ambient air[60] ranging from 80 μg/m^3 (Connecticut) to 120−180 μg/m^3 (Virginia) to 286 μ/m^3 (Nevada).

Determination in Air: Charcoal absorption is followed by CS_2, workup and analysis by gas chromatography. Use NIOSH Analytical Method #1301, Ketones II, Method #2553, or OSHA Analytical Method 7, Organic Vapors.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Inhalation can cause respiratory tract irritation and coughing. Exposure can cause nausea, vomiting, diarrhea, headaches, dizziness, excitement, irrational behavior, mental confusion, epileptiform convulsions. Higher exposures can cause unconsciousness and death.

Long Term Exposure: Camphor may cause kidney damage.

Points of Attack: Central nervous system, eyes, skin, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Whole blood (chemical/metabolite): blood urea nitrogen, calcium, carbon dioxide, blood sugar/glucose, urinalysis, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: OSHA: *50 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOvHie (APF = 25) (any air-purifying full-facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *100 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter)] or PaprTOvHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *200 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with camphor you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Camphor must be stored to avoid contact with oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, and especially chromic anhydride since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flame. Sources of ignition, such as smoking and open flames are prohibited where camphor is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Synthetic camphor requires a “FLAMMABLE SOLID” label. It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Combustion produces lots of soot. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration of a solution in a flammable solvent.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 52−54

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Camphor*. Trenton, NJ

Cantharidin C:0380

Molecular Formula: $C_{10}H_{12}O_4$

Synonyms: Can; Cantharides camphor; 1,2-Dimethyl-3,6-epoxyperhydrophthalic anhydride; 2,3-Dimethyl-7-oxabicyclo [2.2.1] heptane-2,3-dicarboxylic anhydride; 4,7-Epoxyisobenzofuran-1,3-dione, hexahydro-3a, 7a-dimethyl-, (3a a, 4 b, 7 b, 7a a)-; 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic anhydride, 2,3-dimethyl-

CAS Registry Number: 56-25-7

RTECS® Number: RN8575000

EC Number: 200-263-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence, Human No Data, *not classifiable as carcinogenic to humans*, Group 3, 1998.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cantharidin is a brown to black powder. Molecular weight = 196.2; Freezing/Melting point = 218°C (begins to sublime at 110°C). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0.

Potential Exposure: Formerly used as a counter-irritant and vesicant. Also used for the removal of benign epithelial growths, e.g., warts. Used as an experimental antitumor agent. It is an active ingredient in “Spanish fly,” a reputed aphrodisiac.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.75 mg/m^3
PAC-1: 2.5 mg/m^3
PAC-2: 4.3 mg/m^3
PAC-3: 4.3 mg/m^3

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: A deadly poison by ingestion. Symptoms from ingestion include vomiting, abdominal pain, shock, bloody diarrhea, pain in throat and stomach, swelling and blistering of tongue, difficulty in swallowing, salivation, slow and painful urination, and thirst. There may be delirium, fainting, and titanic convulsions. Eye contact results in irritation with much swelling of the lids. Initial tissue reaction upon contact with the skin is swelling, followed by blister formation within 24 h. It is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste of less than 7 drops for a 70-kg (150 lb) person. It is very toxic by absorption through skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. For ingestion, induce vomiting with syrup of ipecac.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Cantharidin is not specifically listed in the DOT Performance-Oriented Packaging Standards[19] with respect to labeling requirements or restrictions on shipping quantities.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Canthariden.* Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report,* 1, No. 2, 27–28

Caprolactam C:0390

Molecular Formula: $C_6H_{11}NO$

Synonyms: Aminocaproic lactam; 6-Aminohexanoic acid cyclic lactam; 2-Azacycloheptanone; e-Caprolactam; Caprolactama (Spanish); 6-Caprolactum; Caprolattame (French); Cyclohexanone isooxime; Hexahydro-2H-azepine-2-one; Hexahydro-2-azepinone; Hexahydro-2H-azepin-2-one; 6-Hexanelactum; Hexanone isoxime; Hexanonisoxim (German); 1,6-Hexolactam; 2-Ketohexamethyleneimine; 2-Ketohexamethylenimine; NCI-C50646; 2-Oxohexamethyleneimine; 2-Oxohexamethylenimine; 2-Perhydroazepinone

CAS Registry Number: 105-60-2

RTECS® Number: CM3675000

EC Number: 203-313-2 [*Annex I Index No.:* 613-069-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/22; R36/37/38; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Caprolactam is a white crystalline combustible solid with an unpleasant odor. The odor threshold is 0.3 mg/m^3. Molecular weight = 113.18; Specific gravity (H_2O:1) = 1.01; Boiling point = 267°C; Freezing/Melting point = 69.6°C; Vapor pressure = 8×10^{-8} mmHg at 20°C; Flash point = 125°C (oc); 139°C (cc); Autoignition temperature = 375°C. Explosive limits: LEL = 1.84%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water; solubility = 53%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Caprolactam is used in the manufacture of nylon, plastics, bristles, film, coatings, synthetic leather, plasticizers, and paint vehicles, as a cross-linking agent for curing polyurethanes, and in the synthesis of lysine.

Incompatibilities: Caprolactam decomposes on heating and on burning producing toxic fumes including nitrogen oxides, ammonia. Reacts violently with strong oxidizers, producing toxic fumes. Toxic decomposition above 400°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.63 mg/m^3.

OSHA PEL: none.

NIOSH REL: (*dust*): 1 mg/m^3 TWA; 3 mg/m^3 STEL; (*vapor*): 0.22 ppm/1 mg/m^3 TWA; 0.66 ppm/3 mg/m^3 STEL.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

DFG MAK: 5 mg/m^3, measured as the inhalable fraction. Peak Limitation Category I(2); Pregnancy Risk Group C.

Australia: (*dust*): TWA 1 mg/m^3; STEL 3 mg/m^3; (*vapor*): TWA 5 ppm (20 mg/m^3); STEL 10 ppm 1993; Austria: MAK 5 mg/m^3 (*dust*), 1999; Belgium: (*dust*): TWA 1 mg/m^3; STEL 3 mg/m^3; (*vapor*): TWA 4.3 ppm (20 mg/m^3); STEL 8.6 ppm (40 mg/m^3), 1993; Denmark: TWA 5 ppm (25 mg/m^3), 1999; (*dust*): TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3 (*dust*), 1999; the Netherlands: Fume: MAC-TGG 20 mg/m^3; (*dust*): MAC-TGG 1 mg/m^3, 2003; France: VME 1 mg/m^3 (*dust*):; 5 ppm (20 mg/m^3) (*vapor*), 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3 (*dust*), 1993; Norway: TWA 5 ppm (25 mg/m^3), moist, 1999; Poland: MAC (TWA) 10 mg/m^3 (*dust*), 1999; Russia: STEL 10 mg/m^3 (*dust*), 1993; Sweden: TWA 5 mg/m^3; STEL 10 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3 (*dust*), 1999; United Kingdom: (*dust*): TWA 1 mg/m^3; STEL 3 mg/m^3; (*vapor*): TWA 5 ppm (23 mg/m^3); STEL 10 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 mg/m^3 (*particulate*). Several states have set guidelines or standards for caprolactam in ambient air ranging from 10 μg/m^3 (North Dakota) to 24 μg/m^3 (Nevada) to 160 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut).

Determination in Air: Use OSHA Analytical Method PV-2012, Caprolactam. Samples are collected by drawing a known volume of air through OSHA versatile sampler (OVS-7) tubes, containing a glass fiber filter and two sections of XAD-7 adsorbent. Samples are extracted with methanol and analyzed by high-performance liquid chromatography (HPLC) using an ultraviolet (UV) detector.

Permissible Concentration in Water: The former USSR-UNEP/IRPTC joint project[43] has adopted Russian value[35] of a MAC of 1 mg/L in water used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.19$.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The vapor irritates the eyes, skin, and respiratory tract. Inhalation may affect the central nervous system. Skin contact can cause irritation and serious burns if contact is prolonged and confined. Other symptoms of exposure include epistaxis (nosebleed), dermatitis, skin sensitization, asthma, dizziness, headache, abdominal cramps, diarrhea, nausea, vomiting. High exposures may also cause irritability, confusion, and convulsions (seizures). Exposure in airborne dust at 5 mg/m^3 causes skin irritation in some people but not at 1 mg/m^3. Sensitivity has not been related to race, skin pigmentation, or other common indices of sensitivity. The prevalence of dermatoses among workers in a caprolactam manufacturing plant showed that contact dermatitis and eczema of the hands were most prevalent. Dry erythematous squamous foci on smooth skin was a typical manifestation. Light sensitivity of the eyes was produced by inhalation of caprolactam at 0.11 mg/m^3 and higher. The olfactory threshold was 0.30 mg/m^3. An oral dose of 3−6 g was given daily for 3−5 years for the treatment of obesity in 90 subjects. No toxic effects were observed. There was no effect on appetite and only one person developed an allergy to caprolactam.

Long Term Exposure: Exposure may damage the developing fetus and may affect the reproductive ability of males. Caprolactam may damage the liver and/or kidneys. Repeated or prolonged contact may cause skin sensitization and dermatitis. The substance may have effects on the nervous system. Exposure to high concentrations over many years may cause irritability and confusion.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures (half the TLV or greater), the following are recommended: liver function tests and lung function tests. If symptoms develop or overexposure has occurred, the following may also be useful: EEG (brain wave test), skin testing with dilute Caprolactam may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm* (*vapor*) or 1 mg/m^3 (*dust*), use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with organic vapor cartridges and a particulate prefilter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Green: General storage may be used. Prior to working with caprolactam you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The DOT[19] has set no specific requirements for caprolactam in their performance oriented packaging standards.

Spill Handling: Restrict persons not wearing protective equipment from area of spill until cleanup is complete. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical will burn but does not easily ignite. Extinguish fire using any agent suitable for the type of surrounding fire. If heated to more than 100°C, caprolactam boils, giving off poisonous gases, including oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices). Also, caprolactam may be recovered from caprolactam still-bottoms or nylon waste.[22]

Reference

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: Caprolactam*. Trenton, NJ

Captafol C:0400

Molecular Formula: $C_{10}H_9Cl_4NO_2S$

Synonyms: Captafol; Captatol; Captofol; 4-Cyclohexene-1,2-dicarboximide, *n*-(1,1,2,2-tetrachloroethyl)thiol-; Difolatan®;

Difosan; Folcid; 1H-Isoindole-1,3(2H)-dione,3a,4,7,7a-tetrahydro-2-(1,1,2,2-tetrachloroethyl)thio-; Ortho 5865; Sanspor; Sulfonimide; Sulpheimide; *n*-(1,1,2,2-Tetrachloraethylthio)-cyclohex-4-en-1,4-diacarboximid (German); *n*-[(1,1,2,2-Tetrachloroethyl)-thio]-4-cyclohexene-1,2-dicarboximide; *n*-1,1,2,2-Tetrachloroethylmercapto-4-cyclohexene-1,2-carboximide; *n*-[(1,1,2,2-Tetrachloroethyl)sulfenyl]-*cis*-4-cyclohexene-1,2-dicarboximide; *n*-(1,1,2,2-Tetrachloroethylthio)-4-cyclohexene-1,2-dicarboximide

CAS Registry Number: 2425-06-1

RTECS® Number: GW4900000

UN/NA & ERG Number: UN2773 (Phthalimide derivative pesticides, solid, toxic)/151

EC Number: 219-363-3 [*Annex I Index No.:* 613-046-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, No Available Data; Group 2A.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (Germany, Norway) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 10/1/88.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R42; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Captafol is a white crystalline solid. Molecular weight = 349.06; Boiling point = 161°C (decomposes); Freezing/Melting point = 160.5°C; Vapor pressure = 8×10^{-6} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.0001%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Those engaged in the manufacture, formulation, and application of this fungicide.

Incompatibilities: Reacts violently with bases, causing fire and explosion hazard. Not compatible with strong acids or acid vapor, oxidizers. Strong alkaline conditions contribute to instability. Attacks some metals.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA [skin]; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin], not classifiable as a human carcinogen.

No TEEL available.

Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], carcinogen, 1993; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000. Several states have set guidelines or standards for captafol in air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.5 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method #0500.

Routes of Entry: Inhalation, ingestion, skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Captafol can affect you when breathed in and by passing through your skin. Caprafol may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Exposure can irritate the skin. It can also cause a skin allergy to develop. Exposure to the sun (or other ultraviolet light) after exposure to captafol may cause severe rash with itching, swelling, and blistering.

Long Term Exposure: Repeated or prolonged contact cause skin sensitization, dermatitis, allergic conjunctivitis. Repeated or prolonged inhalation exposure may cause asthma. The substance may have damaging effects on the liver and kidneys. Captafol is a probable carcinogen in humans. There is some evidence that it causes liver cancer in humans and it has caused kidney cancer in animals. Captafol may cause mutations. Handle with extreme caution.

Points of Attack: Skin, respiratory system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; lung function tests. Skin testing with dilute captafol may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with captafol. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Use splash-proof chemical goggles and face shield when working with liquids containing Captafol.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a MSHA/NIOAH approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Green: General storage may be used. Prior to working with captafol you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, acids, acid fumes, or strong oxidizers (such as peroxides, chlorates, perchlorates, nitrates and permanganates), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Captafol fits the category of "Phthalimide derivative pesticides, solid, toxic." Commercial formulations use different carrier solvents which may change physical properties and affect Packing Group. It requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. If Captafol is in liquid or slurry form, absorb it with vermiculite, dry sand, earth or a similar material. Dispose of the absorbing material in an approved facility. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid but it may be dissolved in a flammable liquid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. The substance decomposes on heating or on burning, producing toxic and corrosive fumes, including hydrogen chloride, nitrogen oxides, sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis.[22]

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Captafol*. Trenton, NJ

Captan C:0410

Molecular Formula: $C_9H_8Cl_3NO_2S$

Synonyms: Aacaptan; Agrosol S; Agrox 2-Way and 3-Way; Amercide; Bangton; Bean seed protectant; Captaf; Captaf 85W; Captan 50W; Captancapteneet 26,538; Captane; Captex; 4-Cyclohexene-1,2-dicarboximide*,* *n*-[(Trichloromethyl)mercapto]; ENT 26538; ESSO Fungicide 406; Flit 406; Fungicide 406; Fungus Ban type II; Glyodex 37-22; Hexacap; 1H-Isoindole-1,3(2H)-dione,3a,4,7,7a-tetrahydro-2-[(trichloromethyl)thiol]-; Isopto carbachol; Isotox seed treater "D" and "F"; Kaptan; le Captane (French); Malipur; Merpan; Micro-Check 12; Miostat; NCI-0077; Neracid; Orthocide®; Orthocide® 406; Orthocide® 50; Orthocide® 7.5; Orthocide® 75; Orthocide® 83; Osocide*;* *n*-Trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide*;* *n*-(Trichloromethylmercapto)-d(sup 4)-tetrahydrophthalimide*;* *n*-[(Trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide; *n*-Trichloromethylthiocyclohex-4-ene-1,2-dicarboximide*;* *n*-Trichloromethylthio-*cis*-δ(sup4)-cyclohexene-1,2-dicarboximide*;* *n*-[(Trichloromethyl)thio]-δ-4-tetrahydrophthalimide*;* *n*-[(Trichloromethyl)thio] tetrahydrophthalimide*;* *n*-Trichloromethylthio-3a,4,7,7a-tetrahydrophthalimide; Trimegol; Vancide 89; Vancide 89RE; Vancide P-75; Vangard K; Vanicide; Vondcaptan

CAS Registry Number: 133-06-2

RTECS® Number: GW5075000

UN/NA & ERG Number: UN2773 (Phthalimide derivative pesticides, solid, toxic)/151

EC Number: 205-087-0 [*Annex I Index No.:* 613-044-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data; Group 3; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat.

FDA—over-the-counter drug.

Banned or Severely Restricted (Finland, Sweden) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 1/1/90.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23; R40; R41; R43; R50; Safety phrases: S1/2; S26; S29; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Captan, when pure, is a colorless crystalline solid. The technical grade is a cream to yellow powder with a strong odor. It is commonly dissolved in a "carrier" which may be combustible or flammable. Molecular weight = 300.6; Boiling point = 177°C (decomposes); Freezing/Melting point = about 160°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Very slightly soluble in water; solubility = 0.0003% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Hormone, Human Data; Primary Irritant. Used as an agricultural fungicide and as a preservative in cosmetics. An over-the counter drug.

Incompatibilities: Incompatible with tetraethyl pyrophosphate, parathion. Keep away from strong alkaline materials (e.g., hydrated lime) as captan may become unstable. May react with water releasing hydrogen chloride gas. Corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: Carcinogen 5 mg/m^3 TWA; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990].

ACGIH TLV®[1]: 5 mg/m^3 TWA, inhalable fraction [sensitizer]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, carcinogen, 1999; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for captan in ambient air[60] ranging from 11.9 μg/m^3 (Kansas) to 35 μg/m^3 (Pennsylvania) to 50 μg/m^3 (North Dakota) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; IV NIOSH Analytical Method #5601.

Permissible Concentration in Water: A no-adverse-effect level of drinking water has been calculated by NAS/NRC as 0.35 mg/L. The former USSR/UPEN joint project[43] set a MAC of 2.0 mg/L in water bodies used for domestic purposes. Guidelines have been set in two states for Captan in drinking water ranging from 100 μg/L in Maine to 350 μg/L in California.

Determination in Water: Fish Tox = 25.36705000 ppb MATC (Maximum Acceptable Toxicant Concentration) (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 2.352.

Routes of Entry: Skin contact, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: The substance irritates the eyes and the skin. The acute oral LD_{50} value for rats is 9000 mg/kg (insignificantly toxic). Most of the chronic-oral-toxicity data on captan suggest that the no-adverse-effect or toxicologically safe dosage is about 1000 ppm (50 mg/kg/day). However, on the basis of fetal mortality observed in monkeys exposed to captan (12.5 mg/kg/day), the acceptable daily intake of captan has been established at 0.1 mg/kg of body weight by the FAO/WHO. Based on long-term feeding studies results in rats and dogs, ADIs were calculated at 0.05 mg/kg/day for captan. A rebuttal presumption against registration for captan was issued on August 19, 1980 by EPA on the basis of possible oncogenicity, mutagenicity, and teratogenicity.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin allergy to develop. Once this occurs, even very small future exposures can cause itching and a skin rash. Exposure may cause mutations or damage the developing fetus; however, this needs further study. Animal studies have found the development of cancer in animals. Whether captan is a human cancer hazard is currently being studied. Human Tox = 145.83333 ppb CHCL (Chronic Human Carcinogen Level) (VERY LOW).

Points of Attack: Eyes, skin, respiratory system, gastrointestinal tract, liver, kidneys. Cancer site in animals: duodenum.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Skin testing with dilute captan may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If

this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with captan you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, heat, and incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Captan fits the category of "Phthalimide derivative pesticides, solid, toxic." Commercial formulations use different carrier solvents which may change physical properties and affect Packing Group. It requires a shipping label of "POISONOUS/TOXIC MATERIALS." It is in Hazard Class 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquid-containing captan in vermiculite, dry sand, earth, or similar material. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200.

Fire Extinguishing: Captan may burn, but does not ignite readily. Use dry chemical, CO_2, or foam extinguishers. *Do not use water.* At high temperatures, captan decomposes and produces poisonous gases, including oxides of sulfur and nitrogen, hydrogen chloride and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Captan decomposes fairly readily in alkaline media (pH>8). It is hydrolytically stable at neutral or acid pH but decomposes when heated alone at its Freezing/Melting point. Alkaline hydrolysis is recommended.[22]

Reference

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Carbachol chloride C:0420

Molecular Formula: $C_6H_{15}ClN_2O_2$

Synonyms: 2-[(Aminocarbonyl)oxy]-*N*,*N*,*N*-trimethylethanaminium chloride; Cabacolina; Carbachol; Carbacholin; Carbacholine chloride; Carbamic acid, Ester with choline chloride; Carbamiotin; Carbamoylcholine chloride; Carbamylcholine chloride; Carbochol; Carbocholin; Carbyl;

Carcholin; Choline carbamate chloride; Choline chlorine carbamate; Choline, chlorine carbamate (ester); Coletyl; Doryl (pharmaceutical); (2-Hydroxyethyl)trimethylammonium chloride carbamate; Isopto carbachol; Jestryl; Lentin; Lentine (French); Miostat; Mistura C; Moryl; P.V. carbachol; TL 457; Vasoperif

CAS Registry Number: 51-83-2

RTECS® Number: GA0875000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-127-3

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Carbachol chloride is a crystalline odorless powder which, on standing in an open container, develops a faint odor resembling that of an aliphatic amine. Molecular weight = 182.68; Freezing/Melting point = 203°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Used in veterinary medicine as a cholinergic; parasympathomimetic, used chiefly in large animals, especially for colic in the horse.

Incompatibilities: Carbachol chloride, a carbamate ester is incompatible with strong oxidizers, hydroperoxides, strong acids, especially oxidizing acids, bases, and especially incompatible with strong reducing agents such as hydrides. Contact with active metals or nitrides form explosive hydrogen gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 15 mg/m^3

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Highly toxic by ingestion. LD_{50} = (oral-rat) 40 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbachol chloride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials.

Shipping: Carbachol chloride is not specifically listed in the DOT Performance-Oriented Packaging Standards.[19] However given its uses and its status as an EHS chemical it may be defined as "Medicine, solid, toxic, n.o.s." This would require a "POISONOUS/TOXIC MATERIALS" label. It would fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with scrubber for chloride and nitrogen oxide removal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Carbachol Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 40−41

Carbaryl C:0430

Molecular Formula: $C_{12}H_{11}NO_2$

Common Formula: $C_{10}H_7OOCNHCH_3$

Synonyms: Arilat; Arilate; Arylam; Bercema NMC50; Caprolin; Carbamic acid, methyl-, 1-naphthyl ester; Carbamine; Carbaryl, NAC; Carbatox; Carbatox 60; Carbatox 75; Carbavur; Carbomate; Carpolin; Carylderm; Compound 7744; Crag Sevin; Denapon; Dicarbam; Dyna-Carbyl; ENT 23969; Experimental insecticide 7744; Gamonil; Germain's; Hexavin; Karbaspray; Karbatox; Karbosep; Menapham;

Methylcarbamate 1-naphthalenol*;* *n*-Methylcarbamate de 1-naphtyle (French); Methylcarbamic acid, 1-naphthyl ester*;* *n*-Methyl-1-naphthyl-carbamat (German)*;* *n*-Methyl α-naphthylcarbamate*;* *n*-Methyl-1-naphthyl carbamate*;* *n*-Methyl-α-naphthylurethan; Microcarb; Mugan; Murvin; Murvin 85; NAC; 1-Naphthol; α-Naphthyl *n*-methylcarbamate; 1-Naphthyl *n*-methylcarbamate; 1-Naphthyl *n*-methylcarbamate; 1-Naphthyl methylcarbamate; NMC 50; Oltitox; OMS-29; OMS 629; Panam; Pomex; Prosevor 85; Ravyon; Seffein; Septene; Sevimol; Sevin®; Sevin® 4; Sewin; Sok; Tercyl; Thinsec; Tornado; Tricarnam; UC 7744 (Union Carbide); Union Carbide 7744; Vioxan

CAS Registry Number: 63-25-2; *(alt.)* 11095-11-7; *(alt.)* 52001-89-5

RTECS® Number: FC5950000

UN/NA & ERG Number: UN2757/151

EC Number: 200-555-0 [*Annex I Index No.*: 006-011-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.006; Nonwastewater (mg/kg), 0.14.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer: 2/5/10; Developmental/Reproductive toxin (male) 8/7/09.

Canada: Drinking water MAC = 0.09 mg/L.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/22; R40; R50; Safety phrases: S2; S36/37; S46; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Carbaryl is a white or grayish, odorless, crystalline solid; or various other forms including liquid and paste. Molecular weight = 201.2; Boiling point = (decomposes below BP); Freezing/Melting point = 142°C; Vapor pressure = <0.00004 mmHg at 25°C; Flash point = about 200°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as a broad-spectrum insecticide and as an acaricide and molluscicide. Workers engaged in production, formulation, and application of carbaryl as a contact insecticide for fruits, vegetables, cotton, and other crops.

Incompatibilities: Contact with strong oxidizers can cause fire and explosions.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 100 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 1.5 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: 5 mg/m^3 measured as the, inhalable fraction TWA; Peak Limitation Category II(4) [skin].

Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, [skin], 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg/m^3, 1999; Hungary: STEL 1 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Japan: 5 mg/m^3, [skin], 1999; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 8 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Switzerland: MAK-W 5 mg/m^3, [skin], 1999; Thailand: TWA 5 mg/m^3, 1993; United Kingdom: LTEL 5 mg/m^3; STEL 10 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen

Several states have set guidelines or standards for carbaryl in ambient air[60] ranging from 3.5 μg/m^3 (Pennsylvania) to 11.9050 μg/m^3 (Kansas) to 50 μg/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5601, NIOSH Analytical Method #5006, and OSHA Analytical Method 63.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been calculated as 0.574 mg/L by NAS/NRC. The UNEP/USSR joint project[43] set a MAC of 0.1 mg/L in water used for domestic purposes and 0.0005 mg/L in water bodies used for fishery purposes. Some states have set guidelines for carbaryl in drinking water[61] ranging from 10 μg/L (Wisconsin) to 60 μg/L (California) to 164 μg/L (Maine) to 574 μg/L (Kansas). See Regulatory section for Canada drinking water level.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.6.

Routes of Entry: Inhalation, skin contact or eye contact, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Carbaryl irritates the eyes, skin, and respiratory tract. The hot liquid may cause severe skin burns. The substance may affect the nervous system resulting in convulsions and respiratory failure. The effects may be delayed. LD$_{50}$ = (oral-rat) 250 mg/kg (moderately toxic). Single doses of up to about 140 mg (0.005 oz) have been reported to cause no effect. However, a single dose of about 200 mg has caused stomach pain and excessive sweating. Individual responses may vary. Several milliliters (0.1-oz fluid) of an 80% solution of carbaryl have caused nausea, salivation, headache, tremors, and excessive tearing. 500 mL (1 pint) of an 80% solution has resulted in death.

Long Term Exposure: The major health problem associated with occupational exposure to Carbaryl is related to its inhibition of the enzyme cholinesterase in the central, autonomic, and peripheral nervous systems. The inhibition of cholinesterase allows acetylcholine to accumulate at these sites and thereby leads to overstimulation of innervated organs. The signs and symptoms observed as a consequence of exposure to carbaryl in the work-place environment are manifestations of excessive cholinergic stimulation, e.g., nausea, vomiting, mild abdominal cramping, dimness of vision, dizziness, headache, difficulty in breathing, and weakness. Carbaryl may affect the kidneys and nervous system. It may cause mutations and may be a teratogen in humans. There is limited evidence that it reduces fertility in both males and females.

Points of Attack: Respiratory system, skin, central nervous system, cardiovascular system.

Medical Surveillance: NIOSH recommends that workers subject to carbaryl exposure have comprehensive preplacement medical examinations, with subsequent annual medical surveillance. If symptoms develop or overexposure has occurred, the following may be useful: kidney function tests. Urine (chemical/metabolite), urinalysis. Examination of the nervous system. If done within 2−3 h after exposure, serum and RBC cholinesterase levels may be helpful. Levels can return to normal before the exposed person feels well.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact; **4 h:** natural rubber gloves, Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots. Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if contaminated. Any employee whose work involves likely exposure of the skin to carbaryl or carbaryl formulations, e.g., mixing of formulations, shall wear full-body coveralls or the equivalent, impervious gloves, i.e., highly resistant to the penetration of carbaryl, impervious footwear, and when there is danger of carbaryl coming in contact with the eyes, goggles or a face shield. Any employee engaged in field application of carbaryl shall be provided with, and required to wear, the following protective clothing and equipment: goggles, full-body coveralls, impervious footwear, and a protective head covering. Employees working as flaggers in the aerial application of carbaryl shall be provided with, and required to wear, full-body coveralls or waterproof rain suits, protective head coverings; impervious gloves and impervious footwear. Significant engineering controls are recommended for this chemical in NIOSH Criteria Document #77-107.

Respirator Selection: Engineering controls should be used, wherever feasible, to maintain carbaryl concentrations below the prescribed limits, and respirators should only be used in certain nonroutine or emergency situations. During certain agricultural applications, however, respirators must be used. *Up to 50 mg/m^3:* Sa* (APF = 10) (any supplied-air respirator). *Up to 100 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with carbaryl you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Carbaryl must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where carbaryl is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Carbaryl requires a "POISONOUS/TOXIC MATERIALS" label. It is in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. If spill involves a liquid containing carbaryl, absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Carbaryl is a noncombustible solid but may be dissolved in flammable liquids. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Submit to alkaline hydrolysis before disposal.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Carbaryl*, NIOSH Document No. 77-107

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 45−46 (1981) and 3, No. 6, 42−48 (1983)

US Environmental Protection Agency. (August 1987). *Health Advisory: Carbaryl*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (March 1986). *Chemical Fact Sheet: Carbaryl*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Carbaryl*. Trenton, NJ

Carbofuran C:0440

Molecular Formula: $C_{12}H_{15}NO_3$

Synonyms: A13-27164; Bay 70143; Bay 704143; Bay 78537; 7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate; Brifur; Carbamic acid, methyl-, 2,2-dimethyl-2,3-dihydrobenzofuran-7-yl ester; Carbofurano (Spanish); Carbosip 5G; Chinufur; Crisfuran; Curaterr; D 1221; 2,3-Dihydro-2,2-dimethyl-7-benzofuranol *n*-methylcarbamate; 2,3-Dihydro-2,2-dimethyl-7-benzofuranol methylcarbamate; 2,3-Dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate; 2,3-Dihydro-2,2-dimethylbenzofuranyl-7 *n*-methylcarbamate; 2,2-Dimethyl-7-coumaranyl *n*-methylcarbamate; 2,2-Dimethyl-2,2-dihydrobenzofuranyl-7 *n*-methylcarbamate; 2,2-Dimethyl-2,3-dihydro-7-benzofuranyl *n*-methylcarbamate; ENT 27,164; FMC 10242; Furadan®; Furadan® 10G; Furadan® 3G; Furadan® 4F; Furadan® G; Furodan®; Kenofuran; Methyl carbamic acid 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester; Nex; NIA-10242; Niagara 10242; Niagra 10242; Niagra NIA-10242; NSC 167822; Pillarfuran; Yaltox

CAS Registry Number: 1563-66-2

RTECS® Number: FB9450000

UN/NA & ERG Number: UN2757/151

EC Number: 216-353-0 [*Annex I Index No.*: 006-026-00-9]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.006; Nonwastewater (mg/kg), 0.14.

Safe Drinking Water Act: MCL, 0.04 mg/L; MCLG, 0.04 mg/L; Regulated chemical (47 FR 9352).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada: Drinking water quality, 0.09 mg/L MAC.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as dustable powder formulations containing a combination of Benomyl at or >7%; carbofuran at or >10%; thiram at or >15%).
European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/28; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Carbofuran is white, odorless crystalline solid. Molecular weight = 221.3; Specific gravity (H_2O:1) = 1.18; Boiling point = 149°C (decomposes); Freezing/Melting point = 151°C; Vapor pressure = 3×10^{-6} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 0.07%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this insecticide, acaricide, and nematocide.

Incompatibilities: Alkaline substances, acid, strong oxidizers, such as perchlorates, peroxides, chlorates, nitrates, permanganates.

Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 0.1 mg/m^3 TWA.
ACGIH TLV®[1]: 0.1 mg/m^3 TWA, inhalable fraction and vapor; BEI issued; not classifiable as a human carcinogen (2001).
Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 0.43 mg/m^3
PAC-3: 0.5 mg/m^3
Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1993; India: TWA 0.1 mg/m^3, 1993; Norway: TWA 0.1 mg/m^3, 1999; Poland: MAC (TWA) 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for carbofuran in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method #5006, Method #5601, and OSHA Analytical Method 63.

Permissible Concentration in Water: EPA[47] has determined 1-day, 10-day, and longer-term health advisories of 50 μg/L of Carbofuran for a 10-kg child. The longer term (1 year) value for a 70-kg adult is 0.18 mg/L or 180 μg/L. A lifetime health advisory for a 70-kg adult has been determined to be 36 μg/L of Carbofuran. Most recently, EPA has proposed a limit of 40 μg/L in drinking water.[62] Some states have set guidelines for carbofuran in drinking water[61] ranging from 10 μg/L (Massachusetts) to 15 μg/L (New York) to 36 μg/L (Arizona and Minnesota) to 50 μg/L (Kansas and Wisconsin).

Determination in Water: Analysis of Carbofuran is by a high-performance liquid chromatographic procedure used for the determination of *n*-methyl carbamoyloximes and *n*-methylcarbamates in drinking water (US EPA 1984). In this method, the water sample is filtered and a 400-μL aliquot is injected into a reverse-phase HPLC column. Separation of compounds is achieved using gradient elution chromatography. After elution from the HPLC column, the compounds are hydrolyzed with sodium hydroxide. The methylamine formed during hydrolysis is reacted with *o*-phthalaldehyde (OPA) to form a fluorescent derivative which is detected using a fluorescence detector. The method detection limit has been estimated to be approximately 0.9 μg/L for carbofuran. Octanol−water coefficient: Log K_{ow} (octanol/water partition coefficient) = 2.32.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Carbofuran may affect the nervous system resulting in convulsions and respiratory failure. Cholinesterase inhibitor. Exposure may result in death. The effects may be delayed and exposed personnel should be kept under medical observation. Symptoms include headache, giddiness, blurred vision weakness, nausea, cramps, diarrhea, chest discomfort, sweating, contraction of pupils, tearing, salivation, blue lips, lungs and abdomen filled with fluid, convulsions, coma, loss of reflexes and sphincter control. This material is extremely poisonous. The LD_{50} for rat is 5.3 mg/kg. May be fatal if swallowed, inhaled, or absorbed through skin. Contact may burn skin or eyes. Probable lethal oral dose to humans is 5−50 mg/kg or 7 drops to 1 teaspoon for a 150-lb person.

Long Term Exposure: The major health problem associated with occupational exposure to carbofuran is related to its inhibition of the enzyme cholinesterase in the central, autonomic, and peripheral nervous systems. The inhibition of cholinesterase allows acetylcholine to accumulate at these sites and thereby leads to over stimulation of innervated organs. The signs and symptoms observed as a consequence of exposure to Carbofuran in the work-place environment are manifestations of excessive cholinergic stimulation, e.g., nausea, vomiting, mild abdominal cramping, dimness of vision, dizziness, headache, difficulty in breathing, and weakness. Carbofuran may affect the immune system.

Points of Attack: Central nervous system, peripheral nervous system, blood cholinesterase.

Medical Surveillance: Before starting work, at regular times after that, and if any symptoms develop, or overexposure occurs, the following is recommended: serum and red blood cell cholinesterase levels (a special test for the substance in the body that Carbofuran affects). For this substance these tests are accurate only if done within about 2 h of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved respirator with a pesticide cartridge. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbofuran you should be trained on its proper handling and storage. Carbofuran must be stored to avoid contact with acids and strong oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates). Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Carbamate insecticides, solid, toxic, n.o.s., have a DOT label requirement of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1, the Packing Group is II.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing carbofuran in vermiculite, dry sand, earth, or similar material. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Carbofuran itself does not burn. The substance decomposes on heating, producing toxic fumes including nitrogen oxides. Dike fire control water for later disposal, do not scatter the material. Stay at maximum distance from fire. Extinguish fire using an agent suitable for the type of surrounding fire; use dry chemical, carbon dioxide, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately.

Disposal Method Suggested: Alkaline hydrolysis is the recommended mode of disposal.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

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US Environmental Protection Agency. (January 25, 1989). *Preliminary Determination to Cancel Registrations of Carbofuran Products*, Federal Register 54, No. 15, 3744−3754

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Carbofuran*. Trenton, NJ

Carbon black C:0450

Molecular Formula: C
Synonyms: Acetylene black; Channel black; C.I. Pigment black 7; Elemental carbon; Furnace black; Lamp black; Thermal black
CAS Registry Number: 1333-86-4
RTECS® Number: FF5800000
UN/NA & ERG Number: UN1361 (Carbon, Animal, or Vegetable origin)/133
EC Number: 215-609-9
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human, Inadequate Evidence, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1996.[1]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Water Pollution Standard Proposed (UNEP).[43]
California Proposition 65 Chemical: (*airborne, unbound particles of respirable size*), Cancer 1/21/03
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): Nonwater polluting agent.
Description: Carbon black (substantially elemental carbon), C, is a black, odorless solid. Molecular weight = 12; Freezing/Melting point = about 3550°C (sublimes). Hazard Identification (based on NFPA-704 M Rating System) (*activated, type C-1*): Health 1, Flammability 1, Reactivity 1. Insoluble in water. Combustible solid that may contain flammable hydrocarbons.
Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen. Used as reinforcing agent and filler for rubber, colorants for ink, paint, and plastics. Workers in carbon black production or in its use in rubber compounding, ink and paint manufacture, plastics compounding, dry-cell battery manufacture.
Incompatibilities: Carbon blacks containing over 8% volatiles may pose an explosion hazard. Dust can form an explosive mixture in air. A reducing agent; keep away from strong oxidizers, such as chlorates, bromates, nitrates.
Permissible Exposure Limits in Air
OSHA PEL: 3.5 mg/m^3 TWA.
NIOSH REL: 3.5 mg/m^3 TWA; Potential human carcinogen, in the presence of PAHs, NIOSH recommends that exposure to carbon black be limited to the lowest feasible concentration. 0.1 mg[PAHs]/m^3 [10 h.] TWA [Carbon black, in the presence of polycyclic aromatic hydrocarbons (PACs)]. See *NIOSH Pocket Guide*, Appendix A & C.
ACGIH TLV®[1]: 3.5 mg/m^3 TWA; not classifiable as a human carcinogen.
DFG MAK: Carcinogen Category 3B, inhalable dust.
NIOSH IDLH: 1750 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 3.5 mg/m^3
PAC-1: 10.5 mg/m^3
PAC-2: 17.5 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: Carcinogen Category 3B, inhalable fraction.
Australia: TWA 3 mg/m^3, 1993; Belgium: TWA 3.5 mg/m^3, 1993; Denmark: TWA 3.5 mg/m^3, 1999; Finland: TWA 3.5 mg/m^3; STEL 7 mg/m^3, 1999; France: VME 3.5 mg/m^3, 1999; Norway: TWA 3.5 mg/m^3, 1999; the Philippines: TWA 3.5 mg/m^3, 1993; the Netherlands: MAC-TGG 3.5 mg/m^3, 2003; Sweden: NGV 3 mg/m^3 [dust], 1999; United Kingdom: TWA 3.5 mg/m^3; STEL 7 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The former USSR-UNEP/IRPTC joint project[43] set a MAC in ambient air in residential areas of 0.15 mg/m^3 on a momentary basis and 0.005 mg/m^3 on an average daily basis. Several states have set guidelines or standards for carbon black in ambient air[60] ranging from 117 μg/m^3 (New York) to 35 μg/m^3 (North Dakota) to 50 μg/m^3 (Virginia) to 70 μg/m^3 (Connecticut) to 83 μg/m^3 (Nevada).
Determination in Air: Filtration from air is followed by gravimetric analysis as described in NIOSH Analytical Method #5000.[18] See also NIOSH Analytical Method 5800, Polycyclic aromatic compounds (PAC), and OSHA Analytical Method ID-196.
Permissible Concentration in Water: The former USSR-UNEP/IRPTC joint project[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.
Routes of Entry: Inhalation, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Inhalation may cause irritation to respiratory tract. Skin contact may cause irritation. Eye contact may cause irritation. *Ingestion:* Animal studies show that toxic effects are unlikely, although carbon black contains several substances that are toxic and known carcinogens.
Long Term Exposure: Exposure to levels well above 3.5 mg/m^3 for several months may result in damage to the skin and nails, temporary or permanent damage to the lungs and breathing passages, and adversely affect the heart. Carbon black containing PAH greater than 0.1% should be considered a suspect carcinogen. Lungs may be affected by repeated or prolonged exposure at very high concentrations: Some carbon blacks may contain compounds which are carcinogenic, and as organic extracts of these have been classified as possibly carcinogenic to humans, special care should be taken to avoid exposure to such extracts. Lung effects remain controversial and may be due to contaminants. It is probable that minor effects reported are nonspecific effects

associated with exposure to nuisance dusts in general. Polynuclear aromatic hydrocarbons (PAH) are reportedly present in some carbon blacks. Depending on the process of manufacture, there are variations in their chemical compositions.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: chest X-ray (to be read by a special NIOSH "B reader" radiologist); lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin and PAH contamination is present, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 17.5 mg/m^3:* Qm (APF = 5) (any quarter-mask respirator). *Up to 35 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 87.5 mg/m^3:* Sa:Cf (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 175 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter). Any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter. Any self-contained breathing apparatus with a full face-piece. Any supplied-air respirator with a full face-piece. *Up to 1750 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

In presence of polycyclicaromatic hydrocarbons: NIOSH *at concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode) *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with carbon black you should be trained on its proper handling and storage. Carbon black must be stored to avoid contact with chlorates, bromates, and nitrates since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where carbon black is used, handled, or stored in a manner that could create a potential fire or explosion hazard. If carbon black contains more than 0.1% PAHs it should be used, handled, and stored in a regulated area as a carcinogen. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Carbon in various forms must carry a "SPONTANEOUSLY COMBUSTIBLE" label. It falls in Hazard Class 4.2 and Packing Group III. The symbol "I" identifies proper shipping names (Carbon, animal, or vegetable origin) which are appropriate for describing materials in international transportation. An alternate proper shipping name may be selected when only domestic transportation is involved.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Carbon black will ignite and burn slowly. Use dry chemical, sand, water spray, or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested

Dump into a landfill or incinerate as a slurry.[22]

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Carbon Black*. Report PB-276,678. Rockville, MD

US Environmental Protection Agency. (August 1, 1976). *Chemical Hazard Information Profile: Carbon Black*. Washington, DC

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Carbon Black*, NIOSH Document No. 78-204. Washington, DC

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New York State Department of Health. (January 1986). *Chemical Fact Sheet*: *Carbon Black*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Eller P. M., & Cassinelli M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. Publication No. 98−119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

Carbon dioxide C:0460

Molecular Formula: CO_2

Synonyms: Acetylene black; Channel black; C.I. Pigment black 7; Elemental carbon; Furnace black; Lamp black; Thermal black

CAS Registry Number: 124-38-9

RTECS® Number: FF6400000

UN/NA & ERG Number: UN1013 (compressed)/120, UN2187 (refrigerated liquid)/120, UN1845 (solid, dry ice)/120

EC Number: 204-696-9

Regulatory Authority and Advisory Bodies

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Carbon dioxide is a colorless, odorless, noncombustible gas. Molecular weight = 44.01; Boiling point = (sublimes); Freezing/Melting point = −78.3°C (sublimes). It is commonly shipped in the compressed liquid form and the solid form (dry ice). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.2% at 25°C.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Gaseous Carbon dioxide is used to carbonate beverages; as a weak acid in the textile, leather, and chemical industries; in water treatment; and in the manufacture of aspirin and white lead; for hardening molds in foundries; in food preservation, in purging tanks, and pipelines; as a fire extinguisher, in foams; and in welding. Because it is relatively inert, it is utilized as a pressure medium. It is also used as a propellant in aerosols, to promote plant growth in green houses; it is used medically as a respiratory stimulant, in the manufacture of carbonates, and to produce an inert atmosphere when an explosive or flammable hazard exists. The liquid is used in fire extinguishing equipment, in cylinders for inflating life rafts, in the manufacturing of dry ice, and as a refrigerant. Dry ice is used primarily as a refrigerant. Occupational exposure to carbon dioxide may also occur in any place where fermentation processes may deplete oxygen with the formation of carbon dioxide, e.g., in mines, silos, wells, vats, ships' holds, etc.

Incompatibilities: The substance decomposes on heating above 2000°C producing toxic carbon monoxide. Reacts violently with strong bases and alkali metals. Various metal dusts from chemically active metals, such as magnesium, zirconium, titanium, aluminum, chromium, and manganese are ignitable and explosive when suspended and heated in carbon dioxide.

Permissible Exposure Limits in Air

OSHA PEL: 5000 ppm/9000 mg/m^3 TWA.

NIOSH REL: 5000 ppm/9000 mg/m^3 TWA; 30,000 ppm/54,000 mg/m^3 STEL.

ACGIH TLV®[1]: 5000 ppm/9000 mg/m^3 TWA; 30,000 ppm/54,000 mg/m^3 STEL.

NIOSH IDLH: 40,000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5000 ppm

PAC-1: 30,000 ppm

PAC-2: 30,000 ppm

PAC-3: 40,000 ppm
DFG MAK: 5000 ppm/9100 mg/m^3 TWA; Peak Limitation Category II(2).
Australia: TWA 5000 ppm (9000 mg/m^3); STEL 30000 ppm, 1993; Austria: MAK 5000 ppm (9000 mg.m^3), 1999; Belgium: TWA 5000 ppm (9000 mg/m^3); STEL 30000 ppm, 1993; Denmark: TWA 5000 ppm (9000 mg/m^3), 1999; Finland: TWA 5000 ppm (9000 mg/m^3), 1999; Hungary: STEL 9000 mg/m^3, 1993; Japan: 5000 ppm (9000 mg/m^3), 1999; the Netherlands: MAC-TGG 9000 mg/m^3, 2003; Norway: TWA 5000 ppm (9000 mg/m^3), 1999; the Philippines: TWA 5000 ppm (9000 mg/m^3), 1993; Poland: MAC (TWA) 9000 mg/m^3, MAC (STEL) 27000 mg/m^3, 1999; Russia: TWA 5000 ppm, 1993; Sweden: NGV 5000 ppm (9000 mg/m^3), KTV 10000 ppm (18000 mg/m^3), 1999; Switzerland: MAK-W 5000 ppm (9000 mg/m^3), 1999; Thailand: TWA 5000 ppm (9000 mg/m^3), 1993; Turkey: TWA 5000 ppm (9000 mg/m^3), 1993; United Kingdom: TWA 5000 ppm (9150 mg/m^3); STEL 15000 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 30,000 ppm. States with guidelines or standards for CO_2 in ambient air[60] are: 150 mg/m^3 (Virginia) and 214 mg/m^3 (Nevada).

Determination in Air: Gas collection bag; none; Gas chromatography/Thermal conductivity detector; IV NIOSH Analytical Method #6603. Collection in a bag followed by gas chromatography. See OSHA Analytical Method ID-172.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation of high concentrations of this gas may cause headache, shortness of breath, nausea, vomiting, dizziness, hyperventilation, and unconsciousness. Rapid evaporation of the liquid or skin contact with "dry ice" may cause frostbite. On loss of containment, this liquid evaporates very quickly causing supersaturation of the air with serious risk of suffocation when in confined areas. Carbon dioxide is a simple asphyxiant. Concentrations of 10% (100,000 ppm) can produce unconsciousness and death from oxygen deficiency. A concentration of 5% may produce shortness of breath and headache. Continuous exposure to 1.5% CO_2 may cause changes in some physiological processes. The concentration of carbon dioxide in the blood affects the rate of breathing.

Long Term Exposure: Long-term exposure at levels between 5000 and 20,000 ppm of carbon dioxide can affect the acid−base balance, causing acidosis, and can affect calcium metabolism.

Points of Attack: Lungs, skin, cardiovascular system.

Medical Surveillance: Consider evaluation of body calcium and acid−base balance.

First Aid: If dry ice gets into the eyes, get medical attention. If this chemical contacts the skin, get medical attention for frostbite. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform rescue breathing and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Carbon dioxide is a heavy gas and accumulates at low levels in depressions and along the floor. Generally, adequate ventilation will provide sufficient protection for the worker. Where concentrations are of a high order, supplied air respirators are recommended.

Respirator Selection: *40,000 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbon dioxide you should be trained on its proper handling and storage. Carbon dioxide must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc) especially in combination with peroxides, since violent reactions occur. Protect containers from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Carbon dioxide (UN1013, UN2187) must carry a "NONFLAMMABLE GAS" label. Dry ice (UN1845) does not require a label. The gas and refrigerated liquid fall in Hazard Class 2.2 and there is no Packing Group; solid, dry ice falls in Hazard Class 9 and Packing Group III. Solid, dry ice carries the symbol "AW." The letter "A" restricts the application of requirements of this subchapter to materials offered or intended for transportation by aircraft, unless the material is a hazardous substance or a hazardous waste. The letter "W" restricts the application of requirements of this subchapter to materials offered or intended for transportation by vessel, unless the material is a hazardous substance or a hazardous waste.

Spill Handling: Inhalation hazard. If carbon dioxide gas is leaked, take the following steps. Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. If carbon dioxide liquid or solid is spilled or leaked, take the following steps: restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate the area of spill or leak.

Fire Extinguishing: Containers may explode in fire. Extinguish fire using an agent suitable for type of surrounding fire. Carbon dioxide itself does not burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere.[22]

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Carbon Dioxide*. NIOSH Document No. 76-194

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Carbon Dioxide*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Carbon Dioxide*. Trenton, NJ

Carbon disulfide C:0470

Molecular Formula: CS_2

Synonyms: Carbon bisulfide; Carbon bisulphide; Carbon disulphide; Carbone (sufure de) (French); Carbon sulfide; Dithiocarbonic anhydride; Kohlendisulfid (schwefelkohlenstoff) (German); NCI-C04591; Schwefelkohlenstoff (German); Sulphocarbonic anhydride; Weeviltox

CAS Registry Number: 75-15-0

RTECS® Number: FF6650000

UN/NA & ERG Number: UN1131

EC Number: 006-003-00-3

EC Number: 200-843-6 [*Annex I Index No.:* 006-003-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000.

Banned or Severely Restricted (in agriculture) (several countries) (UN).[13]

Toxic Substance (World Bank).[15]

US EPA, TSCA Section 8(e) Risk Notification, 8EHQ-0393-8888.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9,080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P022.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 3.8; Nonwastewater (mg/L), 4.8 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as carbon bisulphide.

California Proposition 65 Chemical: Developmental/Reproductive toxin (male, female) 7/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R11; R36/38; R45; R48/23; R62; R63; Safety phrases: S1/2; S16; S33; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Carbon disulfide is a highly refractive, flammable liquid, which, in pure form has a sweet odor and in commercial and reagent grades has a foul smell. It can be detected by odor at about 1 ppm but the sense of smell fatigues rapidly and, therefore, odor does not serve as a good warning property. Molecular weight = 76.13; Specific gravity (H_2O:1): 1.26; Boiling point = 46.3°C; Freezing/Melting point = −110.8°C; Vapor pressure = 279 mmHg at 25°C; Flash point = −30°C; Autoignition temperature = 90°C. The explosive limits are LEL = 1.3%; UEL = 50%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.3%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Carbon disulfide is used in the manufacture of viscose rayon, ammonium salts, carbon tetrachloride, carbanilide, xanthogenates, flotation agents, soil disinfectants, dyes, electronic vacuum tubes, optical glass, paints, enamels, paint removers, varnishes, varnish removers, tallow, textiles, explosives, rocket fuel, putty, preservatives, and rubber cement; also used as a solvent for phosphorus, sulfur, selenium, bromine, iodine; alkali cellulose; fats, waxes, lacquers, camphor, resins, and cold vulcanized rubber. It is also used in degreasing, chemical analysis, electroplating, grain fumigation, oil extraction, and dry-cleaning. It is widely used as a pesticide intermediate.

Incompatibilities: Strong oxidizers, chemically active metals (such as sodium, potassium, zinc), azides, organic amines, halogens. May explosively decompose on shock, friction, or concussion. May explode on heating. The substance may spontaneously ignite on contact with air and on contact with hot surfaces, producing toxic fumes of sulfur dioxide. Reacts violently with oxidants to produce oxides of sulfur and carbon monoxide and causing fire and explosion hazard. Attacks some forms of plastic, rubber, and coating.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.11 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm TWA; 30 ppm, Ceiling Concentration; 100 ppm [30-min maximum peak per 8-h shift].

NIOSH REL: 1 ppm/3 mg/m^3 TWA; 10 ppm/30 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 1 ppm/3.13 mg/m^3 TWA, [skin]; Not Classifiable as a Human carcinogen, BEI: 5 mg/g [2-Thiothiazolidine-4-carboxylic acid (TTCA)] creatinine in urine at end-of-shift.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **13** ppm

PAC-2: **160** ppm

PAC-3: **480** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/16 mg/m^3 TWA; Peak Limitation II(2) [skin] Pregnancy Risk Group B; BAT: 4 mg/g [2-Thio-4-thiazolidine carboxylic acid (TTCA)] creatinine in urine at end-of-shift.

Arab Republic of Egypt: TWA 10 ppm (30 mg/m^3), [skin], 1993; Australia: TWA 10 ppm (30 mg/m^3), [skin], 1993; Austria: MAK 10 ppm (30 mg/m^3), [skin], 1999; Belgium: TWA 10 ppm (31 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (15 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (15 mg/m^3), [skin], 1999; France: VME 10 ppm (30 mg/m^3), VLE 25 ppm (75 mg/m^3), 1999; India: TWA 10 ppm (30 mg/m^3), [skin], 1993; Japan: 10 ppm (31 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 30 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (15 mg/m^3), 1999; the Philippines: TWA 20 ppm (60 mg/m^3), [skin], 1993; Poland: MAC (TWA) 18 mg/m^3, MAC (STEL) 30 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 1 mg/m^3, 1993; Sweden: NGV 5 ppm (16 mg/m^3), KTV 8 ppm (25 mg/m^3), [skin], 1999; Thailand: TWA 20 ppm (60 mg/m^3); STEL 30 ppm (90 mg/m^3), 1993; Turkey: TWA 10 ppm (65 mg/m^3), [skin], 1993; United Kingdom: TWA 10 ppm (32 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppp [skin]. Russia[43] set a MAC of 1.0 mg/m^3 in work-place air, of 0.03 mg/m^3 in ambient residential air on a momentary basis, and 0.003 mg/m^3 in residential ambient air on a daily average basis. Several states have set guidelines or standards for carbon disulfide in ambient air[60] ranging from 60 μg/m^3 (Connecticut) to 100 μg/m^3 (New York) to 150 μg/m^3 (South Carolina) to 186 μg/m^3 (North Carolina) to 300 μg/m^3 (Florida and North Dakota) to 714 μg/m^3 (Nevada). The WHO[35] has recommended a TWA of 10 mg/m^3 for male workers and a TWA of 3 mg/m^3 for women of fertile age.

Determination in Air: Adsorption on charcoal, workup with benzene, gas chromatographic analysis per NIOSH Analytical Method #1600 and Method #3800.[18]

Permissible Concentration in Water: In view of the relative paucity of data on the mutagenicity, carcinogenicity, and long-term oral toxicity of carbon disulfide, it was stated that estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It was recommended by NAS/NRC that studies to produce such information be conducted before limits in drinking water are established. Now, however, EPA[32] has suggested a permissible ambient goal of 830 μg/L. Russia[43] has suggested that limits in drinking water be set on an organoleptic basis and that a MAC of 1 mg/L be set in water bodies used for fishery purposes. Arizona has set a guideline for CS$_2$ in drinking water of 830 μg/L.[61]

Determination in Water: Octanol–water coefficient: Log K_{ow} = 1.82.

Routes of Entry: Inhalation of vapor which may be compounded by percutaneous absorption of liquid or vapor, ingestion, and skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Carbon disulfide irritates the eyes, skin, and respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. This chemical may affect the central nervous system. In acute poisoning, early excitation of the central nervous system occurs, followed by depression with stupor, restlessness, and unconsciousness. If recovery occurs, the patient usually passes through the after-stage of narcosis, with nausea, vomiting, headache, etc. Also possible are motor disturbances of the bowel, anemia, disturbances of cardiac rhythm, loss of weight, polyuria, and menstrual disorders. Severe chronic poisoning may also result in liver degeneration and jaundice. Exposure can cause a loss of consciousness. Exposure far above the PEL may result in death. The probable oral lethal dose for a human is between 0.5 and 5 g/kg or between 1 oz and 1 pint (or 1 lb) for a 70-kg (150 lb) person. In chronic exposures, the central nervous system is damaged and results in the disturbance of vision and sensory changes as the most common early symptoms. Lowest lethal dose for humans has been reported at 14 mg/kg or 0.98 g for a 70-kg person. Alcoholics and those suffering from neuropsychic trouble are at special risk.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin allergy, dermatitis, increased cholesterol, atherosclerosis, high blood pressure, heart disease, and damage to the eyes and other organs from its effects on arteries. Carbon disulfide may affect the central nervous system resulting in severe neurobehavioral effects, polyneuritis, and psychoses. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

Points of Attack: The material affects the central nervous system, cardiovascular system, eyes, kidneys, liver, and skin.

Medical Surveillance: Preplacement and periodic medical examinations should be concerned especially with skin, eyes, central and peripheral nervous system, cardiovascular disease, as well as liver and kidney function. Electrocardiograms should be taken. CS_2 can be determined in expired air, blood, and urine. The iodine−azide test detects carbon disulfide metabolites in the urine and it may indicate other sulfur compounds. Examination of the nervous system. NIOSH lists the following medical tests: blood urea nitrogen, electrocardiogram, expired air, ophthalmic examination; urine (chemical/metabolite)/sediment; liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. NIOSH recommends the use of Viton™ and polyvinyl alcohol as protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with carbon disulfide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The DOT-required shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." The Hazard Class is 3 and the Packing Group is I.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. For small leaks, absorb on paper towels. Evaporate the spills in a safe place, such as a fume hood. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas-cleaning device. If carbon disulfide is spilled in water, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. If dissolved, apply activated carbon at ten times the spilled amount. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. In case of a spill or leak from a drum or smaller container or a small leak from a tank, isolate 50 feet in all directions. In case of a large spill, first isolate 100 feet in all directions, then evacuate in a downwind direction an area 0.2 miles wide and 0.3 miles long. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Wear positive-pressure breathing apparatus and special protective clothing. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Note that the ignition temperature is dangerously low: 100°C. Vapors may be ignited by contact with ordinary light bulb; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur. If the vapor concentration exceeds 2% by volume or is unknown, self-contained breathing mask with full face should be used by all persons entering contaminated area to fight fires. Wear special protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Use dry chemical, carbon dioxide, or other inert gas extinguishers. Foam may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is a very flammable liquid which evaporates rapidly. It burns with a blue flame to carbon dioxide (harmless) and sulfur dioxide. Sulfur dioxide has a strong suffocating odor; 1000 ppm in air is lethal to rats. The pure liquid presents an acute fire and explosion hazard. The following disposal procedure is suggested[22]: all equipment or contact surfaces should be grounded to avoid ignition by static charges. Absorb on vermiculite, sand, or ashes and cover with water. Transfer underwater in buckets to an open area. Ignite from a distance with an excelsior trail. If quantity is large, Carbon disulfide may be recovered by distillation and repackaged for use.

References

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US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Carbon Disulfide*. Washington, DC: Chemical Emergency Preparedness Program

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Carbon Disulfide*. Trenton, NJ

Carbon monoxide C:0480

Molecular Formula: CO

Synonyms: Carbone (oxyde de) (French); Carbonic oxide; Carbon oxide (CO); Exhaust gas; Flue gas; Kohlenmonoxid (German); Oxyde de carbone (French)

CAS Registry Number: 630-08-0

RTECS® Number: FG3500000

UN/NA & ERG Number: UN1016 (compressed)/119; NA9202 (cryogenic liquid)/168

EC Number: 211-128-3 [*Annex I Index No.:* 006-001-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 7/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R61; R12; R23; R48/23; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Carbon monoxide is a flammable, colorless, odorless, tasteless gas, partially soluble in water. Molecular weight = 28.01; Boiling point = − 192°C; Freezing/Melting point = −205°C; Relative vapor density (air = 1) = 0.97; Vapor pressure = >35 atm; Autoignition temperature = 605°C. The explosive limits are LEL = 12.5%; UEL = 74.20%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water; solubility = 2% at 20°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data. Carbon monoxide is used in metallurgy as a reducing agent, particularly in the Mond process for nickel; in organic synthesis, especially in the Fischer-Tropsch process for petroleum products, and in the oxo reaction; and in the manufacture of metal carbonyls. It is usually encountered in industry as a waste product of incomplete combustion of carbonaceous material (complete combustion produces CO_2). The major source of CO emission in the atmosphere is the gasoline-powered internal combustion engine. Special industrial processes which contribute significantly to CO emission are iron foundries, particularly the cupola; fluid catalytic crackers; fluid coking; and moving-bed catalytic crackers in thermal operations in carbon black plants; beehive coke ovens; basic oxygen furnaces, sintering of blast furnace feed in steel mills; and formaldehyde manufacture. There are numerous other operations in which a flame touches a surface that is cooler than the ignition temperature of the gaseous part of the flame where exposure to CO may occur, e.g., arc welding, automobile repair, traffic control, tunnel construction, fire fighting, mines, use of explosives, etc.

Incompatibilities: Forms extremely explosive mixture with air. Keep away from strong oxidizers. In the presence of finely dispersed metal powders the substance forms toxic and flammable carbonyls. May react vigorously with oxygen, acetylene, chlorine, fluorine, nitrous oxide.

Permissible Exposure Limits in Air

OSHA PEL: 50 ppm/55 mg/m^3 TWA.

NIOSH REL: 35 ppm/40 mg/m^3 TWA; 200 ppm/229 mg/m^3, Ceiling Concentration.

ACGIH TLV®[1]: 25 ppm/29 mg/m^3 TWA; BEI: 3.5% carboxyhemoglobin (CO-Hb) in blood at end-of-shift; 20 ppm CO in end-exhaled air at end-of-shift.

Protective Action Criteria (PAC)*

TEEL-0: 50 ppm

PAC-1: 83 ppm

PAC-2: **83** ppm

PAC-3: **330** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 30 ppm/35 mg/m^3 TWA; Peak Limitation Category II(1); Pregnancy Risk Group B; BAT: 5% carboxyhemoglobin (CO-Hb) in blood at end-of-shift.

NIOSH IDLH: 1200 ppm.

Arab Republic of Egypt: TWA 50 ppm (55 mg/m^3), 1993; Australia: TWA 50 ppm (55 mg/m^3); STEL 400 ppm (440 mg/m^3), 1993; Austria: MAK 30 ppm (33 mg/m^3), 1999; Belgium: TWA 50 ppm (57 mg/m^3); STEL 400 ppm (458 mg/m^3), 1993; Denmark: TWA 35 ppm (40 mg/m^3), 1999; Finland: TWA 30 ppm (34 mg/m^3); STEL 75 ppm (86 mg/m^3), 1999; France: VME 50 ppm (55 mg/m^3), 1999; India: TWA 50 ppm (55 mg/m^3); STEL 400 ppm (440 mg/m^3), 1993; Japan: 50 ppm (57 mg/m^3), 1999; the Netherlands: MAC-TGG 29 mg/m^3, 2003; Norway: TWA 35 ppm (40 mg/m^3), 1999; the Philippines: TWA 50 ppm (55 mg/m^3), 1993; Poland: MAC (TWA) 30 mg/m^3, MAC (STEL) 180 mg/m^3, 1999; Russia: TWA 50 ppm; STEL 20 mg/m^3, 1993; Sweden: NGV 35 ppm (40 mg/m^3), KTVSTEL 100 ppm (120 mg/m^3), 1999; Switzerland: MAK-W 30 ppm (35 mg/m^3), KZG-W 60 ppm (70 mg/m^3), 1999; Thailand: TWA 50 ppm (55 mg/m^3), 1993; Turkey: TWA 50 ppm (55 mg/m^3), 1993; United Kingdom: LTEL 50 ppm (55 mg/m^3); STEL 300 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 20 mg/m^3 in work-place air and MAC values for ambient air in residential areas of 3 mg/m^3 on a momentary basis and 1 mg/m^3 on an average daily basis. Several states have set guidelines or standards for CO in ambient air[60] ranging from 10−40 μg/m^3 (Arizona) to 1310 μg/m^3 (Nevada) to 10,000 μg/m^3 (10 mg/m^3) (Connecticut).

Determination in Air: NIOSH Analytical Method (IV) #6604, OSHA Analytical Methods ID-209 and ID-210.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient level of 552 μg/L based on health effects.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short Term Exposure: Carbon monoxide may affect the blood, cardiovascular system, and central nervous system. Exposure at high levels may result in a loss of consciousness and death. Carbon monoxide combines with hemoglobin to form carboxyhemoglobin which interferes with the oxygen-carrying capacity of blood, resulting in a state of tissue hypoxia. The typical signs and symptoms of acute CO poisoning are headache, dizziness, drowsiness, vomiting, collapse, coma, and death. Initially the victim is pale; later the skin and mucous membranes may be cherry-red in color. Loss of consciousness occurs at about the 50% carboxyhemoglobin level. The amount of carboxyhemoglobin formed is dependent on concentration and duration of CO exposure, ambient temperature, and health and metabolism of the individual. The formation of carboxyhemoglobin is a reversible process. Recovery from acute poisoning usually occurs without sequelae unless tissue hypoxia was severe enough to result in brain cell degeneration. Carbon monoxide at low levels may initiate or enhance deleterious myocardial alterations in individuals with restricted coronary artery blood flow and decreased myocardial lactate production. Severe carbon monoxide poisoning has been reported to permanently damage the extrapyramidal system, including the basal ganglia.

Long Term Exposure: Carbon monoxide may affect the nervous system and the cardiovascular system, causing neurological and cardiac disorders. Suspected to cause reproductive effects, such as neurological problems, low-birth weight, increased still births, and congenital heart problems. The DFG lists pregnancy risk to fetus probable.

Points of Attack: Central nervous system, lungs, blood, cardiovascular system.

Medical Surveillance: Preplacement and periodic medical examinations should give special attention to significant cardiovascular disease and any medical conditions which could be exacerbated by exposure to CO. Heavy smokers may be at greater risk. Methylene chloride exposure may also cause an increase in carboxyhemoglobin. Smokers usually have higher levels of carboxyhemoglobin than nonsmokers (often 5−10% or more). Carboxyhemoglobin levels are reliable indicators of exposure and hazard. Carboxyhemoglobin should be tested within a few hours following exposure to the gas. EKG. Examination of the nervous system. Persons with heart disease should not be exposed to levels of CO above 35 ppm. Medical tests listed by NIOSH: whole blood (chemical/metabolite)/carboxyhemoglobin (end-of-shift, end of work-week), complete blood count, expired air (end-of-shift, end of work-week).

First Aid: *Gas:* Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 min. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation for 24−48 h. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Refrigerated liquid: Move victims to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 min. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Under certain circumstances where carbon monoxide levels are not exceedingly high, gas masks with proper canisters can be used for short periods but are not recommended. In areas with high concentrations, self-contained air apparatus is recommended.

Respirator Selection: NIOSH: *350 ppm:* Sa (APF = 10) (any supplied-air respirator). *875 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *1500 ppm:* GmFS *end of service life indicator (ESLI) required.* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS *end of service life indicator (ESLI) required* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with Carbon monoxide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Carbon monoxide must be stored to avoid contact with strong oxidizers, such as chlorine or chlorine dioxide since violent reactions occur. Keep containers in a cool, well-ventilated area away from heat, flame, and sunlight. Metal containers involving the transfer of 5 gallons or more of liquid carbon monoxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of carbon monoxide. Sources of ignition, such as smoking and open flames, are prohibited where carbon monoxide is used, handled, or stored. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Carbon Monoxide (compressed or cryogenic liquid) must carry a "POISON GAS, FLAMMABLE GAS" label.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package) UN1016/UN 9202

Carbon monoxide & Carbon monoxide, compressed

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.7/2.7

Fire Extinguishing: This chemical is a flammable gas that can cause explosion. Use dry chemical extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Carbon monoxide can also be recovered from gas mixtures as an alternative to disposal.

References

National Institute for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Carbon Monoxide*, NIOSH Document No. 73-11000

National Academy of Sciences. (1977). *Medical and Biologic Effects of Environmental Pollutants: Carbon Monoxide*. Washington, DC

US Environmental Protection Agency. (1979). *Air Quality Criteria for Carbon Monoxide*, Report EPA 600/8-79-022. Research Triangle Park, NC: Environmental Criteria and Assessment Office

US Environmental Protection Agency. (August 18, 1980). *Carbon Monoxide: Proposed Revisions to the National Ambient Air Quality Standards.* Federal Register, 45, No. 161, 55066−55084

World Health Organization. (1979). *Carbon Monoxide*. Environmental Health Criteria No. 13. Geneva, Switzerland

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 43−45 (1981) and 3, No. 5, 87−89 (1983). New York: Van Nostrand Reinhold Co.

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Carbon Monoxide*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: Carbon Monoxide*. Trenton, NJ

Carbon oxysulfide C:0490

Molecular Formula: COS

Synonyms: Carbon monoxide monosulfide; Carbon oxide sulfide; Carbon oxygen sulfide; Carbon oxygen sulphide; Carbon oxysulphide; Carbonyl sulfide-(32)S; Carbonyl sulphide; Oxycarbon sulfide; Oxycarbon sulphide; SCO; Sulfuro de carbonilo (Spanish)

CAS Registry Number: 463-58-1

RTECS® Number: FG6475000; FG6400000

UN/NA & ERG Number: UN2204/119

EC Number: 207-340-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (carbon oxysulfide); *Theft hazard* 500 (≥56.67% concentration) (carbonyl sulfide).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Carbonyl oxysulfide is a colorless gas or cold liquid. Molecular weight = 60.07. Boiling point = −50°C. Flammable limits: LEL = 12%; UEL = 29%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 1.

Potential Exposure: Carbon oxysulfide is an excellent source of usable atomic sulfur; therefore, it can be used in various chemical syntheses, such as the production of episulfides, alkenylthiols, and vinylicthiols. It is also used to make viscose rayon.

It is probable that the largest source of Carbon oxysulfide is as a by-product from various organic syntheses and petrochemical processes. Carbon oxysulfide is always formed when carbon, oxygen, and sulfur, or their compounds, such as carbon monoxide, carbon disulfide, and sulfur dioxide, are brought together at high temperatures. Hence, carbon oxysulfide is formed as an impurity in various types of manufactured gases and as a by-product in the manufacture of carbon disulfide. Carbon oxysulfide is also often present in refinery gases.

Incompatibilities: COS can form explosive mixtures with air. Incompatible with strong bases. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 10 ppm
PAC-1: 30 ppm
PAC-2: **55** ppm
PAC-3: **150** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Can cause irritation of the eyes, skin, and respiratory tract. Contact with the liquefied gas can cause frostbite. Inhalation can cause irritation, coughing, and sneezing. High exposure can cause salivation, nausea, vomiting, diarrhea, sweating, weakness, and muscle cramps. It may cause tachycardia or arrhythmia. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. COS is an irritant to the lungs and trachea. It depresses the central nervous system. It can be fatal by paralysis of the respiratory system.[24] The acute toxicity of carbon oxysulfide was examined by Japanese workers. Exposure of laboratory animals to this contaminant of coal gas and petroleum gas was associated with pathological changes in the brain, medulla oblongata, liver, kidney, and lung. When rats were placed in chambers containing 0.05% and 0.2% Carbon oxysulfide, death occurred in 10 h and 0.5−1.0 h, respectively.

Long Term Exposure: High or repeated exposure may affect the nervous system causing headache, dizziness, and confusion with memory problems. May cause brain damage, reduced memory, inability to concentrate, and/or personality changes. COS can cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Lungs, brain, central nervous system.

Medical Surveillance: Evaluate the cerebellar, autonomic, and peripheral nervous systems. Brain functions. Tests include: EKG, complete nervous system evaluation, chest X-ray following acute overexposure.

First Aid: *Gas:* Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 min. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Refrigerated liquid: Move victims to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 min. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented impact-resistant goggles when working with gasses. When working with liquid, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear rubber gloves and coveralls.[24]

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with carbon oxysulfide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Carbon oxysulfide must be stored to avoid contact with bases and strong oxidizers since violent reactions occur. Keep containers in a cool, well-ventilated area away from heat, flame, and sunlight. Metal containers involving the transfer of 5 gallons or more of liquid carbon oxysulfide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of COS. Sources of ignition, such as smoking and open flames, are prohibited where carbon oxysulfide is used, handled, or stored. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Carbonyl oxysulfide must carry a "POISON GAS, FLAMMABLE GAS" label. It falls in Hazard Class 2.3 and there is no Packing Group listed. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and allow to vaporize. Or, cover the spill with weak hypochlorite solution (up to 15%). After 12 h, the produce may be neutralized and flushed to a sewer with abundant water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 2.1/3.3
Night 5.4/8.7

Fire Extinguishing: COS is a flammable gas or liquid. Fire may restart after it has been extinguished. Poisonous gases, including hydrogen sulfide and sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only

respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent, such as alcohol, benzene, etc. Burn in a furnace with afterburner and scrubber to remove SO_2.[22]

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Carbon Oxysulfide*, Publication No. TR79-607. Rockville, MD. pp. 34−38

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Carbonyl Sulfide*. Trenton, NJ

Carbon tetrabromide C:0500

Molecular Formula: CBr_4

Synonyms: Carbon bromide; Methane, tetrabromide; Methane, tetrabromo-; Tetrabromide methane; Tetrabromomethane

CAS Registry Number: 558-13-4

RTECS® Number: FG4725000

UN/NA & ERG Number: UN2516/151

IMDG Code: 6096

EC Number: 209-189-6

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Carbon tetrabromide is a colorless powder, white crystalline solid, or yellow-brown crystals. Slight odor. Molecular weight = 331.65; Boiling point = 189.8°C; Freezing/Melting point = 90°C; Vapor pressure = 40 mmHg at 96.1°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Very slightly soluble in water; solubility = 0.02%.

Potential Exposure: CBr_4 is used in organic synthesis.

Incompatibilities: Incompatible with strong oxidizers, lithium, and hexacyclohexyldilead since violent reactions occur.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 13.57 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.1 ppm/1.4 mg/m^3 TWA; 0.3 ppm/4 mg/m^3 STEL.

ACGIH TLV®[1]: 0.1 ppm/1.4 mg/m^3 TWA; 0.3 ppm/4.1 mg/m^3 STEL.

No TEEL available.

Australia: TWA 0.1 ppm (1.4 mg/m^3); STEL 0.3 ppm, 1993; Belgium: TWA 0.1 ppm (1.4 mg/m^3); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (1.4 mg/m^3), 1999; Finland: TWA 0.1 ppm (1.4 mg/m^3); STEL 0.4 ppm, [skin], 1999; France: VME 0.1 ppm (1.4 mg/m^3), 1999; Norway: TWA 0.1 ppm (1.4 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (1.4 mg/m^3), 1999; the Netherlands: MAC-TGG 1.4 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.3 ppm. Several states have set guidelines or standards for CBr_4 in ambient air[60] ranging from 14−40 μg/m^3 (North Dakota) to 20 μg/m^3 (Virginia) to 28 μg/m^3 (Connecticut) to 33 μg/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: The material is a potent lachrymator even at low concentrations. Carbon tetrabromide is corrosive to the eyes and skin and may cause permanent damage. Inhalation can cause severe irritation of the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. It can affect the nervous system, liver, and kidneys. Exposure to high concentrations may result in unconsciousness.

Long Term Exposure: The substance may damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: liver, kidney, and lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: kidney, liver, and lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 0.1 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Green: General storage may be used. Prior to working with carbon tetrabromide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials listed above.

Shipping: Carbon tetrabromide must carry a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Absorb liquid-containing Carbon tetrabromide in vermiculite, dry sand, earth, or similar material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Poisonous gases are produced in fire. Use any agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Purify by distillation and return to suppliers.

Reference

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Carbon Tetrabromide*. Trenton, NJ

Carbon tetrachloride C:0510

Molecular Formula: CCl_4

Synonyms: Benzinoform; Carbona; Carbon chloride; Carbon tet; ENT 4705; Fasciolin; Flukoids; Freon 10; Halon 104; Katharin; Methane tetrachloride; Methane, tetrachloro-; Necatorina; Necatorine; Perchloromethane; R 10; Tetrachloormetan; Tetrachlorkohlenstoff, tetra (German); Tetrachlormethan (German); Tetrachlorocarbon; Tetrachloromethane; Tetrachlorure de carbone (French); Tetracloruro de carbono (Spanish); Tetrafinol; Tetraform; Tetrasol; Twawpit; UN1846; Univerm; Vermoestricid

CAS Registry Number: 56-23-5

RTECS® Number: FG4900000

UN/NA & ERG Number: UN1846/151

EC Number: 200-262-8 [*Annex I Index No.:* 602-008-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human, Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B[9]; NTP: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 1.1.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U211, D019.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0.

RCRA Maximum Concentration Limit for Ground Water Protection (Section 264.94): 8010 (1); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Chemical: Cancer.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Toxic Substance List.
Mexico, Drinking water criteria, 0.004 mg/L.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R40; R48/23; R59; R52/53; Safety phrases: S1/2; S23; S36/37; S45; S59; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Carbon tetrachloride is a colorless, nonflammable liquid with a characteristic ether-like odor. The odor threshold is 0.52 mg/L in water and 140−548 ppm in air. Molecular weight = 153.84; Boiling point = 76.5°C; Freezing/Melting point = − 23°C; Vapor pressure = 91 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Very slightly soluble in water; solubility = 0.05%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Carbon tetrachloride is used as a solvent for oils, fats, lacquers, varnishes, rubber, waxes, and resins. Fluorocarbons are chemically synthesized from it. It is also used as an azeotropic drying agent for spark plugs, a dry-cleaning agent, a fire extinguishing agent, a fumigant, and an anthelmintic agent. The use of this solvent is widespread, and substitution of less toxic solvents when technically possible is recommended.

Incompatibilities: Oxidative decomposition on contact with hot surfaces, flames, or welding arcs. Carbon tetrachloride decomposes forming toxic phosgene fumes and hydrogen chloride. Decomposes violently (producing heat) on contact with chemically active metals, such as aluminum, barium, magnesium, potassium, sodium, fluorine gas, allyl alcohol, and other substances, causing fire and explosion hazard. Attacks copper, lead, and zinc. Attacks some coatings, plastics, and rubber. Becomes corrosive when in contact with water; corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 6.29 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm TWA; 25 ppm STEL; 200 ppm [5-min maximum peak in any 3 h] STEL.
NIOSH REL: 2 ppm/12.6 mg/m^3 STEL [60 min] STEL; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. *See NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 5 ppm/31 mg/m^3 TWA; 10 ppm/63 mg/m^3 STEL [skin]; Suspected Human Carcinogen.
Protective Action Criteria (PAC)*
TEEL-0: 10 ppm
PAC-1: **44** ppm
PAC-2: **190** ppm
PAC-3: **520** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 0.5 ppm/3.2 mg/m^3 TWA; Peak Limitation Category.
II(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 3.5 μg/L in blood end-of-shift.
NIOSH IDLH: 200 ppm.
Arab Republic of Egypt: TWA 5 ppm (30 mg/m^3), [skin], 1993; Australia: TWA 5 ppm (30 mg/m^3), [skin], carcinogen, 1993; Austria: MAK 10 ppm (65 mg/m^3), [skin], Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (31 mg/m^3), [skin], carcinogen, 1993; Denmark: TWA 2 ppm (13 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (31 mg/m^3); STEL 10 ppm (63 mg/m^3), [skin], carcinogen, 1999; France: VME 2 ppm (12 mg/m^3), VLE 10 ppm (60 mg/m^3), carcinogen, 1999; India: TWA 5 ppm (30 mg/m^3), [skin], carcinogen, 1993; Japan: 5 ppm (31 mg/m^3), [skin], 2B carcinogen, 1999; Norway: TWA 2 ppm (13 mg/m^3), 1999; the Philippines: TWA 10 ppm (65 mg/m^3), [skin], 1993; Poland: MAC (TWA) 20 mg/m^3, MAC (STEL) 100 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 20 mg/m^3, 1993; Sweden: NGV 2 ppm (13 mg/m^3), KTV 3 ppm (19 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-W 5 ppm (30 mg/m^3); STEL 10 ppm (60 mg/m^3), [skin], 1999; Thailand: TWA 10 ppm; STEL 25 ppm, 1993; the Netherlands: MAC-TGG 3.2 mg/m^3, [skin], 2003; United Kingdom: TWA 2 ppm (13 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm [skin]. Several states have set guidelines or standards for CCl_4 in ambient air[60] ranging from zero (North Dakota) to 0.03 μg/m^3 (Rhode Island) to 0.0667 μ/m^3 (Indiana) to 0.67 μg/m^3 (Massachusetts and North Carolina) to 72 μg/m^3 (Pennsylvania) to 100 μg/m^3 (New York) to 150 μg/m^3 (South Carolina) to 300 μg/m^3 (Connecticut and Virginia) to 714 μg/m^3 (Nevada).

Determination in Air: Charcoal adsorption followed by workup with CS_2 and analysis by gas chromatography; Use NIOSH Analytical Method #1003 for Hydrocarbons, Chlorinated or OSHA Analytical Method 7, Organic Vapors.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 2000 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 50,000 μg/L on an acute toxicity basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is presented by a concentration of 4.0 μg/L. Mexico's drinking water criteria is 0.004 mg/L.

The former USSR-UNEP/IRPTC joint project[43] set a MAC of 0.3 mg/L in water bodies used for domestic purposes. The US EPA[48] has set a lifetime health advisory of 0.0007 mg/kg/day and a drinking water equivalent level of 25 μg/L. Several states have set standards and guidelines for CCl_4 in drinking water[61] ranging from standards of 2 μg/L (New Jersey) to 3 μg/L (Florida) to 10 μg/L (New Mexico) and guidelines of 2.7 μg/L (Minnesota) to 5 μg/L (California, Kansas and Maine, Colorado).

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} (octanol/water partition coefficient) = 2.6.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, skin, and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Carbon tetrachloride irritates the eyes, causing redness.

Inhalation: Levels of 20 ppm may cause dizziness, headache, vomiting, visual disturbances, extreme fatigue, nose and throat irritation. Other symptoms may include restlessness, loss of balance, twitching, and tremors. Severe exposure can lead to liver, kidney, eye, and nerve damage that may be delayed after exposure; can cause stoppage of breathing, coma, and death. 1000 ppm for an unspecified time has caused death. *Skin:* May cause irritation and redness; carbon tetrachloride is readily absorbed through the skin. Symptoms as listed above may occur through skin absorption even when vapor concentrations are below OSHA Standards. *Ingestion:* May cause severe abdominal pain with diarrhea, followed by symptoms described under inhalation. Death may occur by ingestion of as little as ½ teaspoon. Between 45 and 100 ppm, carbon tetrachloride may cause headache, drowsiness, fatigue, nausea, and vomiting. 100−300 ppm may cause additional effects of mental confusion, weight loss, and sluggishness. Liver, kidney, eye, and nerve damage can result from more severe exposures. Coma and death may occur.

Long Term Exposure: Repeated or prolonged skin contact may cause dermatitis. Carbon tetrachloride is a possible human carcinogen. Cancer site in animals: liver.

Points of Attack: Central nervous system, eyes, lungs, liver, kidneys, skin.

Medical Surveillance: Preplacement and periodic examinations should include an evaluation of alcohol intake and appropriate tests for liver and kidney functions. Special attention should be given to the central and peripheral nervous system, the skin, and blood. Expired air and blood levels may be useful as indicators of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm²/min): polyvinyl alcohol gloves; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Responder™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 0.1 μg/cm²/min): Teflon™ gloves, suits, boots. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 500) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbon tetrachloride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Carbon tetrachloride must be stored to avoid contact with chemically active metals, such as sodium, potassium, and magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Carbon tetrachloride requires a “POISONOUS/TOXIC MATERIALS” label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of

spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire, including phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.[22] Recover and purify by distillation where possible.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Carbon Tetrachloride*, NIOSH Document No. 76-133

US Environmental Protection Agency. (1980). *Carbon Tetrachloride: Ambient Water Quality Criteria.* Washington, DC

National Academy of Sciences. (1978). *Chloroform, Carbon Tetrachloride and Other Halomethanes: An Environmental Assessment.* Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 30−32 (1980) and 3, No. 5, 88−94 (1983)

US Public Health Service. (December 1988). *Toxicological Profile for Carbon Tetrachloride*. Atlanta, Georgia: Agency for Toxic Substance and Disease Registry

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Carbon Tetrachloride*. Trenton, NJ

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Carbon Tetrachloride*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Carbonyl fluoride C:0520

Molecular Formula: CF_2O
Common Formula: COF_2
Synonyms: Carbon difluoride oxide; Carbon fluoride oxide; Carbonic difluoride; Carbon oxyfluoride; Carbonyl difluoride; Difluoroformaldehyde; Fluophosgene; Fluoroformyl fluoride; Fluorophosgene; Fluoruro de carbonilo (Spanish)
CAS Registry Number: 353-50-4
RTECS® Number: FG6125000
UN/NA & ERG Number: UN2417 (Toxic-Inhalation Hazard Zone B)/125
EC Number: 206-534-2

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥12.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U033.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TPQ = 10,000 lb (4540 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Carbonyl fluoride is a carboxy halide. It is colorless or light yellow, hygroscopic, compressed liquefied gas, with a pungent, highly irritating and suffocating odor. Molecular weight = 66.01; Specific gravity (H_2O:1) = 1.39 at −190°C; Boiling point = −83°C; Freezing/Melting point = −114°C; Relative vapor density (air = 1) = 2.29; Vapor pressure = 55.4 atm. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity ₩. Reacts with water.

Potential Exposure: The major source of exposure to COF_2 results from the thermal decomposition of fluorocarbon plastics, such as PTFE in air. Carbonyl fluoride is used for synthesizing fluoroalkanes, difluoroisocyanates, and fluorinated alkyl isocyanates. It has been suggested for use as a military poison gas.

Incompatibilities: Reacts with water to form toxic and corrosive hydrogen fluoride (HF) gas. HF gas is highly reactive and forms explosive hydrogen gas on contact with metals. Do not use cast iron or malleable fittings with carbonyl fluoride. Carbonyl fluoride decomposes on heating above 450°C producing toxic gases, including hydrogen fluoride. Not compatible with hexafluoroisopropylidene-amino lithium.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2 ppm/5 mg/m^3 TWA; 5 ppm/15 mg/m^3 STEL.
ACGIH TLV®[1]: 2 ppm/5.4 mg/m^3 TWA; 5 ppm/13 mg/m^3 STEL.
Protective Action Criteria (PAC)*
TEEL-0: 0.28 ppm
PAC-1: 0.28 ppm
PAC-2: **0.28** ppm
PAC-3: **0.83** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Australia: TWA 2 ppm (5 mg/m^3); STEL 5 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Denmark: TWA 2.99 m (6 mg/m^3), 1999; Finland: STEL 2 ppm (5 mg/m^3), 1999; France: VME 2 ppm (5 mg/m^3), 1999; Norway: TWA 2 ppm (5 mg/m^3), 1999; Poland: MAC (TWA) 1 mg(HF)/m^3, MAC (STEL) 3 mg(HF)/m^3, 1999; Switzerland: MAK-W 2 ppm (5 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 5 ppm. Several states have set guidelines or standards for COF_2 in ambient air[60] ranging from 50−150 μg/m^3 (North Dakota) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: None available.

Routes of Entry: Inhalation, skin and/or eye contact. May be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: The substance irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Rapid evaporation of the liquid may cause frostbite. On an acute basis, COF_2 is about as toxic as HF as a respiratory irritant gas. Carbonyl fluoride is rapidly hydrolyzed to hydrofluoric acid and carbon dioxide. Hydrogen fluoride burns on skin or in eyes cause immediate redness, severe pain, possible swelling, and may lead to early necrosis. See entry on hydrogen fluoride: H:0450. Prompt medical attention is essential, if not mandatory.

Long Term Exposure: The long-term effects are due to the fluoride ion generated by hydrolysis; this inhibits succinic dehydrogenase activity, since this is a fluoride-sensitive enzyme. May cause liver and kidney damage. Repeated exposure may cause bronchitis. Chronic exposure: gastrointestinal pain, muscle fibrosis, skeletal fluorosis (NIOSH).

Points of Attack: Eyes, skin, respiratory system, bone, liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact-resistant goggles when working with gas. Wear indirect-vent and splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA (APF = 10)* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or *† *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Storage area must be absolutely dry.

Shipping: Carbonyl fluoride must be labeled “TOXIC GAS, CORROSIVE.” It falls in Hazard Class 2.3 and there is no Packing Group listed. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. *Do not use water or wet method.* Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Carbonyl fluoride and carbonyl fluoride, compressed

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.9/3.1

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Carbonyl Fluoride*. Trenton NJ

Carbophenothion C:0530

Molecular Formula: $C_{11}H_{16}ClO_2PS_3$

Common Formula: $(C_2H_5O)_2PSSCH_2SC_6H_4Cl$

Synonyms: Acarithion®; Akarithion; *S*-[(*p*-Chlorophenylthio)methyl] *O*,*O*-diethyl phosphorodithioate; *S*-(4-Chlorophenylthiomethyl)diethyl phosphorothiolothionate; Dagadip®; *O*,*O*-Diaethy-S-[(4-chlor-phenyl-thio)-methyl]dithiophosphat (German); *O*,*O*-Diethyl *S*-*p*-chlorophenylthiomethyl dithiophosphate; *O*,*O*-Diethyl *S*-(*p*-chlorophenylthiomethyl) phosphorodithioate; *O*,*O*-Diethyldithiophosphoric acid, *p*-chlorophenylthiomethyl ester; *O*,*O*-Diethyl *p*-chlorophenylmercaptomethyl dithiophosphate; *O*,*O*-Diethyl 4-chlorophenylmercaptomethyl dithiophosphate; Dithiophosphate de *O*,*O*-diethyle et de (4-chlorophenyl) thiomethyle (French); Endyl; ENT 23,708; Garrathion®; Lethox; Nephocarb®; Oleoakarithion; R-1303; Stauffer R-1,303; Trithion® miticide

CAS Registry Number: 786-19-6

RTECS® Number: ID5250000

UN/NA & ERG Number: UN3018 (organophosphorus pesticides, liquid, toxic)/152

EC Number: 212-324-1 [*Annex I Index No.:* 015-044-00-6]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (India) (UN).[13]

Very Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Carbophenothion is a colorless to light amber liquid with a characteristic odor. Molecular weight = 342.87.

Specific gravity (H_2O:1) = 1.3; Boiling point = 82°C at 0.01 mmHg; Relative vapor density (air = 1) = 11.78. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Those engaged in the manufacture or application of this material, which is an insecticide and acaricide; primarily for citrus crops and deciduous fruits and nuts. Compound Description: Agricultural Chemical; Mutagen.

Incompatibilities: The substance decomposes on heating or on burning, producing toxic fumes including phosphorus oxides, sulfur oxides, hydrogen chloride. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 6.8 mg/m^3

PAC-3: 6.8 mg/m^3

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} (octanol/water partition coefficient) = 5.1.

Routes of Entry: Inhalation, ingestion and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance may affect the nervous system, resulting in convulsions and respiratory failure. Cholinesterase inhibitor. Exposure may result in death. Produces headaches, nausea, weakness, and dizziness. Symptoms may include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, weakness, muscle twitching, difficult breathing, blurring or dimness of vision, and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. This material is highly toxic; the estimated fatal oral dose is 0.6 g for a 150-lb (70 kg) person. Oral LD_{50} for rats is 6.8 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible: see acute hazards/symptoms. The state of Massachusetts lists this chemical as a neurotoxin.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Requires a DOT label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19,20]

Spill Handling: Stay upwind; keep out of low areas. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The substance decomposes on heating or on burning producing toxic fumes including phosphorus oxides, sulfur oxides, hydrogen chloride. This material may burn, but does not ignite readily. For small fires: use dry chemicals, carbon dioxide; water spray, or foam. For large fires: use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in heat of fire. Fire and runoff from fire control water may produce irritating or poisonous gases. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis by hypochlorites may be used, as may incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 55−59. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Carbophenothion.* Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Carboxin C:0540

Molecular Formula: $C_{12}H_{13}O_2NS$

Common Formula: $C_6H_2NHCO-C_5OSH_7$

Synonyms: Carbathiin; 5-Carboxanilido-2,3-dihydro-6-methyl-1,4-oxathiin; Carboxine; Carboxin oxathion pesticide; Caswell No. 165 A; D-735; DCMO; 2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin; 2,3-Dihydro-6-methyl-1,4-oxathiin-5-carboxanilide; 5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide; 2,3-Dihydro-6-methyl-5-phenylcarbamoyl-1,4-oxathiin; 5,6-Dihydro-2-methyl-*N*-phenyl-1,4-oxathiin-3-carboxamide;-DMOC; EPA pesticide chemical code 090201; F-735; Flo Pro V seed protectant; NSC 263492; 1,4-Oxathiin-3-carboxamide,5,6-dihydro-2-methyl-*N*-phenyl; 1,4-Oxathiin-3-carboxanilide,5,6-dihydro-2-methyl; 1,4-Oxathiin-3-carboxanilide,5,6-dihydro-2-methyl-; 1,4-Oxathiin-2,3-dihydro-5-carboxanilido-6-methyl; V 4X; Vitaflo; Vitavax; Vitavax 100; Vitavax 735d; Vitavax 75 PM; Vitavax 75W

CAS Registry Number: 5234-68-4

RTECS® Number: RP4550000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 226-031-1

Regulatory Authority and Advisory Bodies

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Carboxin is a white crystalline solid. Molecular weight = 235.32; Freezing/Melting point = 91.5−95°C (depending on crystal structure); Vapor pressure = 1.78×10^{-7} mmHg. Practically insoluble in water; solubility = 25 mg/L; 0.15 g/L at 20°C.

Potential Exposure: Those involved in the production, formulation, and application of this systemic fungicide, seed protectant and wood preservative. Human toxicity (long term)[77]: Extra high—0.91 ppb, Health Advisory; Fish toxicity (threshold)[77]: High—1.06008 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Incompatibilities: Keep away from strong oxidizers. Avoid heat and humidity. Decomposition products include cyanide gas and cyanide salts.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: The no-observed-adverse-effect level has been determined by EPA to be 10 mg/kg body weight/day. This results in a long-term health advisory of 3.5 mg/L and a lifetime health advisory of 0.7 mg/L.

Determination in Water: Analysis of carboxin is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen-phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen-phosphorus detector. The method detection limit has not been determined for carboxin, but it is estimated that detection limits for analyses included in this method are in the range of 0.1−2 μg/L.

Harmful Effects and Symptoms

LD_{50} = (oral-mouse) 3550 mg/kg (slightly toxic). A value for LD_{50} rat of 430 mg/kg puts carboxin in the moderately toxic category.

Short Term Exposure: Harmful if inhaled or absorbed by the skin or eyes.

Long Term Exposure: Based on animal studies, carboxin may cause kidney effects or result in damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carboxin you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Requires a DOT label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1; Packing Group N/A.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including cyanide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

Reference

US Environmental Protection Agency. (1987). *Health Advisory: Carboxin*. Washington, DC: Office of Drinking Water, 8

Carmustine C:0550

Molecular Formula: $C_5H_9C_{12}N_3O_2$
Synonyms: BCNU; BiCNU; Bischloroethyl nitrosourea; *N, N′*-Bis(2-chloroethyl)-*N*-nitrosourea; Carmubris; Carmustin; FDA 0345
CAS Registry Number: 154-93-8
RTECS® Number: YS2625000
UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151
EC Number: 205-838-2
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: (BCNU) Animal Sufficient Evidence; Human, Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1998; NTP: Reasonably anticipated to be a human carcinogen; NCI: some evidence, rat; clear evidence, mouse.
California Proposition 65 Chemical: Cancer 7/1/87; Developmental/Reproductive toxin 7/1/90.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Carmustine is an orange-yellow crystalline solid or powder. Molecular weight = 114.1; Freezing/Melting point = 30−32°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0.
Potential Exposure: BCNU has been used since 1971 as an antineoplastic agent in the treatment of Hodgkin's lymphoma, multiple myeloma, and primary or metastatic brain tumors. It also has been reported to have antiviral, antibacterial, and antifungal activity, but no evidence was found that it is used in these ways. BCNU is not known to be naturally occurring. Health professionals who handle this drug (e.g., pharmacists, nurses, and physicians) may possibly be exposed to BCNU during drug preparation, administration, or cleanup; however, the risks can be avoided through use of containment equipment and proper work practices.
Incompatibilities: Acids and acid solutions above pH 7 cause rapid decomposition. Most stable at pH 4 in aqueous solution or petroleum ether.[NTP]
Permissible Exposure Limits in Air
No standards or TEEL available.
As a confirmed carcinogen, exposure must be kept to the lowest feasible level.
Harmful Effects and Symptoms
Short Term Exposure: Symptoms include nausea, vomiting, diarrhea, dyspnea; flushing of the skin; esophagitis; cytotoxic effects on the liver, kidneys, and central nervous system; delayed bone marrow suppression (e.g., leukopenia and thrombocytopenia). LD_{50} = (oral-rat) 120 mg/kg (highly toxic).
Long Term Exposure: Potential human carcinogen. May cause liver, kidney, and nervous system damage.
Points of Attack: Liver, kidney, central nervous system, bone marrow.
Medical Surveillance: Liver and kidney function tests. Examination of the nervous system.
First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Escape: 100F (APF = 50) (any air-purifying, full-face-piece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids.[52] A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Requires a DOT label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% ethanol to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Carvone C:0560

Molecular Formula: $C_{10}H_{14}O$

Synonyms: D-Carvone; δ-Carvone; dextro-Carvone; 1-6, 8 (9)-*p*-Menthadien-2-one; δ-1-Methyl-4-isopropenyl-6-cyclohexen-2-one

CAS Registry Number: 2244-16-8

RTECS® Number: OS8670000

EC Number: 218-827-2

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Carvone is a pale yellow to white clear liquid. Molecular weight = 150.22; Boiling point = 230°C; Flash point = 93°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 2, Reactivity 0.

Potential Exposure: Compound Description*:* Mutagen, Primary irritant. Carvone is found in various natural oils, including caraway and dill seed, mandarin peel and spearmint oils. A food additive, it is used in flavoring liqueurs; in perfumes and soaps.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. This material is highly toxic by ingestion on skin absorption. LD_{50} = (oral-rat) 3.71 mg/kg.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to all rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in a cool, dry place or in a refrigerator.

Shipping: "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter, or has a flash point above 60.5°C/141°F but *below* 93°C. This chemical has a flash point of 93°C.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well first with alcohol, then with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to

clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Carvone*. Washington, DC: Chemical Emergency Preparedness Program

Catechol C:0570

Molecular Formula: $C_6H_6O_2$

Common Formula: $C_6H_4(OH)_2$

Synonyms: Benzene, *o*-dihydroxy-; *o*-Benzenediol; 1,2-Benzenediol; Burmar Nophenol-922 HB; Catacol (Spanish); Catechin; C.I. 76500; C.I. Oxidation base 26; *o*-Dihydroxybenzene; 1,2-Dihydroxybenzene; *o*-Dioxybenzene; *o*-Diphenol; Durafur developer C; Fouramine PCH; Fourrine 68; *o*-Hydroquinone; *o*-Hydroxyphenol; 2-Hydroxyphenol; NCI-C55856; Oxyphenic acid; P-370; Pelagol grey C; *o*-Phenylenediol; Pyrocatechin; Pyrocatechine; Pyrocatechinic acid; Pyrocatechol; Pyrocatechuic acid

CAS Registry Number: 120-80-9

RTECS® Number: UX1050000

UN/NA & ERG Number: UN2811/154

EC Number: 204-427-5 [*Annex I Index No.:* 604-016-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999.

Banned or severely restricted (The Czech Republic) (In Cosmetics).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/15/03.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/21/22; R36/38; Safety phrases: S2; S22; S26; S27 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Catechol is a white crystalline solid. Turns brown on contact with light and air. Molecular weight = 110.12; Specific gravity (H_2O:1) = 1.3; Boiling point = 245.5°C; Freezing/Melting point = 104°C. It sublimes readily; Vapor pressure = 10 mmHg at 117°C; Flash point = 127°C; Autoignition temperature = 512°C. Explosive Limits in air: LEL = 1.4%; UEL−Unknown. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 1, Reactivity 2. Solubility in water = 44%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Used as a chemical intermediate; pharmaceutical and veterinary drug; as an antiseptic; in photography; in dyestuff manufacture and application. It is also used in electroplating, in the formulation of specialty inks, in antioxidants, and light stabilizers.

Incompatibilities: Strong oxidizers, nitric acid.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 ppm/20 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/23 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 7.5 ppm

PAC-3: 25 ppm

Australia: TWA 5 ppm (20 mg/m^3), 1993; Austria: MAK 5 pppm (20 mg/m^3), 1999; Belgium: TWA 5 ppm (23 mg/m^3), 1993; Denmark: TWA 5 ppm (20 mg/m^3), 1999; Finland: TWA 5 ppm (22 mg/m^3); STEL 10 ppm (45 mg/m^3), 1999; France: VME 5 ppm (20 mg/m^3), 1999; the Netherlands: MAC-TGG 20 mg/m^3, 2003; Norway: TWA 5 ppm (20 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (23 mg/m^3), 1999; United Kingdom: TWA 5 ppm (23 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for catechol in ambient air[60] ranging from 200 μg/m^3 (North Dakota) to 350 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 476 μg/m^3 (Nevada).

Determination in Air: None available.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 280 μg/L on a health basis. Russia set a MAC of 0.1 mg/L in surface water.

Determination in Water: Log $K_{ow} = 0.9$.

Routes of Entry: Skin absorption, skin and eye contact, inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Catechol can affect you when breathed in. It can also rapidly enter the body through the skin. Death can occur from extensive skin contact. Lower exposures can cause skin burns, headaches, nausea, muscle twitching, and convulsions. Skin allergy with rash can also occur. Catechol is a lacrimator. It irritates the respiratory and digestive tracts. It is corrosive to the eyes and can cause severe burns. The substance may affect the central nervous system causing depression, convulsions, and respiratory failure. Because this is a mutagen, handle it as a possible cancer-causing substance, with extreme caution. Exposure lowers the ability of the blood to carry oxygen, causing a bluish color of the skin. Absorption through the skin results in illness akin to that which phenol produces except convulsions are more pronounced. Catechol increases blood pressure, apparently from peripheral vasoconstriction. Catechol can cause death, apparently initiated by respiratory failure. LD_{50} = (rat-oral) 260 mg/kg (moderately toxic).

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. A mutagen that may have a cancer or reproductive risk. High or repeated damage may cause kidney and liver damage. Repeated lower exposures can cause methemoglobinemia, with blue color to the skin, rapid breathing, and dizziness.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: tests for liver and kidney function. Blood methemoglobin level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered, air-purifying respirator. If while wearing a filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect 1,2-Dihydroxybenzene, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with catechol you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and acids. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic solids, organic, require a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust or use a vacuum. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, alcohol foam, or carbon dioxide. Water and conventional foam may be ineffective.[41] Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 1,2-Dihydroxybenzene*. Trenton, NJ

Cesium hydroxide C:0580

Molecular Formula: CsHO

Common Formula: CsOH

Synonyms: Caesium hydroxide; Cesium hydrate; Cesium hydroxide dimer

CAS Registry Number: 21351-79-1

RTECS® Number: FK9800000

UN/NA & ERG Number: UN2682 (solid)/157; UN2681 (solution)/154

EC Number: 244-344-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cesium hydroxide is a colorless-to-yellow crystalline compound. It is often used in a water solution. Molecular weight = 142.92; Specific gravity (H_2O:1) = 3.68; Freezing/Melting point = 272°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 0, Reactivity 0. Highly soluble in water; solubility 395% at 15°C.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Cesium hydroxide may be used as a raw material for other cesium salts; such as the chloride which in turn may be used to produce cesium metal. Cesium metal is used in electronic devices.

Incompatibilities: Cesium hydroxide is the strongest base known. It must be stored in silver or platinum and out of contact with air because of its reactivity with glass. CsOH causes the generation of considerable heat in contact with water or moisture. Contact with many organic compounds, many metals (i.e., aluminum, lead, tin, zinc), glass, oxygen, or carbon dioxide causes a violent reaction.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2 mg/m^3 TWA.

ACGIH TLV®[1]: 2 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 250 mg/m^3

Australia: TWA 2 mg/m^3, 1993; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3, 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Russia: STEL 0.3 mg/m^3, 1993; United Kingdom: TWA 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3. Several states have set guidelines or standards for CsOH in ambient air[60] ranging from 20 μg/m^3 (North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 48 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. This chemical is corrosive to the eyes and can cause permanent damage. LD_{50} = (oral-rat) 570 mg/kg (slightly toxic).

Long Term Exposure: May cause lung irritation with the development of bronchitis, shortness of breath, coughing, phlegm.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: *Clothing:* Avoid skin contact with cesium hydroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. ACGIH recommended protective gloves be made of butyl rubber, natural rubber, nitrile rubber, Neoprene™, or polyvinyl chloride. *Eye Protection:* Wear dust-proof goggles and face shield when working with powders or dusts unless full face-piece respiratory protection is worn. Wear gas-proof goggles and face shield where cesium hydroxide is in solution, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures over 2 mg/m^3, use a MSHA/NIOSH-approved full face-piece respirator equipped with a particulate (dust/fume/mist) filter. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—White: Corrosive or Contact Hazard: Store separately in a corrosion-resistant location. Prior to working with cesium hydroxide you should be trained on its proper handling and storage. Cesium hydroxide should be stored in silver or platinum away from air because it reacts violently with oxygen. Store in tightly closed containers in a cool, well-ventilated area away from moisture and incompatible materials listed above.

Shipping: Cesium hydroxide must bear a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water* in cleanup. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Do not use water*. Use dry chemical appropriate for extinguishing metal fires. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Cesium Hydroxide*. Trenton, NJ

Chloral C:0590

Molecular Formula: C_2HCl_3O

Common Formula: CCl_3CHO

Synonyms: Acetaldehyde, trichloro-; Anhydrous chloral; Chloral, anhydrous, inhibited; Cloralio; Ethanal, trichloro-; Grasex; 2,2,2-Trichloroacetaldehyde; Trichloroacetaldehyde; Trichloroethanal; Tricloroacetaldehido (Spanish)

CAS Registry Number: 75-87-6 (chloral); 302-17-0 (chloral hydrate)

RTECS® Number: FM7870000 (chloral); FM8750000 (chloral hydrate)

UN/NA & ERG Number: UN2075 (chloral, anhydrous, inhibited); UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-911-5; 206-117-5 [*Annex I Index No.:* 605-014-00-6 (chloral hydrate)]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*chloral and chloral hydrate*): Animal, limited evidence; Human, inadequate evidence, *not classifiable as carcinogenic to humans*, Group 3, 1995; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; EPA (*chloral hydrate*): Possible Human Carcinogen; (*oral*): Cannot be determined.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U034, as chloral.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as chloral.

Reportable Quantity (RQ): 5000 lb (2270 kg), as chloral.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as chloral.

European/International Regulations: Hazard Symbol: T (*chloral hydrate*); Risk phrases: R25; R36/38; Safety phrases: S1/2; S25; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*chloral hydrate*).

Description: Chloral is a combustible, oily liquid with a pungent irritating odor. Molecular weight = 147.38; Boiling point = 97−98°C; Flash point = 75°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 1. Soluble in water. Chloral hydrate is colorless crystals, with characteristic odor. Molecular weight = 165.40; Boiling point = 97°C (decomposes); Freezing/Melting point = 57−60°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 1. Very soluble in water.

Potential Exposure: Compound Description (chloral hydrate): Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Chloral is used as an intermediate in the manufacture of such pesticides as DDT, methoxychlor, DDVP, naled, trichlorfon, and TCA. Chloral is also used in the production of chloral hydrate; used as a therapeutic agent with hypnotic, sedative, and narcotic effects; used in a time prior to the introduction of barbiturates.

Incompatibilities: Chloral hydrate reacts with strong bases forming chloroform. Contact with acids, or exposure to light may cause polymerization. Reacts with water, forming chloral hydrate. Reacts with oxidizers, with a risk of fire or explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 40 mg/m^3

Chloral hydrate

TEEL-0: 7.5 mg/m^3
PAC-1: 25 mg/m^3
PAC-2: 125 mg/m^3
PAC-3: 125 mg/m^3

Russia has recommended a maximum concentration in work-room air of 220 mg/m^3.

Permissible Concentration in Water: There are no US criteria but Russia has set 0.2 mg/L as the MAC for water bodies used for domestic purposes.[43]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1$.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, respiratory tract. Skin and eye contact may cause burns. Chloral may affect the central nervous system, kidneys, liver, and the cardiovascular system causing impaired functions or damage. Exposure to high levels may cause tiredness, dizziness, lightheadedness, and loss of consciousness. Specific information on the pharmacokinetic behavior, carcinogenicity, mutagenitcity, teratogenicity, and other reproductive effects of chloral was not found in the available literature. However, the pharmacokinetic behavior of chloral may be similar to chloral hydrate, where metabolism to ritchloroethanol and trichloroacetic acid and excretion via the urine (and possibly bile) have been observed. Chloral hydrate produced skin tumors in 4 of 20 mice dermally exposed. Alcohol synergistically increases the depressant effect of the compound, creating a potent depressant commonly referred to as "Mickey Finn" or "knock-out drops." Addiction to chloral hydrate through intentional abuse of the compound has been reported.

Long Term Exposure: Repeated skin contact may cause acne-like rash. Repeated contact may cause sedation. Chronic effects from respiratory exposure to chloral as indicated in laboratory animals include reduction of kidney function and serum transaminase activity; change in central nervous system function (unspecified); decrease in antitoxic and enzyme-synthesizing function of the liver; and alteration of morphological characteristics of peripheral blood. Slowed growth rate, leukocytosis, and changes in the arterial blood pressure were also observed.

Points of Attack: Inhalation, ingestion.

Medical Surveillance: Lung function tests. Serum trichloroethanol level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for exposure to chloral:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloral you should be trained on its proper handling and storage. Protect from light, moisture, air, and acids. DEA regulations require storage in a locked storage area. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloral, anhydrous, inhibited, and chloral hydrate require a "POISONOUS/TOXIC MATERIALS" label. Chloral falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire, including hydrogen chloride. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel; care must be taken to assure complete combustion to prevent phosgene formation; an acid scrubber is necessary to remove the halo acids produced.

References

US Environmental Protection Agency. (April 30, 1980). *Chloral: Health and Environmental Effects Profile No. 34.* Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Chloral.* Trenton, NJ

Chloramben C:0600

Molecular Formula: $C_7H_5Cl_2NO_2$

Synonyms: ACP-M-728; Amben®; Ambiben®; Amiben®; Amibin®; 3-Amino-2,5-dichlorobenzoic acid; 3-Amino-2,6-dichlorobenzoic acid; Amoben; Benzoic acid, 3-amino-2,5-dichloro-; Chlorambed; Chloramben, aromatic carboxylic acid; Chloramben benzoic acid herbicide; Chlorambene; 2,5-Dichloro-3-aminobenzoic acid; NCI-C00055; Ornamental weeder; Vegaben®; Vegiben®; Weedone garden weeder

CAS Registry Number: 133-90-4

RTECS® Number: DG1925000

UN/NA & ERG Number: UN2588/151

EC Number: 205-123-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies; positive evidence: mouse; NCI: Results negative, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloramben is a colorless, odorless, crystalline solid. Molecular weight = 206.03; Freezing/Melting point = 200−201°C; Vapor pressure = 6.8×10^{-3} mmHg at 100°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 690 ppm at 25°C.

Potential Exposure: A General Use Pesticide (GUP) that is no longer produced or sold in the United States. It is used as a herbicide for grasses, broadleaf weeds, soybeans, beans, and some vegetables. Workers involved in the manufacture, formulation, or application of this reemergence herbicide. Human toxicity (long term)[77]: Very low—100.00 ppb, Health Advisory. Fish toxicity (threshold)[77]: Very low—1584.89319 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Incompatibilities: Rapidly decomposed by light. Strong acids and acid fumes.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.04 mg/m^3
PAC-1: 0.125 mg/m^3
PAC-2: 0.75 mg/m^3
PAC-3: 500 mg/m^3
Russia set a MAC of 0.01 mg/m^3 in ambient air in residential areas on a momentary basis and 0.006 mg/m^3 on an average daily basis.
Pennsylvania[60] set a guideline for chloramben in ambient air of 1.3333 mg/m^3.

Permissible Concentration in Water: The USR[35] set a MAC of 0.5 mg/L in surface water. A lifetime health advisory of 0.105 mg/L has been determined by EPA (see "References" below).

Routes of Entry: Inhalation, passes through the skin.

Harmful Effects and Symptoms
The available data on Chloramben are very sparse. Much additional information is needed regarding its chronic toxicity, teratogenicity, and carcinogenicity before limits can be confidently set. No-observed-adverse-effect doses for chloramben were 15 mg/kg/day. Based on these data an ADI was calculated at 0.015 mg/kg/day. The LD_{50} rat is 3500 mg/kg (slightly toxic).

Short Term Exposure: Skin or eye contact may cause irritation.

Long Term Exposure: There is evidence that this chemical causes cancer in animals. It may cause cancer of the liver. Repeated exposure may cause skin rash with itching.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloramben you should be trained on its proper handling and storage. Store in a cool, dry place, or a refrigerator, and avoid contact with strong acids, acid fumes, and light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pesticides, solid, toxic, n.o.s., require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including toxic chloride fumes and nitrous oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chloramben is stable to heat, oxidation, and hydrolysis in acidic or basic media. The stability is comparable to that of benzoic acid. Wet oxidation or incineration are recommended disposal methods.[22]

References

National Cancer Institute. (1977). *Bioassay of Chloramben for Possible Carcinogenicity*, Technical Report Series No. 25. Bethesda, MD

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 28–29. New York: Van Nostrand Reinhold Co. (As 3-Amino-2,5-dichlorobenzoic acid)

US Environmental Protection Agency. (August 1987). *Health Advisory: Chloramben*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Chloramben*. Trenton, NJ

Chlorambucil C:0610

Molecular Formula: $C_{14}H_{19}Cl_2NO_2$

Common Formula: $(ClCH_2CH_2)_2N-C_6H_4-(CH_2)_3COOH$

Synonyms: Ambochlorin; Amboclorin; Benzenebutanoic acid, 4-[Bis(2-chloroethyl)amino]-; 4-[Bis(2-Chloroethyl) amino]benzenebutanoic acid; γ-[*p*-bis(2-Chloroethyl)aminophenyl]butyric acid; 4-[bis(2-Chloroethyl)amino]-benzenebutanoic acid; 4-(*p*-[bis(2-Chloroethyl)amino]phenyl) butyric acid; 4-[*p*-bis(β-Chloroethyl)aminophenyl]butyric acid; CB 1348; Chloraminophene; Chloroambucil; Chloroaminophen; Chlorobutin; Chlorobutine; Clorambucil (Spanish); γ(*p*-Di-(2-chloroethyl)aminophenyl)butyric acid; *N*,*N*-Di-2-chloroethyl-γ-*p*-aminophenylbutyric acid; *p*-(*N*,*N*-Di-2-chloroethyl)aminophenyl butyric acid; *p*-*N*,*N*-Di-(β-chloroethyl)aminophenylbutyric acid; Ecoril; Elcoril; Leukeran; Leukersan®; Leukoran®; Linfolizin; Linfolysin; NCI-CO3485; NSC-3088; Phenylbuyyric acid nitrogen mustard

CAS Registry Number: 305-03-3

RTECS® Number: ES7525000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 206-162-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, Sufficient Evidence; Animal, Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998; NTP: Known to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U035.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 2/27/87; Developmental/Reproductive toxin 1/1/89.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlorambucil is a crystalline solid. Molecular weight = 304.24; Freezing/Melting point = 64–66°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Chlorambucil, an anticancer drug, is a derivative of nitrogen mustard. This drug is primarily used as an antineoplastic agent for the treatment of lymphocytic leukemia, malignant lymphomas, follicular lymphoma, and Hodgkin's disease. The treatments are not curative but do produce some marked remissions. Chlorambucil has also been tested for treatment of chronic hepatitis, rheumatoid arthritis, and as an insect chemosterilant. All of the chemical used in this country is imported from the United Kingdom. Work exposure in the United States would be limited to workers formulating the tablets, or to those patients receiving the drug.

Incompatibilities: Moisture.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Chlorambucil is carcinogenic in rats and mice following intraperitoneal injection, producing lymphomas in rats and lymphosarcomas, ovarian tumors in mice. Excesses of acute leukemia were reported in a number of epidemiological studies of people treated with chlorambucil, either alone or in combination with other therapies, for both nonmalignant and malignant diseases. Other cancers have also been associated with the use of chlorambucil and other agents. An excess of acute leukemia in association with Chlorambucil was seen in a further study in which 431 previously untreated patients with polycythemia vera were given phlebotomy alone or chlorambucil with phlebotomy and followed for a mean of 6.5 years. Of the 26 cases of acute leukemia that occurred, 16 were in the group receiving chlorambucil. The risk increased with increasing dose and time of treatment. LD_{50} = (oral-rat) 76 mg/kg (moderately toxic). Causes nausea and vomiting and CNS excitation in humans.

Short Term Exposure: Irritates the eyes and respiratory tract. Exposure can cause dizziness, loss of coordination, numbness, weakness, muscle twitching, convulsions, and unconsciousness.

Long Term Exposure: This chemical is a carcinogen in humans. It has been shown to cause lung cancer and leukemia. It is a probable teratogen in humans and may damage the testes in males and decrease fertility in females.

Points of Attack: Lung, kidney, liver, blood.

Medical Surveillance: Liver and kidney function tests, lung function tests, complete blood count (CBC).

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.
Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.
Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.
Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).
Escape: 100F (APF = 50) (any air-purifying, full-face-piece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorambucil you should be trained on its proper handling and storage. Store in cool, dry place. Store in sealed ampules or in amber screw-capped bottles or vials with Teflon™ cap liners. Solutions may be stored in bottles or vials with a silicone system having a Teflon™ liner and sampled with needle and syringe. Prevent exposure to light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic Solid, Organic, n.o.s [4-[bis(2-Chloroethyl) amino]-benzenebutanoic acid] "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide, nitrogen oxides, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Permanganate oxidation, high-temperature incineration with scrubbing equipment, or microwave plasma treatment.

References

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Chlorambucil*. Trenton, NJ

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 43−44 (1981) and 5, No. 1, 49−53 (1985)

Chloramphenicol C:0620

Molecular Formula: $C_{11}H_{12}Cl_2N_2O_5$

Common Formula: $O_2NC_6H_4CHOHCH(NHCOCHCl_2)CH_2OH$

Synonyms: Acetamide, 2,2-dichloro-*N*-(β-hydroxy-α-(hydroxymethyl)-*p*-nitrophenethyl)-, δ-(−)-Threo-; Acetamide, 2,2-dichloro-*N*-[2-hydroxy-1-(hydroxymethyl)-2-(4-nitrophenyl)ethyl]-; Acetamide, 2,2-dichloro-*N*-2-hydroxy-1-(hydroxymethyl)-2-(4-nitrophenyl)ethyl-, R-(R*, R*)-; Alficetyn; Ambofen; Amphenicol; Amphicol; Amseclor; Aquamycetin; Austracil; Austracol; Biocetin; Biophenicol; CAF; CAM; CAP; Catilan; Chemicetin; Chemicetina; Chlomin; Chlomycol; Chloramex; D-Chloramphenicol; Chloramsaar; Chlorasol; Chlora-tabs; Chloricol; Chloro-25 Vetag; Chlorocaps; Chlorocid; Chlorocide; Chlorocidin C; Chlorocidin C Tetran; Chlorocol; Chloromycetin; Chloromycetin R; Chloronitrin; Chloroptic; Cidocetine; Ciplamycetin; Cloramficin; Cloramicol; Cloramidina; Clorocyn; Cloromisan; Clorosintex; Comycetin; CPH; Cylphenicol; Desphen; Detreomycine; Dextromycetin; Doctamicina; D-Threochloramphenicol; D-Threo-*N*-dichloroacetyl-1-*p*-nitrophenyl-2-amino-1,3-propanediol; D-Threo-*N*-(1,1′-dihydroxy-1-*p*-nitrophenylisopropyl)dichloroacetamide; D-Threo-1-(*p*-nitrophenyl)-2-(dichloroacetylamino)-1,3-propanediol; Econochlor; Embacetin; Emetren; Enicol; Enteromycetin; Erbaplast; Ertilen; Farmicetina; Fenicol; Globenicol; Glorous; Halomycetin; Hortfenicol; I 337A; Intramycetin; Isicetin; Ismicetina; Isophenicol; Isopto fenicol; Juvamycetin; Kamaver; Kemicetina; Kemicetine; Klorita; Klorocid S; Leukomyan; Leukomycin; Levomicetina; Levomycetin; Loromisan; Loromisin; Mastiphen; Mediamycetine; Micloretin; Micochlorine; Micoclorina; Microcetina; Mychel; Mycinol; NCI-C55709; Normimycin V; Novochlorocap; Novomycetin; Novophenicol; NSC 3069; Oftalent; Oleomycetin; Opclor; Opelor; Ophthochlor; Ophtochlor; Otachron; Otophen; Pantovernil; Paraxin; Pentamycetin; Quemicetina; Rivomycin; Romphenil; Septicol; Sificetina; Sintomicetina; Sintomicetine R; Stanomycetin; Synthomycetin; Synthomycetine; Synthomycine; Tevcocin; Tevcosin; D-(−)-Threochloramphenicol; D-(−)-Threo-2-dichloroacetamido-1-*p*-nitrophenyl-1,3-propanediol; D-(−)-Threo-2,2-dichloro-*N*-[b-hydroxy-α-(hydroxymethyl)]-*p*-nitrophenethylacetamide; D-(−)-Threo-1-*p*-nitrophenyl-2-dichloracetamido-1,3-propanediol; Tifomycin; Tifomycine; Treomicetina; U-6062; Unimycetin; Veticol

CAS Registry Number: 56-75-7

RTECS® Number: AB6825000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-287-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC[9]: Human, Limited Evidence, animal Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1990; NTP: Reasonably anticipated to be a human carcinogen.

Banned or severely restricted (Medical Uses Restricted) (UN).[13]

California Proposition 65 Chemical: Cancer 1/1/89.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloramphenicol is a white to grayish-white or yellowish-white crystalline solid. Molecular weight = 323.2; Freezing/Melting point = 151°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: An antibiotic derived from *Streptomyces venezuelae*; Those involved in the manufacture, formulation, and application of this antibiotic and antifungal agent.

Permissible Exposure Limits in Air

AIHA WEEL: 0.5 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 350 mg/m^3

The FDA (Food and Drug Administration) has set standards for *Good Manufacturing Practices for Drugs and Pharmaceuticals.* These should be followed for personal protection as well as product quality. See the FDA regulation 21 CFR 210. Also, there may be no safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level. It should be recognized that this chemical can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chloramphenicol can affect you when breathed in and by passing through your skin. Skin or eye contact can cause irritation. Exposure can damage the bone marrow's ability to make blood cells and/or platelets (for blood clotting). This can lead to severe illness or death.

Long Term Exposure: High or repeated exposure can damage the liver. Effects on the nervous system may also occur, such as numbness and tingling in the fingers or toes and blurred vision. Chloramphenicol is a carcinogen, mutagen, and teratogen. LD_{50} = (oral-rat) 2500 mg/kg (slightly toxic).

Points of Attack: Liver, nervous system, blood.

Medical Surveillance: Before beginning work and monthly after that, the following is recommended: complete blood count (CBC) with platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests; exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chloramphenicol you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Chloramphenicol is not specifically cited by DOT, but reference may be made to the category "Medicine, solid, toxic, n.o.s." It requires a label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chlorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chloramphenicol*. Trenton, NJ

Chlordane C:0630

Molecular Formula: $C_{10}H_6Cl_8$

Synonyms: Aspon-Chlordane; Belt; CD 68; Chlordan; Chlorindan; Chlor kil; Chlorodane; Clordano (Spanish); Corodane; Cortilan-Neu; Dichlorochlordene; Dowchlor; ENT 25,552-X; ENT 9,932; γ-Chlordan; HCS 3260; Kypchlor; M 140; M 410; 4,7-Methanoindan, 1,2,3,4,5,6,7,8,8-octachloro-2,3,3a, 4,7,7a-hexahydro-; 4,7-Methanoindan, 1,2,4,5,6,8,8-octachloro 3a,4,7,7a-tetrahydro; 4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; NCI-C00099; Niran; Octachlor; Octachlorodihydrodicyclopentadiene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-hexahydro-4,7-methyleneindane; Octachloro-4,7-methanohydroindane; 1,2,4,5,6,7,8,8-Octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane; Octachloro-4,7-methanotetrahydroindane; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindan; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane; 1,2,4,5,6,7,10,10-Octachloro-4,7,8,9-tetrahydro-4,7-methyleneindane; 1,2,4,5,6,7,8,8-Octachlor-3a,4,7,7a-tetrahydro-4,7-endo-methano-indan (German); Octa-klor; Oktaterr; OMS 1437; Ortho-klor; SD 5532; Shell SD-5532; Synklor; TAT; TAT Chlor 4; Topichlor 20; Topiclor; Topiclor 20; Toxichlor; Velsicol 1068

CAS Registry Number: 57-74-9; 12789-03-6 (technical grade); *(alt.)* 39400-80-; *(alt.)* 53637-13-1
RTECS® Number: PB9800000
UN/NA & ERG Number: UN2996 (organochlorine pesticide, liquid, toxic)/151
EC Number: 200-349-0 [*Annex I Index No.:* 602-047-00-8]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, sufficient evidence; Human, inadequate evidence, *possibly carcinogenic to humans*, Group 2B, 2001; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; (*technical grade*): Likely to produce cancer in humans; NCI[9] Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Banned or severely restricted (in agriculture) (many countries) (UN).[13,35]
Persistent Organic Pollutants (UN).
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15) as technical mixture and metabolites.
US EPA Hazardous Waste Number (RCRA No.): U036.
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.03 mg/L.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L) (alpha- and gamma-isomers) 0.0033; Nonwastewater (mg/kg), 0.26.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10).
Safe Drinking Water Act: MCL, 0.002 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.
California Proposition 65 Chemical: Cancer.
Canada, Drinking water quality: 0.007 mg/L MAC.
Mexico, Drinking water quality: 0.003 mg/L.
California Proposition 65 Chemical: Cancer 1/1/88.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].
List of Stockholm Convention POPs: Annex A (Elimination).
European/International Regulations: (*57-74-9*) Hazard Symbol: Xn, N; Risk phrases: R21/22; R40; R50/53; Safety phrases: S2; S36/37; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlordane is a colorless, or light-yellow or amber, thick liquid with a pungent, chlorine-like odor. It may occur as a crystalline solid. Molecular weight = 409.76; Specific gravity (H_2O:1) = 1.6 at 25°C; Boiling point = 175°C; Freezing/Melting point = 104−107°C; Vapor pressure = 0.00001 mmHg; Practically insoluble in water; solubility = 0.0001%. The *commercial grade* of chlordane is a noncombustible liquid, but may be utilized in flammable solutions: Flash point = 56°C has been found in the literature, but his may vary depending on the carrier. Hazard Identification (based on NFPA 704 M Rating System): *(in a flammable solution such as n-hexane)* Health 3, Flammability 3, Reactivity 0; (*dry*) Health 3; Flammability 1; Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Chlordane is a broad-spectrum insecticide of the group of polycyclic chlorinated hydrocarbons called cyclodiene insecticides. Chlordane has been used extensively since the 1950s for termite control; as an insecticide for homes and gardens; and as a control for soil insects during the production of crops such as corn. Both the uses and the production volume of chlordane have decreased extensively since the issuance of a registration suspension notice for all food crops and home and garden uses of chlordane by the US Environmental Protection Agency. However, significant commercial use of chlordane for termite control continues. Special groups at risk include children as a result of milk consumed; fishermen and their families because of the high consumption of fish and shellfish, especially freshwater fish; persons living downwind from treated fields; and persons living in houses treated with chlordane pesticide control agents. Human toxicity (long term)[77]: High—2.00 ppb, MCL (Maximum Contaminant Level); Fish toxicity (threshold)[77]: Extra high—0.04936 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. High heat and contact with alkaline solutions cause decomposition with the production of toxic fumes including chlorine, phosgene, hydrogen chloride. Attacks iron, zinc, plastics, rubber, and coatings.

Permissible Exposure Limits in Air
OSHA PEL: 0.5 mg/m^3 TWA [skin].
NIOSH REL: 0.5 mg/m^3 TWA [skin]. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: 100 mg/m^3.
Protective Action Criteria (PAC)
57-74-9
TEEL-0: 0.5 mg/m^3
PAC-1: 7.5 mg/m^3

PAC-2: 50 mg/m^3
PAC-3: 100 mg/m^3
DFG MAK: 0.5 mg/m^3, inhalable fraction [skin]; Peak limitation II(8); Carcinogen Category 3B.

Arab Republic of Egypt: TWA 0.5 mg/m^3 [skin], 1993; Australia: TWA 0.5 mg/m^3; STEL 2 mg/m^3 [skin], Carcinogen 1993; Austria: MAK 0.5 mg/m^3 [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.5 mg/m^3; STEL 2 mg/m^3 [skin], 1993; Denmark: TWA 0.5 mg/m^3 [skin], 1999; Finland: carcinogen, 1999; France: VME 0.5 mg/m^3 [skin], carcinogen, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3 [skin], 2003; Norway: TWA 0.5 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3 [skin], 1993; Russia: STEL 0.01 mg/m^3 [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3 [skin], 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg/m^3 [skin], 1993; United Kingdom: LTEL 0.5 mg/m^3; STEL 2 mg/m^3 [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for chlordane in ambient air[60] ranging from 0.068 μg/m^3 (Massachusetts) to 0.36 μg/m^3 (Pennsylvania) to 1.19 μg/m^3 (Kansas) to 1.7 μ/m^3 (New York) to 2.5 μg/m^3 (Connecticut and South Carolina) to 5.0 μg/m^3 (Florida) to 5–20 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 12.0 μg/m^3 (Nevada).

Determination in Air: Filter/Chromosorb tube-102; Toluene; Gas chromatography/Electrochemical detection; NIOSH Analytical Method (IV) #5510 or OSHA Analytical Method 67.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0043 μg/L as a 24-h average, not to exceed 2.4 μg/L at any time. *To protect saltwater aquatic life:* 0.0040 μg/L as a 24-h average, never to exceed 0.09 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is presented by a concentration of 0.0046 μg/L.[6] The EPA[47] has found a lowest-observed-adverse-effect-level (LOAEL) of 0.045 mg/kg body weight/day which results in a lifetime health advisory of 2 μg/L. Several states have set standards and guidelines for chlordane in drinking water.[61] Standards range from 0.5 μg/L (New Jersey) to 3.0 μg/L (Illinois) and guidelines range from 0.055 μg/L (California) to 0.22 μg/L (Kansas and Minnesota) to 0.50 μg/L (Arizona) to 0.55 μ/l (Maine). See values listed under Regulatory Authority and Advisory Bodies for Canada and Mexico. It is strongly advised not to let the chemical enter into the environment because it persists in the environment. The substance may cause long-term effects in the aquatic environment.

Determination in Water: Filter/Chromosorb tube-102; Toluene; Gas chromatography/Electrochemical detection; NIOSH Analytical Method (IV) #5510. Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol–water coefficient: Log $K_{ow} = 2.8$.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Chlordane can irritate the eyes and skin and can cause burns on contact. Skin rash or acne may develop. The vapor can irritate the respiratory tract. Exposure can cause blurred vision, nausea, headache, abdominal pain, and vomiting. Exposure at high levels may result in disorientation, tremors, convulsions, respiratory failure, and death. Medical observation is indicated. Symptoms include increased sensitivity to stimuli, tremors; lack of muscular coordination; and convulsions with or without coma. Fatal oral dose to adult humans is between 6 and 60 g with onset of symptoms within 45 min to several hours after ingestion, although symptoms have occurred following very small doses either orally or by skin exposure. Some reports of delayed development of liver disease, blood disorders, and upset stomach. Chlordane is considered to be borderline between a moderately and highly toxic substance. The oral LD_{50} for rats is 283 mg/kg.

Long Term Exposure: This chemical has been shown to cause liver cancer in animals and may be a human carcinogen. It may damage the developing fetus. Chlordane may damage the kidneys, liver, and affect the immune system. May cause an acne-like rash following skin contact.

Points of Attack: Central nervous system, eyes, lungs, liver, kidneys, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Examination by a qualified allergist. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): CPF3™ suits, Trellchem HPS™ suits; **4 h** (at least 4 h but <8 h of resistance to breakthrough > 0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chlordane you should be trained on its proper handling and storage. Chlordane must be stored to avoid contact with strong oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: There are no shipping regulations specific to chlordane, perhaps because its use is so widely banned. However, "Pesticides, liquid, toxic, n.o.s.," or "Organochlorine pesticide, liquid, toxic," require a "POISONOUS/TOXIC MATERIALS" label. Chlordane falls in Hazard Class 6.1 and Packing Group III.[19,20]

Spill Handling: Do not touch spilled material. Use water spray to reduce vapors. Stay upwind. Avoid breathing vapors. Wear positive-pressure breathing apparatus and full protective clothing. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills*: absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid but it may be dissolved in flammable or combustible liquids for commercial application. Poisonous gases, including chlorine, phosgene, hydrogen chloride, are produced in fire. If the flammable or combustible commercial material catches fire, use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chlordane is dehydrochlorinated in alkali to form "nontoxic" products, a reaction catalyzed by traces of iron, but the reaction is slow. The environmental hazards of the products are uncertain. Chlordane is completely dechlorinated by sodium in isopropyl alcohol. The UN recommends incineration methods for disposal of chlordane.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

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US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chlordane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chlordane*. Trenton, NJ

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Chlordecone (Kepone) C:0640

Molecular Formula: $C_{10}Cl_{10}O$

Synonyms: Chlordecone; Ciba 8514; Compound 1189; 1,2,3,5,6,7,8,9,10,10-Decachloro(5.2.2.$0^{2.6}$.$0^{3.9}$.$0^{5.8}$)decano-4-one; Decachloroketone; Decachlorooctahydrokepone-2-one; 1,1a, 3, 3a, 4,5,5,5a, 5b, 6-Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta(cd)pentalen-2-one; 1,1a,3,3a, 4,5,5,5a,5b,6-Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta(c,d)pentalen-2-one; Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta(cd)-pentalen-2-one; Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta(cd)pentalen-2-one; Decachlorotetracyclodecanone; Decachlorotetrahydro-4,7-methanoindeneone; ENT 16,391; GC-1189; General chemicals 1189; Kepone; Merex®; 1,3,4-Metheno-2H-cyclobuta(cd)pentalen-2-one,1,1a,3,3a,4,5,5a,5b,6-decachlorooctahydro-, Kepone®; NCI-C00191

CAS Registry Number: 143-50-0

RTECS® Number: PC8575000

UN/NA & ERG Number: UN2761/151

EC Number: 205-601-3 [*Annex I Index No.*: 606-019-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC[9]: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B; NTP[10]; 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen DFG[3]: (Animal Positive, Human Suspected); EPA (*oral*): Likely to produce cancer in humans.

Banned or Severely Restricted (many countries) (UN)[13,35].

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U142.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0011; Nonwastewater (mg/kg), 0.13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 1/1/89.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R40; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Kepone is a tan to white, odorless crystalline solid. Molecular weight = 490.60; Freezing/Melting point = 360°C (sublimes); Vapor pressure = 3×10^{-7} mmHg at 25°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solubility = 0.5 at 100°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector. Kepone was registered for the control of root-borers on bananas with a residue tolerance of 0.01 ppm. This constituted the only food or feed use of Kepone. Nonfood uses included wireworm control in tobacco fields and bait to control ants and other insects in indoor and outdoor areas. A rebuttable presumption against registration of chlordecone was issued by the US EPA on March 25, 1976, on the basis of oncogenicity. The trademarked Kepone™ and products of six formulations were the subject of voluntary cancellation according to a US EPA notice dated July 27, 1977. In a series of decisions, the first of which was issued on June 17, 1976, the EPA effectively canceled all registered products containing Kepone as of May 1, 1978.

Incompatibilities: Acids, acid fumes.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: Carcinogen, 0.001 mg/m³ TWA. Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

Protective Action Criteria (PAC)

TEEL-0: 0.001 mg/m³

PAC-1: 5 mg/m³

PAC-2: 35 mg/m³

PAC-3: 40 mg/m³

DFG MAK: Carcinogen Category 3B.

Austria: Suspected: carcinogen, 1999; France: carcinogen, 1993. Guidelines or standards for Kepone in ambient air have been set[60] ranging from 0 (South Carolina) to 0.03 μ/m³ (New York) to 0.88 μg/L (Pennsylvania).

Determination in Air: Collection by membrane filter and backup impinger containing NaOH solution, workup with benzene, analysis by gas chromatography with electron capture detector. Use NIOSH Analytical Method #5508.

Routes of Entry: Inhalation of dust, ingestion, skin absorption.

Harmful Effects and Symptoms

In July 1975, a private physician submitted a blood sample to the Center for Disease Control (CDC) to be analyzed for Kepone, a chlorinated hydrocarbon pesticide. The sample had been obtained from a Kepone production worker who suffered from weight loss, nystagmus, and tremors. CDC notified the state epidemiologist that high levels of Kepone were present in the blood sample, and he initiated an epidemiologic investigation which revealed other employees suffering with similar symptoms. It was evident to the state official after visiting the plant that the employees had been exposed to Kepone at extremely high concentrations through inhalation, ingestion, and skin absorption. He recommended that the plant be closed, and company management complied. Of the 113 current and former employees of this Kepone-manufacturing plant examined, more than half exhibited clinical symptoms of Kepone poisoning. Medical histories of tremors (called "kepone shakes" by employees), visual disturbances, loss of weight, nervousness, insomnia, pain in the chest and abdomen, and, in some cases, infertility and loss of libido were reported. The employees also complained of vertigo and lack of muscular coordination. The intervals between exposure and onset of the signs and symptoms varied between patients but appeared to be dose-related. NIOSH has received a report on a carcinogenesis bioassay of technical grade Kepone which was conducted by the National Cancer Institute using Osborne-Mendel rats and B6C3F1 mice, Kepone was administered in the diet at two tolerated dosages. In addition to the clinical signs of toxicity, which were seen in both species, a significant increase ($P<0.05$) of hepatocellular carcinoma in rats given large dosages of Kepone and in mice at both dosages was found. Rats and mice also had extensive hyperplasia of the liver. In view of these findings, NIOSH must assume that Kepone is a potential human carcinogen. LD_{50} = (oral-rat) 95 mg/kg (moderately toxic).

Short Term Exposure: May be poisonous if absorbed through the skin. Skin or eye contact may cause irritation and rash. Poisonous if swallowed. Exposure can cause headache, nervousness, tremor; liver, kidney damage; visual disturbance; ataxia, chest pain; skin erythema (skin redness).

Long Term Exposure: Has been shown to cause liver cancer in animals; potential human carcinogen. May cause testicular atrophy; low sperm count; damage to the developing fetus; reproductive damage; sterility, breast enlargement; skin changes; liver and kidney damage; brain and nervous system damage with hyperactivity; hyperexcitability; muscle spasms, tremors.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys, reproductive system. Cancer site in animal: liver cancer.

Medical Surveillance: Employers shall make medical surveillance available to all workers occupationally exposed to Kepone, including personnel periodically exposed during routine maintenance or emergency operations. Periodic examinations shall be made available at least on an annual basis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Qualified medical personne may consider the administration of cholestyramine resin (QUESTRAN). Medical personnel should wear Neoprene™ gloves as protection against contamination (Dreisbach).

Personal Protective Methods: *Protective Clothing: a:* Coveralls or other full-body protective clothing shall be worn in areas where there is occupational exposure to Kepone. Protective clothing shall be changed at least daily at the end of the shift and more frequently if it should become grossly contaminated. *b:* Impervious gloves, aprons, and footwear shall be worn at operations where solutions of Kepone may contact the skin. Protective gloves shall be worn at operations where dry Kepone or materials containing Kepone are handled and may contact the skin. *c:* Eye protective devices shall be provided by the employer and used by the employees where contact of Kepone with eyes is likely. Selection, use, and maintenance of eye protective equipment shall be in accordance with the provisions of the American National Standard Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1968. Unless eye protection is afforded by a respirator hood or face-piece, protective goggles or a face shield shall be worn at operations where there is danger of contact of the eyes with dry or wet materials containing Kepone because of spills, splashes, or excessive dust or mists in the air. *d:* The employer shall ensure that all personal protective devices are inspected regularly and maintained in clean and satisfactory working condition. *e:* Work clothing may not be taken home by employees. The employer shall provide for maintenance and laundering of protective clothing. *f:* The employer shall ensure that precautions necessary to protect laundry personnel are taken while soiled protective clothing is being laundered. *g:* The employer shall ensure that Kepone is not discharged into municipal waste treatment systems or the community air.

Respiratory Protection from Kepone: Engineering controls shall be used wherever feasible to maintain airborne Kepone concentrations at or below that recommended. Compliance with the environmental exposure limit by the use of respirators is allowed only when airborne Kepone concentrations are in excess of the work-place environmental limit because required engineering controls are being installed or tested, when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with NIOSH requirements.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Kepone you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, dry place in a refrigerator under inert atmosphere.[52] Keep away from acids and acid fumes.

Shipping: While not specifically cited, chlordecone may be classified under Organochlorine pesticides, solid, toxic n.o.s., which requires a “POISONOUS/TOXIC MATERIALS” label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Do not touch spilled material. Use water spray to reduce vapors. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. For larger spills, dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, halon, water spray, or standard foam. Poisonous gases are produced in fire, including toxic chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A process has been developed which effects chlordecone degradation by treatment of aqueous wastes with UV radiation in the presence of hydrogen in aqueous sodium hydroxide solution. Up to 95% decomposition was effected by this process. Chlordecone previously presented serious disposal problems because of its great resistance to bio- and photodegradation in the environment. It is highly toxic to normally occurnring degrading microorganisms. Although it can undergo some photodecomposition when exposed to sunlight to the dihydro compound (leaving a compound with 8 chloro substituents) that degradation product does not significantly reduce toxicity. Disposal by incineration with HCl scrubbing is recommended.[22]

References

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National Academy of Sciences. (1978). *Kepone, Mirex, Hexachlorocyclopentadiene: An Environmental Assessment*. Washington, DC

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New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Kepone*. Trenton, NJ

Chlorfenvinphos C:0650

Molecular Formula: $C_{12}H_{14}Cl_3O_4P$

Synonyms: Apachlor; Benzyl alcohol,2,4-dichloro-α-(chloromethylene)-, diethyl phosphate; Birlane; Birlane liquid; C-10015; C8949; CFV; CGA 26351; *O*-2-Chlor-1-(2,4-dichlor-phenyl)-vinyl-*O*,*O*-diaethylphosphat (German); Chlorfenvinphos; β-2-Chloro-1-(2′,4′-dichlorophenyl) vinyl diethylphosphate; 2-Chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate; Chlorofenvinphos; Chlorphenvinfos; Chlorphenvinphos; Clofenvinfos; Clorfenvinfos (Spanish); Compound 4072; CVP; Diethyl1-(2,4-dichlorophenyl)-2-chlorovinyl phosphate; *O*,*O*-Diethyl *O*-[2-chloro-1-(2′,4′-dichlorophenyl)vinyl] phosphate; ENT 24969; GC 4072; OMS 1328; Phosphate de *O*,*O*-diethyle etdeo-2-chloro-1-(2,4-dichlorophenyl) vinyle (French); Phosphoric acid, 2-chloro-1-(2,4-dichlorophenyl)ethenyldiethyl ester; Sapecron; Sapecron 10FGEC; Sapecron 240; Saprecon C;

SD 4072; SD 7859; Shell 4072; Supona; Supone; Unitox; Vinylphare; Vinylphate

CAS Registry Number: 470-90-6

RTECS® Number: TB8750000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 207-432-0 [*Annex I Index No.:* 015-071-00-3]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chlorfenvinphos is a nonflammable, yellow or amber liquid with a mild odor. Molecular weight = 359.58; Boiling point = 110°C at 0.001 mmHg; 168−170°C at 0.5 mmHg; Freezing/Melting point = −23−19°C. Hazard Identification (based on NFPA 704 M Rating System): Health 4, Flammability 1, Reactivity 0. Very slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Human Data. Used as a soil insecticide for root maggots, rootworms, and cutworms. Those engaged in the production, formulation, and application of this insecticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. May be corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 10 mg/m^3

Poland: MAC (TWA) 0.01 mg/m^3, MAC (STEL) 0.1 mg/m^3.

However, it should be recognized that this chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method IV #5600, Organophosphorus pesticides.

Permissible Concentration in Water: 0.1 mg/L in drinking water is a recommended drinking water limit.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.79$.

Routes of Entry: Inhalation, passes through the unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: Highly toxic (LD_{50} for rats is 10 mg/kg). Symptoms exhibited on chlorfenvinphos exposure are typical of cholinesterase poisoning. Nausea is often first symptom, with vomiting, abdominal cramps, diarrhea, and excessive salivation. Headache, giddiness, weakness, tightness in chest, blurring of vision, pinpoint pupils, loss of muscle coordination, and difficulty breathing. Convulsions and coma precede death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Chlorfenvinphos can cause the heart to beat slower (bradycardia) or irregularly (arrhythmia).

Long Term Exposure: There is limited evidence that this chemical may damage the developing fetus. Symptoms resembling influenza with headache, nausea, and weakness have been reported. Cholinesterase inhibitor; cumulative effect is possible. Chlorfenvinphos may damage the nervous system with repeated exposure, resulting in impaired memory, depression, anxiety, or irritability, convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorfenvinphos you should be trained on its proper handling and storage. Should be protected from moisture and stored in glass-lined or polyethylene-lined containers. Keep away from strong bases. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1[19, 20] and Packing Group I.

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The state of New Jersey has assigned a flammability rating of "2" to chlorfenvinphos. This chemical may burn, but does not readily ignite. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride, phosphorous oxides, and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 63−67. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chlorfenvinphos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Chlorinated diphenyl oxide C:0655

Molecular Formula: $C_{12}H_4Cl_6O$
Common Formula: $C_{12}H_{10-n}Cl_nO$ (general, for chlorinated diphenyl oxides)
Synonyms: Benzene, 1,1′-Oxybis, hexachloro derivatives; Chlorinated biphenyl oxide; *o*-Chlorinated diphenyl oxide; Ether, hexachlorophenyl; Hexachlorodiphenyl ether; Hexachlorodiphenyl oxide; Phenyl ether, hexachloro derivative; Trichloro diphenyl ether; Trichloro diphenyl oxide
hexachloro-isomer: see PCBs.
CAS Registry Number: 31242-93-0; 57321-63-8 (trichloro-); *(alt.)*
RTECS® Number: KO4200000 (trichloro-); KO0875000 (hexachloro-)
UN/NA & ERG Number: UN3077/171
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Chlorinated diphenyl oxide is a white or yellowish waxy solid or very viscous liquid. Molecular weight = 376.88; Boiling point = 230−260°C at 8 mmHg; 361.2 °C at 760 mmHg; Vapor pressure = 4.37^{-5} mmHg at 25°C; Flash point = 123°C.
Hexachloro Diphenyl Oxide: Autoignition temperature = 620°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 1, Reactivity 0.
Potential Exposure: These materials are used as dielectric fluids in the electrical industry; they may be used as organic intermediates to make other chemicals and in dry cleaning detergents.
Incompatibilities: Strong oxidizers or heat may cause fire and explosion. May be able to form unstable peroxides.
Permissible Exposure Limits in Air
OSHA PEL: 0.5 mg/m³ TWA.
NIOSH REL: 0.5 mg/m³ TWA.
ACGIH TLV®[1]: 0.5 mg/m³ TWA.
NIOSH IDLH: 5 mg/m³.
No TEEL available.
DFG MAK: [skin], *as chlorinated biphenyl oxide*.
Australia: TWA 0.5 mg/m³; STEL 2 mg/m³, 1993; Austria: MAK 0.5 mg/m³ [skin], 1999; Belgium: TWA 0.5 mg/m³; STEL 2 mg/m³, 1993; Finland: TWA 0.5 mg/m³; STEL 1.5 mg/m³ [skin], 1999; France: CME 0.5 mg/m³, 1999; the Netherlands: MAC-TGG 0.5 mg/m³, 2003; Norway: TWA 0.5 mg/m³, 1999; Switzerland: MAK-W0.5 mg/m³ [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m³.
Several states have set guidelines or standards for Chlorinated Diphenyl Oxide in ambient air[60] ranging from 5 μg/m³ to 20 μg/m³ (North Dakota) to 8 μg/m³ (Virginia) to 10 μg/m³ (Connecticut) to 12 μg/m³ (Nevada).
Determination in Air: Collect on filter, work up with isooctane, analyze by gas chromatography. Use NIOSH Analytical Method IV #5025.[18]
Permissible Concentration in Water: Because of the lack of data on both toxicologic effects and environmental contamination, the hazard posed by these compounds cannot be estimated according to the Environmental Protection Agency.[6]
Routes of Entry: Inhalation, ingestion, eye and skin contact.
Harmful Effects and Symptoms
Acne-form dermatitis and liver damage.
Short Term Exposure: Contact can cause skin irritation, rash, burning sensation, chloracne. LD_{50} (oral-rat) = > 500 mg/kg. Moderately toxic by ingestion, inhalation, and skin absorption.
Long Term Exposure: May cause acne-form dermatitis and liver damage. More than light alcohol consumption may increase the liver damage.
Points of Attack: Skin, liver.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Examination by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: OSHA: *5 mg/m³:* Sa (APF = 10) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode; SCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary

self-contained positive-pressure breathing apparatus). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor and acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with chlorinated diphenyl oxides you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid or liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Although chlorinated diphenyl oxide is listed as a "noncombustible solid or liquid" by the state of New Jersey; and in some of the literature; however, hexachloro diphenyl oxide has a NFPA Flammability rating of "1." Poisonous gases, including chlorine, are produced in fire. Use dry chemical or carbon dioxide extinguishers. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For trichlorophenyl ether, solution in a flammable solvent and incineration in a furnace with afterburner and scrubber is recommended.[22]

References

US Environmental Protection Agency. (1980). *Haloethers: Ambient Water Quality Criteria*. Washington, DC

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Chlorinated Diphenyl Oxide*. Trenton, NJ

Chlorinated naphthalenes C:0660

Molecular Formula: $C_{10}H_{8-x}Cl_x$

Synonyms: *1-chloro isomer:* α-Chloronaphthalene; 1-Cloronaftaleno (Spanish)

2-chloro-isomer: β-Chloronaphthalene; 2-Cloronaftaleno (Spanish)

hexachloro-isomer: Halowax 1014; Hexachloronaphthalene; Hexacloronaftaleno (Spanish); Naphthalene, hexachloro-

octachloro-isomer: Halowax 1051; Octachloronaphthalene; Perchloronaphthalene; Perna

pentachloro-isomer: Halowax 1013; Pentachloronaphthalene

tetrachloro-isomer: Halowax; Nibren wax; Seekay wax; Tetrachloronaphthalene

trichloro-isomer: Halowax; Nibren wax; Seekay wax; Trichloronaphthalene

CAS Registry Number: 90-13-1 (1-chloro-; α-Chloronaphthalene); 91-58-7 (2-chloro-); 1321-65-9 (trichloro-); 1335-88-2 (tetrachloro-); 1321-64-8 (pentachloro-); 1335-87-1 (hexachloro-); 2234-13-1 (octachloro-)

RTECS® Number: QJ2100000 (1-chloro-); QJ2275000 (2-chloro-); QK4025000 (trichloro-); QK3700000 (tetrachloro-); QK0300000 (pentachloro-); QJ7350000 (hexachloro-); QK0250000 (octachloro-)

EC Number: 201-967-3 (1-chloro-); 202-079-9 (2-chloro); 215-321-3 (trichloro); 1335-88-2 (tetrachloro); 215-320-8 [*Annex I Index No.:* 602-041-00-5] (pentachloro-); 215-641-3 (hexachloro)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Chlorinated naphthalenes:

Clean Water Act: Toxic Pollutant (Section 401.15).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

2-chloronaphthalene:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U047.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 5.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (10); 8270 (10).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Hexachloronaphthalene:

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: [*1321-65-9 (trichloro-)*] Xn, N; Risk phrases: R21/22; R36/38; R50/53; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (1-chloro-); 3—Highly water polluting (*polychlorinated naphthalenes*).

Description: The chlorinated naphthalenes in which one or more hydrogen atoms have been replaced by chlorine to form wax-like substances, beginning with monochloronaphthalene and going on to the octachlor derivatives. Their physical states vary from mobile liquids to waxy solids depending on the degree of chlorination; Freezing/Melting points of the pure compounds range from 17°C for 1-chloronaphthalene to 198°C for 1,2,3,4-tetrachloronaphthalene.

1-chloro-isomer: Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 1, Reactivity 0.

2-chloro-isomer: Molecular weight = 162.62; Boiling point = 256°C; Freezing/Melting point = 61°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

hexa-isomer: White to light-yellow solid with an aromatic odor. Molecular weight = 334.82; Boiling point = 343−388°C; Freezing/Melting point = 137°C. Insoluble in water.

octa-isomer: Waxy, pale yellow solid with an aromatic odor. Molecular weight = 403.74; Boiling point = 410−440°C; Freezing/Melting point = 185−192°C. Insoluble in water.

penta-isomer: Colorless to white crystalline solid with a benzene-like odor. Molecular weight = 300.40; Boiling point = 336°C; Freezing/Melting point = 120°C. Slightly soluble in water.

tetra-isomer: Colorless to pale yellow solid with an aromatic odor. Molecular weight = 265.96; Boiling point = 315−360°C; Freezing/Melting point = 182°C; Flash point = 210°C (oc). Insoluble in water.

tri-isomer: Colorless to pale yellow solid with an aromatic odor. Molecular weight = 231.51; Boiling point = 304−354°C; Freezing/Melting point = 93°C; Flash point: 198°C (oc). Insoluble in water.

Potential Exposure: Industrial exposure from individual chlorinated naphthalenes is rarely encountered; rather it usually occurs from mixtures of two or more Chlorinated naphthalenes. Due to their stability, thermoplasticity, and nonflammability, these compounds enjoy wide industrial application. These compounds are used in the production of electric condensers; in the insulation of electric cables and wires; as additives to extreme-pressure lubricants; as supports for storage batteries; and as a coating in foundry use. *octachloro-:* Used as a fireproof and waterproof additive and lubricant additive. *Pentachloro-:* Used in electric wire insulation and in additives to special lubricants. *tetrachloro-:* Used in electrical insulating materials and as an additive in cutting oils. *trichloro-:* Used in lubricants and in the manufacture of insulation for electrical wire.

Because of the possible potentiation of the toxicity of higher Chlorinated naphthalenes by ethanol and carbon tetrachloride, individuals who ingest enough alcohol to result in liver dysfunction would be a special group at risk. Individuals, for example, analytical and synthetic chemists, mechanics and cleaners, who are routinely exposed to carbon tetrachloride or other hepatotoxic chemicals would also be at a greater risk than a population without such exposure. Individuals involved in the manufacture, utilization, or disposal of polychlorinated naphthalenes would be expected to have higher levels of exposure than the general population.

Incompatibilities: All are incompatible with strong oxidizers. Keep away from heat. Penta- is also incompatible with acids, alkalis.

Permissible Exposure Limits in Air

1-chloro- 90-13-1

TEEL-0: 6 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 125 mg/m^3

PAC-3: 500 mg/m^3

2-chloro- 91-58-7

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

hexachloro- 1335-87-1

OSHA PEL: 0.2 mg/m^3 TWA [skin].

NIOSH REL: 0.2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.2 mg/m^3 TWA [skin].

NIOSH IDLH: 2 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 2 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 2 mg/m^3
Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.2 mg/m^3 [skin], 1999; France: VME 0.2 mg/m^3 [skin], 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; the Philippines: TWA 0.2 mg/m^3 [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Sweden: NGV 0.2 mg/m^3, KTV 0.6 mg/m^3 [skin], 1999; Switzerland: MAK-W 0.2 mg/m^3 [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg/m^3 [skin].
octachloro- 2234-13-1
OSHA PEL: 0.1 mg/m^3 TWA [skin].
NIOSH REL: 0.1 mg/m^3 TWA; 0.3 mg/m^3 STEL [skin].
ACGIH TLV®[1]: 0.1 mg/m^3 TWA; 0.3 mg/m^3 STEL [skin].
Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 0.3 mg/m^3
PAC-3: 1 mg/m^3
Denmark: TWA 0.1 mg/m^3 [skin], 1999; France: VME 0.1 mg/m^3 [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3 [skin], 2003; Norway: TWA 0.1 mg/m^3, 1999; the Philippines: TWA 0.1 mg/m^3 [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Sweden: NGV 0.2 mg/m^3, KTV 0.6 mg/m^3 [skin], 1999; Switzerland: MAK-W 0.1 mg/m^3 [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.3 mg/m^3 [skin].
pentachloro- 1321-64-8 (see also separate record)
OSHA PEL: 0.5 mg/m^3 TWA [skin].
NIOSH REL: 0.5 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin].
DFG MAK: 0.5 mg/m^3 TWA [skin].
Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3 [skin], 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3 [skin], 1999; France: VME 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Norway: TWA 0.5 mg/m^3, 1999; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Sweden: NGV 0.2 mg/m^3, KTV 0.3 mg/m^3 [skin], 1999; Switzerland: MAK-W 0.5 mg/m^3, KZG-W 2.5 mg/m^3 [skin], 1999; Turkey: TWA 0.5 mg/m^3 [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m^3 [skin].
tetrachloro- 1335-88-2
OSHA PEL: 2 mg/m^3 TWA [skin].
NIOSH REL: 2 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 2 mg/m^3 TWA [skin].
Australia: TWA 2 mg/m^3, 1993; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3 [skin], 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3 [skin], 2003; Norway: TWA 0.01 mg(Ag)/m^3, 1999; the Philippines: TWA 2 mg/m^3 [skin], 1993; Sweden: NGV 0.2 mg/m^3, KTV 0.6 mg/m^3 [skin], 1999; Switzerland: MAK-W 2 mg/m^3, 1999; United Kingdom: LTEL 2 mg/m^3; STEL 4 mg/m^3, 1993; TWA 2 mg/m^3; STEL 4 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3.
trichloro- 1321-65-9
OSHA PEL: 5 mg/m^3 TWA [skin]
NIOSH REL: 5 mg/m^3 TWA [skin]
ACGIH TLV®[1]: 5 mg/m^3 TWA [skin]
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 50 mg/m^3
DFG MAK: [skin]
Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 5 mg/m^3 [skin], 1993; Austria: MAK 5 mg/m^3 [skin], 1999; Belgium: TWA 5 mg/m^3 [skin], 1993; Denmark: TWA 5 mg/m^3 [skin], 1999; France: VME 5 mg/m^3 [skin], 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; the Philippines: TWA 5 mg/m^3 [skin], 1993; Poland: MAC (TWA) 5 mg/m^3, 1999; Russia: STEL 1 mg/m^3 [skin], 1993; Sweden: NGV 0.2 mg/m^3, KTV 0.5 mg/m^3 [skin], 1999; Switzerland: MAK-W 5 mg/m^3 [skin], 1999; Turkey: TWA 5 mg/m^3 [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 5 mg/m^3 [skin]

Determination in Air: *Hexa-isomer:* Filter; Hexane; Gas chromatography/Electrochemical detection; NIOSH II(2) Method #S100.

Octa-isomer: Filter; Hexane; Gas chromatography/Flame ionization detection; NIOSH II(2) Method #S97.

Penta-isomer: Filter/Bubbler; Isooctane; Gas chromatography/Electrochemical detection; NIOSH II(2) Method #S96.

Tetra-isomer: Filter/Bubbler; none; Gas chromatography/ Flame ionization detection; NIOSH II(2) Method #S130 (II-1).

Tri-isomer: Filter/Bubbler; none; Gas chromatography/ Flame ionization detection; NIOSH II(2) Method #S128.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 1600 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 7.5 μg/L on an acute toxicity basis. For the protection of human health from the toxic properties of chlorinated naphthalenes ingested through water and through contaminated aquatic organisms, there are insufficient data to permit establishment of criteria.[6] Russia has set MAC limits in surface water of 0.01 mg/L for 1-Chloronaphthalene and for 2-Chloronaphthalene.

Determination in Water: 2-Chloronaphthalene may be determined by gas chromatography (EPA Method 612) or by gas chromatography plus mass spectrometry (EPA

Method 625). Octanol−water coefficient: Log K_{ow} = *Tetra-isomer:* about 6.1; *Tri-isomer*: 5.12−7.56; *Penta-isomer:* 8.73−9.13.

Routes of Entry: Inhalation of fumes and percutaneous absorption of liquid, ingestion, eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate eyes and skin. Cases of systemic poisoning are few in number and they may occur without the development of chloracne. It is believed that chloracne develops from skin contact and inhalation of fumes, while systemic effects result primarily from inhalation of fumes. Symptoms of poisoning may include headaches, fatigue, vertigo, and anorexia. Jaundice may occur from liver damage. Highly chlorinated naphthalenes seem to be more toxic than those chlorinated naphthalenes with a lower degree of substitution.

Long Term Exposure: May cause acne-like dermatitis. May affect the liver, resulting in jaundice. Can affect the nervous system. Chronic exposure to chlorinated naphthalenes can cause chloracne, which consists of simple erythematous eruptions with pustules, papules, and comedones. Cysts may develop due to plugging of the sebaceous gland orifices.

Points of Attack: Skin, liver, nervous system.

Medical Surveillance: Preplacement and periodic examinations should be concerned particularly with skin lesions, such as chloracne and with liver function. Liver function tests. Examination by a qualified allergist. Examination of the nervous system. More than light consumption of alcohol may increase liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection:

hexa-isomer: up to 2 mg/m^3: SA*: (any supplied-air respirator); or SCBAF: (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*May require eye protection.

octa-isomer: up to 1 mg/m^3: SA*: (any supplied-air respirator); or SCBAF: (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

penta-isomer: up to 5 mg/m^3: SA*: (any supplied-air respirator); or SCBAF: (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*May require eye protection.

tetra-isomer: up to 20 mg/m^3: SCBAF: (any self-contained breathing apparatus with a full face-piece); or SAF: (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH* *conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

tri-isomer: up to 50 mg/m^3: SCBAF: (any self-contained breathing apparatus with a full face-piece); or SAF: (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in a refrigerator or a cool, dry place.[52]

Shipping: The chlorinated naphthalenes are not specifically cited in the DOT Performance-Oriented Packaging Standards.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen material with toluene. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are noncombustible solids. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with flue gas scrubbing. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

The references to Sax, N. I. (Ed.). “Dangerous Properties of Industrial Materials Report,” may be tabulated as follows:

Isomer	Volume	No.	Pages	Year
1-Chloro-	3	2	77–78	(1983)
2-Chloro-	4	6	85–88	(1984)
Trichloro-	6	6	78–80	(1986)
Tetrachloro-	6	6	76–78	(1986)
Pentachloro-	5	1	84–87	(1985)
Hexachloro-	5	1	81–84	(1985)
Octachloro-	4	5	40–45	(1984)

US Environmental Protection Agency. (1980). *Chlorinated Naphthalenes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Chlorinated Naphthalenes: Health and Environmental Effects Profile No. 38*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *2-Chloronaphthalene: Health and Environmental Effects Profile No. 49*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Hexachloronaphthalene*. Trenton, NJ

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Octachloronaphthalene*. Trenton, NJ

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Pentachloronaphthalene*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Tetrachloronaphthalene*. Trenton, NJ

Chlorine C:0670

Molecular Formula: Cl_2

Synonyms: Bertholite; Chlor (German); Chlore (French); Chlorine molecular (C12); CL (military designation); Cloro (Spanish); Diatomic chlorine; Dichlorine; Molecular chlorine; Poly I gas

CAS Registry Number: 7782-50-5
RTECS® Number: FO2100000
UN/NA & ERG Number: UN1017/124
EC Number: 231-959-5 [*Annex I Index No.:* 017-001-00-7]
Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (≥1.00% concentration); *Theft hazard* 500 (≥9.77% concentration)

Carcinogenicity: NCI: Carcinogenesis Studies (water); equivocal evidence: rat; no evidence: mouse.

Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: RED.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Safe Drinking Water Act: SMCL, 250 mg/L; Priority List (55 FR 1470).

In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant level Goals (MRDG) for chlorine was set at 4 mg/L.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23; R36/37/38; R50 Safety phrases: S1/2; S9; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chlorine is a greenish-yellow gas with a pungent, irritating odor. Shipped as a liquefied compressed gas. It is the commonest of the four halogens which are among the most chemically reactive of all the elements. It is not flammable; but it is a strong oxidizer, and contact with other materials may cause fire. The odor threshold is 0.01 ppm in air. Molecular weight = 70.91; Specific gravity = (H_2O:1) = 1.4 at 20°C, 6.86 atm (liquid); Boiling point = −34.6°C; Freezing/Melting point = − 101°C; Relative vapor density (air = 1) = 2.47; Vapor pressure = 6.8 atm; 5168 mmHg at 20°C. Slightly soluble in water; solubility = 0.7%. Hazard Identification (based on NFPA 704 M Rating System): Health 4, Flammability 0, Reactivity 0, Oxidizer.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Environmental danger. Chlorine is a toxic gas with corrosive properties. Gaseous chlorine is widely used as a bleaching agent in the paper, pulp, and textile industries for bleaching cellulose for artificial fibers. It is used in the manufacture of chlorinated lime; inorganic and organic compounds, such as metallic chlorides; chlorinated solvents; refrigerants, pesticides; and polymers, for example, synthetic rubber and plastics; it is used as a disinfectant, particularly for water and refuse; and in detinning and dezincing iron. CL has been used as a warfare choking/pulmonary agent.

Note: The lowest level at which humans can detect chlorine through smell and become alert to its irritant properties generally provides sufficient warning of exposure. However, chronic exposure to chlorine causes olfactory fatigue and tolerance to its irritant effects. Those with a history of prolonged exposure to chlorine may eventually lose their ability to identify incidents of exposure.

Incompatibilities: A powerful oxidizer. Reacts explosively or forms explosive compounds with many organic compounds and common substances, such as acetylene, ether, turpentine, ammonia, fuel gas, hydrogen, and finely divided metals. Keep away from combustible substances and reducing agents. Corrosive to some plastic, rubber, and coating materials. Reacts with water to form hypochlorous acid. Corrosive to many metals in presence of water.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.90 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/3 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.5 ppm/1.45 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 0.5 ppm/1.5 mg/m^3 TWA; 1 ppm/2.9 mg/m^3 STEL, not classifiable as a human carcinogen.

Protective Action Criteria (PAC) Chlorine*

TEEL-0: 0.5 ppm

PAC-1: **0.5** ppm

PAC-2: **2** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Emergency Response Planning Guidelines (AIHA).

ERPG-1: 1 ppm.

ERPG-2: 3 ppm.

ERPG-3: 20 ppm.

DFG MAK: 0.5 ppm/1.5 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

NIOSH IDLH: 10 ppm.

Arab Republic of Egypt: TWA 1 ppm (3 mg/m^3), 1993; Australia: TWA 1 ppm (3 mg/m^3), 1993; Austria: MAK 0.5 ppm (1.5 mg/m^3), 1999; Belgium: TWA 0.5 ppm (1.5 mg/m^3); STEL 1 ppm, 1993; Denmark: TWA 0.5 ppm (1.5 mg/m^3), 1999; Finland: TWA 0.5 ppm (1.5 mg/m^3); STEL 1 ppm (3 mg/m^3), 1999; France: VLE 1 ppm (3 mg/m^3), 1999; India: TWA 1 ppm (3 mg/m^3); STEL 3 ppm

(9 mg/m^3), 1993; Japan: 1 ppm (2.9 mg/m^3), 1999; the Netherlands: MAC 3 mg/m^3, 2003; Norway: TWA 0.5 ppm (1.5 mg/m^3), 1999; the Philippines: TWA 1 ppm (3 mg/m^3), 1993; Poland: MAC (TWA) 1.5 mg/m^3; STEL 9 mg/m^3, 1999; Russia: TWA 1 ppm; STEL 1 mg/m^3, 1993; Sweden: NGV 0.5 ppm (1.5 mg/m^3), TGV 1 ppm (3 mg/m^3), 1999; Switzerland: MAK-W 0.5 ppm (1.5 mg/m^3), KZG-W 1 ppm (3 mg/m^3), 1999; Thailand: TWA 1 ppm (3 mg/m^3), 1993; Turkey: TWA 1 ppm (3 mg/m^3), 1993; United Kingdom: TWA 0.5 ppm (1.5 mg/m^3); STEL 1 ppm (2.9 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1 ppm. Russia set a MAC in work-place air of 1.0 mg/m^3 and values for ambient air in residential areas of 0.1 mg/m^3 on a momentary basis and 0.03 mg/m^3 on an average daily basis. Several states have set guidelines or standards for chlorine in ambient air[60] ranging from 0 (North Carolina) to 7.143 μg/m^3 (Kansas) to 10.0 μg/m^3 (New York) to 30.0 μ/m^3 (Florida) to 30−90 μg/m^3 (North Dakota) to 39 μ/m^3 (Massachusetts) to 50 μg/m^3 (Virginia) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada) to 75 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #6011, OSHA Analytical Method ID-101, ID-126SGX.

Permissible Concentration in Water: EPA has suggested the following limits: Total residual chlorine: 2.0 μg/L for salmonid fish; 10.0 μg/L for other freshwater and marine organisms. Russia[43] recommends an absence of active chlorine (taking into account the absorbing capacity of water) in domestic water supplies and a MAC of zero in water for fishery purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.85$.

Routes of Entry: Inhalation, eye, and skin contact.

Harmful Effects and Symptoms

Chlorine reacts with body moisture to form acids. It is itself extremely irritating to skin, eyes, and mucous membranes; and it may cause corrosion of teeth. Prolonged exposure to low concentrations may produce chloracne.

Chlorine in high concentrations acts as an asphyxiant by causing cramps in the muscles of the larynx (choking), swelling of the mucous membranes, nausea, vomiting, anxiety, and syncope. Acute respiratory distress including cough, hemoptysis, chest pain, dyspnea, and cyanosis develop, and later tracheobronchitis, pulmonary edema, and pneumonia may supervene. Exposure to 1.0 ppm may produce irritation of the nose, mouth, and throat; at 1.3 ppm and above, irritation may be more pronounced with coughing and labored breathing; high concentrations may cause throat muscle spasm leading to suffocation and death; delayed effects may include accumulation of fluid in the lungs, bronchitis, and pneumonia. Death may occur after a few breaths at 1000 ppm.

Short Term Exposure: A lacrimator. Chlorine is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause permanent damage. Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Rapid evaporation of the liquid may cause frostbite.

Long Term Exposure: Repeated exposure may permanently damage the lungs, or cause chronic bronchitis. Chlorine may affect the teeth, resulting in erosion, and cause skin rash. A single high exposure may cause similar health effects.

Points of Attack: Lungs, respiratory system.

Medical Surveillance: Special emphasis should be given to the skin, eyes, teeth, and cardiovascular status in placement and periodic examinations. Chest X-rays should be taken and pulmonary function followed.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Whenever there is likelihood of excessive gas levels, workers should use respiratory protection in the form of full-face gas masks with proper canisters or supplied-air respirators. The skin effects of chlorine can generally be controlled by good personal hygiene practices. Where very high gas concentrations or liquid chlorine may be present, full protective clothing, gloves, and eye protection should be used. Saranex™, Butyl rubber/Neoprene™, Viton™, Neoprene™, butyl rubber, and Viton™/Neoprene™ are among the recommended protective materials. Changing work clothes daily and showering following each shift where exposures exist are recommended.

Respirator Selection: *5 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern); or CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorine you should be trained on its proper handling and storage. Protect containers against physical damage. Store cylinders and containers in a cool, dry, relatively isolated area, protected from weather and extreme temperature changes.

Shipping: This chemical requires a shipping label of "POISON GAS, CORROSIVE." The Hazard Class is 2.3 and there is no Packing Group.[19,20] Subsidiary Hazardous Class or Division 8. Chlorine is a DOT regulated marine pollutant.

Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. If the gas is leaked, stop the flow of gas if it can be done safely. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty. If the leak can be stopped in place, bubble chlorine through a sodium sulfide and excess sodium bicarbonate solution including a trap in the line. For liquid spills, ventilate area and wash down spill with water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

CL, when used as a weapon—not listed in current DOT manual

UN1017 Chlorine

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.0/1.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2000/600
Then: Protect persons downwind (miles/kilometers)
Day 2.2/3.6
Night 5.0/8.0

Fire Extinguishing: Chlorine is a noncombustible solid, but it will increase the intensity of a fire and cause fire upon contact with combustible materials. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Vapors are heavier than air and will collect in low areas. Hydrogen and chlorine mixtures (5−95%) are exploded by almost any form of energy (heat, sunlight, sparks, etc.). May combine with water or steam to produce toxic and corrosive fumes of hydrochloric acid. Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only

respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Introduce into large volume and solution of reducing agent (bisulfite, ferrous salts, or hypo), neutralize and flush to sewer with water. Recovery is an option to disposal for chlorine in the case of gases from aluminum chloride electrolysis and chlorine in waste waters. See also "Spill Handling." Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

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Chlorine dioxide C:0680

Molecular Formula: ClO_2

Synonyms: Alcide; Anthium dioxcide; Chlorine oxide; Chlorine(IV) oxide; Chlorine peroxide; Chloroperoxyl; Chloryl radical: "ClO_2"; Dioxido de cloro (Spanish); Doxcide 50; Ez flow; Purogene

CAS Registry Number: 10049-04-4

RTECS$^{®}$ Number: FO3000000

UN/NA & ERG Number: NA 9191 (hydrate, frozen)/143

EC Number: 233-162-8 [*Annex I Index No.:* 006-089-00-2]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration).

Carcinogenicity: EPA: Cannot be Determined; Not Classifiable as to human carcinogenicity.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 1000 lb (454 kg).

Safe Drinking Water Act: Priority List (55 FR 1470).

In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), Maximum Residual Disinfectant level Goals (MRDG) for chlorine dioxide was set at 0.8 mg/L.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; C (Oxidizing Material); D1B (Toxic); E (Corrosive Material); F (Dangerously Reactive); National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: O, T+, N; Risk phrases: R6; R8; R26; R34; R50; Safety phrases: S1/2; S23; S26; S28; S36/37/39; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlorine dioxide is a flammable, reddish-yellow gas or reddish-brown liquid (below 11°C/52°F) with an irritating odor like chlorine or nitric acid. Molecular weight = 67.46; Specific gravity (H_2O:1) = 1.6 (liquid at 0°C); Boiling point = 11°C; Freezing/Melting point = −59°C; Relative vapor density (air = 1) = 2.3; Vapor pressure = >1 atm at 20°C. Explosive Limits in air: >10%. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 3, Reactivity 3 (Shock; Oxidizer). Soluble in water (reactive); solubility = 0.3% at 25°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Primary Irritant. Chlorine dioxide is used in bleaching cellulose pulp; bleaching flour; water purification; as a liquid sterilizer in an ultrasonic cleaner.

Incompatibilities: Unstable in light. A powerful oxidizer. Chlorine dioxide gas is explosive at concentrations over 10% and can be ignited by almost any form of energy, including sunlight, heat (explosions can occur in air in temperature above 130°C), or sparks, shock, friction, or concussion. This chemical reacts violently with dust, combustible materials, and reducing agents. Reacts violently with mercury, phosphorus, sulfur, and many compounds, causing fire and explosion hazard. Contact with water forms perchloric and hydrochloric acid. Corrosive to metals.

Permissible Exposure Limits in Air
OSHA PEL: 0.1 ppm/0.3 mg/m^3 TWA.
NIOSH REL: 0.1 ppm/0.3 mg/m^3 TWA; 0.3 ppm/0.9 mg/m^3 STEL.
ACGIH TLV®[1]: 0.1 ppm/0.28 mg/m^3 TWA; 0.3 ppm/0.83 mg/m^3 STEL.
NIOSH IDLH: 5 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.1 ppm
PAC-1: **0.15** ppm
PAC-2: **1.1** ppm
PAC-3: **2.4** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.
Emergency Response Planning Guidelines (AIHA).
ERPG-1: Not appropriate.
ERPG-2: 50 ppm.
ERPG-3: 5000 ppm.
DFG MAK: 0.1 ppm/0.28 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.
Australia: TWA 0.1 ppm (0.3 mg/m^3); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.3 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.28 mg/m^3); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.3 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.3 mg/m^3); STEL 0.3 ppm (0.9 mg/m^3), 1999; France: VME 0.1 ppm (0.3 mg/m^3), VLE 0.3 ppm (0.8 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.3 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.3 mg/m^3), 1993; Poland: MAC (TWA) 0.3 mg/m^3, MAC (STEL) 0.9 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, 1993; Sweden: NGV 0.1 ppm (0.3 mg/m^3), KTV 0.3 ppm (0.8 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.3 mg/m^3), KZG-W 0.2 ppm (0.6 mg/m^3), 1999; Thailand: TWA 0.1 ppm (0.3 mg/m^3), 1993; Turkey: TWA 0.1 ppm (0.3 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.28 mg/m^3); STEL 0.3 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.3 ppm. Several states have set guidelines or standards for ClO_2 in ambient air[60] ranging from 1.0 μg/m^3 (New York) to 3.0 μg/m^3 (Florida) to 3.0–9.0 μg/m^3 (North Dakota) to 5.0 μg/m^3 (Virginia) to 6.0 μg/m^3 (Connecticut) to 7.0 μg/m^3 (Nevada).

Determination in Air: Collection by bubbler; Potassium iodide; Ion chromatography; OSHA Analytical Method #ID202.

Permissible Concentration in Water: Values in guidelines or standards for chlorine in drinking water[61] have been set by Maine at 110 μg/L and by the US EPA at 1000 μg/L.

Routes of Entry: Inhalation, ingestion, eye, and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator. Chlorine dioxide is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation at levels above 0.25 ppm may cause slight irritation to the nose, throat, and mouth. Levels above 5 ppm may cause severe irritation to the nose, throat, and mouth. 19 ppm for an unspecified time has caused death.

Long Term Exposure: Chlorine dioxide may affect the lungs, causing chronic bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may affect the teeth, causing erosion. There is limited evidence that Chlorine dioxide may damage the developing fetus.

Points of Attack: Respiratory system, lungs, eyes.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid, wear splash-proof chemical goggles and face shield when there is a potential for exposure to gas, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 ppm:* CcrS (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or Sa (APF = 10) (any supplied-air respirator). *2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection. Only nonoxidizable sorbents allowed (not charcoal).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with chlorine dioxide you should be trained on its proper handling and storage. This chemical is a powerful oxidizer, and is shock-, light- and heat-sensitive. It is violently explosive in air at concentrations over 10%. Keep frozen when not in use. Store in tightly closed containers in a cool, dark, well-ventilated area at temperatures well below 130°C. Gas explosions may occur above 130°C. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use explosion-proof electrical equipment and fittings in storage area. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: The frozen hydrate can be shipped but must be labeled "OXIDIZER, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak or spill. If the gas is leaked, stop the flow of gas if it can be done safely. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air and repair the leak or allow the cylinder to empty. If the leak can be stopped in place, bubble chlorine dioxide through a solution made up of reducing agent sodium bisulfide and sodium bicarbonate with a trap in the line. For liquid spills, allow chlorine dioxide to evaporate with all available ventilation. Keep chlorine dioxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

Chlorine dioxide, hydrate, frozen

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Fire Extinguishing: A powerful oxidizer, this chemical will increase the intensity of a fire, and can cause fire upon contact with combustibles. This chemical is an explosive at concentrations over 10% and can be ignited by almost any form of energy. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Poisonous gases, including chlorine, are produced in fire. Use water only. *Do not* use dry chemical or carbon dioxide extinguishers. Use water with caution as chlorine dioxide reacts with water, forming hydrogen chloride gas. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volume of concentrated solution of ferrous salt or bisulfite solution as reducing agent. Then neutralize and flush to sewer with abundant water.[24]

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Chlorine Dioxide*. Albany, NY: Bureau of Toxic Substance Assessment (revision)

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Chlorine Dioxide*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Chlorine trifluoride C:0690

Molecular Formula: ClF_3

Synonyms: Chlorine fluoride; Chlorine trifluoride; Chlorotrifluoride; Trifluorure de chlore (French); Trifluoruro de cloro (Spanish)

CAS Registry Number: 7790-91-2

RTECS® Number: FO2800000

UN/NA & ERG Number: UN1749/124

EC Number: 232-230-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥9.97% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlorine trifluoride is a greenish yellow, almost colorless, liquid (below 12°C/53°F) or colorless gas with a sweet, irritating odor. Shipped as a liquefied compressed gas. Molecular weight = 92.45; Boiling point = 11.8°C; Freezing/Melting point = − 76.3°C; Vapor pressure = 1.4 atm; Relative vapor density (air = 1) = 3.21. Hazard Identification (based on NFPA 704 M Rating System): Health 4, Flammability 0, Reactivity 3 (Oxidizer). Reacts with water.

Potential Exposure: Chlorine trifluoride is used as a fluorinating agent. It may be used as an igniter and propellant in rockets. It is used in nuclear fuel processing.

Incompatibilities: A powerful oxidizer. Most combustible materials ignite spontaneously on contact with chlorine trifluoride. Explodes on contact with organic materials. The liquid can explode if mixed with halocarbons or hydrocarbons. It reacts violently with oxidizable materials, finely divided metals and metal oxides, sand, glass, asbestos, silicon-containing compounds. Emits highly toxic fumes on contact with acids. Chlorine trifluoride decomposes above 220°C, forming poisonous gases, including hydrogen chloride and hydrogen fluoride. Reacts violently with water, forming chlorine gas and hydrofluoric acid. Reacts with most forms of plastics, rubber, coatings, and resins; except the highly fluorinated polymers, such as Teflon™ and "Kel-F."

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.78 mg/m^3.

OSHA PEL: 0.1ppm/0.4 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.1ppm/0.4 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.1 ppm/ 0.38 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.04 ppm

PAC-1: **0.12** ppm

PAC-2: **2.0** ppm

PAC-3: **21** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1:0.1 ppm

ERPG-2: 1 ppm

ERPG-3: 10 ppm

DFG MAK: No numerical value established. Data may be available. (2005)3.

NIOSH IDLH: 20 ppm.

Some states have set guidelines or standards for ClF_3 in ambient[60] air, ranging from 3.0 μg/m^3 (Virginia) to 4.0 μ/m^3 (North Dakota) to 10.0 μg/m^3 (Nevada).

Determination in Air: No test available.

Routes of Entry: Inhalation, ingestion, eye, and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Chlorine trifluoride is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact with the liquefied gas can cause frostbite.

Long Term Exposure: Can cause lung irritation; bronchitis may develop with cough, phlegm, and shortness of breath.

Points of Attack: Skin, eyes, respiratory tract.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles if working with the liquid and face shield when working with gas, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2.5 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *20 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color Code—Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with chlorine trifluoride you should be trained on its proper handling and storage. Chlorine trifluoride must be stored to avoid contact with water, sand, glass, silicon-containing compounds, asbestos, and combustible materials, since violent reactions occur. See Incompatibilities. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Chlorine trifluoride must be labeled: "POISON GAS, OXIDIZER, CORROSIVE." It falls in Hazard Class 2.3 and there is no Packing Group.[19] It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. If in a building, shut down HVAC systems. Remove all ignition sources. Collect solid chlorine trifluoride in the most convenient and safe manner and deposit in sealed containers. If the gas has leaked, stop the flow of gas if it can be done safely. Ventilate area of leak or spill. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air and repair the leak or allow the cylinder to empty. Keep chlorine trifluoride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)

Day 0.3/0.5
Night 1.1/1.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 1.7/2.8
Night 4.5/7.2

Fire Extinguishing: This chemical does not burn but it will increase the activity of fire and will cause combustibles to ignite. *Do not use water* or foam. Use dry chemical, carbon dioxide. Poisonous gases are produced in fire, including hydrogen fluoride and hydrogen chloride. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Chlorine Trifluoride.* Trenton, NJ

Chlormephos C:0700

Molecular Formula: $C_5H_{12}ClO_2PS_2$

Synonyms: *S*-(Chloromethyl) *O*,*O*-diethyl ester phosphorodithioic acid; *S*-(Chloromethyl) *O*,*O*-diethyl phosphorodithioate; *S*-Chloromethyl *O*,*O*-diethyl phosphorodithioate; *S*-(Chloromethyl) *O*,*O*-diethyl phosphorodithioic acid; *S*-Chloromethyl *O*,*O*-diethyl phosphorodithiothiolothionate; Dotan®; MC2188; Phosphorodithioic acid, *S*-(chloromethyl) *O*,*O*-diethyl ester

CAS Registry Number: 24934-91-6

RTECS® Number: TD5170000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 246-538-1 [*Annex I Index No.:* 015-114-00-6]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 500 lb (227 kg).
Not registered as a pesticide in the US.
Reportable Quantity (RQ): 1 lb (0.454 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.
European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S27; S28; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlormephos is an organophosphate, colorless liquid. Molecular weight = 234.70; Boiling point = 81−85°C at 0.1 mmHg. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water; solubility = 60 mg/L at 20°C.

Potential Exposure: This material is a soil insecticide. Not registered as a pesticide in the US.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Contact with alkaline materials causes rapid hydrolysis. May corrode metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 7 mg/m^3
PAC-3: 35 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method IV #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin contact, passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This material is poisonous; it may be fatal if inhaled, swallowed, or absorbed through the skin. The acute oral LD_{50} for rats is 7 mg/kg (highly toxic). Symptoms exhibited on chlormephos exposure are typical of cholinesterase poisoning. Nausea is often first symptom, with vomiting, abdominal cramps, diarrhea, and excessive salivation, headache, giddiness, weakness, tightness in chest, blurring of vision, pinpoint pupils, loss of muscle coordination, and difficulty breathing. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. Convulsions and coma precede death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Chlormephos can cause the heart to beat slower (bradycardia) or irregularly (arrhythmia).

Long Term Exposure: There is limited evidence that this chemical may damage the developing fetus. Can affect the nervous system and cause impaired memory, depression, anxiety, or irritability. Symptoms resembling influenza with headache, nausea, and weakness have been reported.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chlormephos you should be trained on its proper handling and storage. Should be protected from moisture and stored in glass-lined or polyethylene-lined containers. Keep away from strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS" for organophosphorus pesticides, liquid, toxic. It falls in Hazard Class 6.1.[19,20]

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride, phosphorous oxides, and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chlormephos*. Washington, DC: Chemical Emergency Preparedness Program

Chlormequat chloride C:0710

Molecular Formula: $C_5H_{13}Cl_2N$

Common Formula: $ClCH_2CH_2N(CH_3)_3Cl$

Synonyms: 60-CS-16; AC 38555; Ammonium (2-chloroethyl)trimethyl-, chloride 2-chloro-*N*,*N*,*N*-trimethylethanaminium chloride; Antywylegacz; CCC plant growth regulant; 2-Chloraethyl-trimethylammoniumchlorid (German); Chlorcholinchlorid; Chlorcholine chloride; Chlormequat; Chlorocholine chloride; (β-Chloroethyl) trimethylammonium chloride; (2-Chloroethyl)trimethylammonium chloride; 2-Chloroethyl trimethylammonium chloride; 2-Chloro-*N*,*N*,*N*-ethyl)trimethylethanaminium chloride; 2-Chloro-*N*,*N*,*N*-trimethylammonium chloride; Choline dichloride; Clormecuato de cloroacetilo (Spanish); Cloruro de clormecuat (Spanish); Cyclocel; Cycocel; Cycocel-extra; Cycogan; Cycogan extra; Cyocel; EI 38,555; Ethanaminium, 2-chloro-*N*,*N*,*N*-trimethyl-, chloride; Hico CCC; Hormocel-2CCC; Increcel; Lihocin; NCI-C02960; Retacel; Stabilan; Trimethyl-β-chlorethylammoniumchlorid; Trimethyl-β-chloroethyl ammonium chloride; Tur

CAS Registry Number: 999-81-5

RTECS® Number: BP5250000

EC Number: 213-666-4 [*Annex I Index No.*: 007-003-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chlormequat chloride is a white to yellowish crystalline solid with a fish-like odor. Molecular weight = 158.1; Freezing/Melting point = 245°C (decomposes); Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 0, Reactivity 0. Highly soluble in water. Carrier solvents used in commercial products may alter physical and toxicological properties.

Potential Exposure: People engaged in the manufacture, formulation, and application of this plant growth regulator said to be effective for cereal grains, tomatoes, and peppers.

Incompatibilities: Chlormequat chloride decomposes on heating or in fire, forming nitrogen oxides, carbon monoxide, and hydrogen chloride fumes. This chemical decomposes on heating with strong aqueous alkali solutions forming trimethylamine and other gaseous products. Contact with strong oxidizers may cause fire and explosions. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7 mg/m^3

PAC-3: 7.5 mg/m^3

Permissible Concentration in Water: Russia set a MAC of 0.2 mg/L in surface water.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: The LD_{low} oral (human) is 10 mg/kg. It is an irritant and can be absorbed through the skin. Irritates the eyes and the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause nausea and vomiting. Higher levels can cause slow or irregular heartbeat; tremors, seizures, and coma. This can be fatal. Chlormequat chloride may affect the nervous system.

Long Term Exposure: May cause liver damage.

Points of Attack: Lungs, liver, nervous system.

Medical Surveillance: Liver function tests. Consider chest X-ray following acute overexposure. EKG examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Permeation data indicate that Neoprene™ gloves may provide protection from exposure to this compound. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlormequat chloride you should be trained on its proper handling and storage. Keep away from strong oxidizers. Store in a cool, dry place and protect from heat and moisture. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The label required for Poisonous Solids, n.o.s., is "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, or water extinguishers. Poisonous gases are produced in fire, including carbon monoxide, nitrogen oxide, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit with effluent gas scrubbing.[22]

References

New Jersey Department of Health. (April 1999). *Hazardous Substances Fact Sheet: Chlormequat Chloride*. Trenton, NJ

US Environmental Protection Agency. (October 31, 1985) *Chemical Hazard Information Profile: Chlormequat Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Chlornaphazine C:0720

Molecular Formula: $C_{14}H_{15}Cl_2N$

Common Formula: $(ClCH_2CH_2)_2NC_{10}H_7$

Synonyms: 2-Bis(2-chloroethyl)aminonaphthalene; *N*,*N*-Bis (2-chloroethyl)-2-naphthylamine; Bis(2-chloroethyl)-β-naphthylamine; Chlornaftina; Chlornaphazin; Chlornaphthin; Chloronaftina; Chloronaphthine; *N*,*N*-Di(2-chloroethyl)-β-naphthlamine; 2-*N*,*N*-Di(2-chloroethyl)naphthlamine; Di(2-chloroethyl)-β-naphthlamine; Dichloroethyl-β-naphthylamine; Erysan; 2-Naphthalenamine, *N*,*N*-bis(2-chloroethyl)-; Naphthlamine mustard; β-Naphthyl-bis(β-chloroethyl)amine; 2-Naphthl-bis(β-chloroethyl)amine; β-Naphthl-di(2-chloroethyl)amine; NSC-62209; R48

CAS Registry Number: 494-03-1

RTECS® Number: QM2450000

UN/NA & ERG Number:

EC Number: 207-785-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998.

Banned or Severely Restricted (Israel) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U026.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

California Proposition 65 Chemical: Cancer 2/27/87.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlornaphazine is composed of clear, colorless plates or may be a brown solid. Molecular weight = 268.2; Freezing/Melting point = 54−56°C. Slightly soluble in water; solubility = < 1 mg/mL at 22°C.

Potential Exposure: May be combustible and possibly explosive. Not produced or used commercially in the United States, Chlornaphazine has been used in other countries in the treatment of leukemia and related cancers. Currently, this drug does not have wide therapeutic usage.

Incompatibilities: Keep away from oxidizers, nucleophiles,[NTP] and nitromethanes. Amines may react violently with nitric acid, cellulose nitrate (of high surface area), 1-chloro-2,3-epoxypropane (exothermic reaction may occur). Incompatible with acids, acid halides, alcohols, aldehydes, alkylene oxides, anhydrides, cresols, caprolactam solution, epichlorohydrin, epoxides, isocyanates, glycols, peroxides, phenols. Contact with strong reducing agents may generate flammable hydrogen gas. May attack copper and copper alloys.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical method 93.

Medical Surveillance: OSHA mandates the following tests or information for 1- and 2-naphthylamine which are related to this chemical: *Increased Risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking. NIOSH lists the following tests: *Increased Risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking, cystoscopy, urinalysis (routine).

First Aid: *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pesticides, solid, toxic, n.o.s., required label is "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% ethanol to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent paper dampened with 60−70% ethanol to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Chloroacetaldehyde C:0730

Molecular Formula: C_2H_3ClO

Common Formula: $ClCH_2CHO$

Synonyms: Acetaldehyde, chloro-; 2-Chloroacetaldehyde; Chloroacetaldehyde monomer; 2-Chloro-1-ethanal; 2-Chloroethanal; Cloroacetaldehido (Spanish); Monochloroacetaldehyde

CAS Registry Number: 107-20-0

RTECS® Number: AB2450000

UN/NA & ERG Number: UN2232/153

EC Number: 203-472-8 [*Annex I Index No.:* 605-025-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P023.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R34; R40; R50; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloroacetaldehyde is a combustible, colorless liquid with a very sharp, irritating odor. Molecular weight = 78.50; Specific gravity (H_2O:1) = 1.19 (40% solution); Boiling point = 85−100°C; Freezing/Melting point = 16°C (40% solution); Vapor pressure = 100 mmHg at 20°C; Flash point = 87.7°C (40%

solutions). Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 0 (able to polymerize on standing). Soluble in water.

Potential Exposure: Compound Description: Mutagen. Chloroacetaldehyde is used as a fungicide; as an intermediate in 2-aminothiazole manufacture; and in bark removal from tree trunks.

Incompatibilities: Heat and water sensitive; concentrations of >50% form insoluble hemihydrate material on contact with water. Reacts with oxidizers, acids. On heating, chloroacetaldehyde releases chlorine fumes. Polymerizable upon standing.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.21 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/3 mg/m^3 Ceiling Concentration.

NIOSH REL: 1 ppm/3 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/3.2 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 45 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.4 ppm

PAC-1: **1.3** ppm

PAC-2: **2.2** ppm

PAC-3: **9.9** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 3B.

Arab Republic of Egypt: TWA 1 ppm (3 mg/m^3), 1993; Australia: TWA 1 ppm (3 mg/m^3), 1993; Austria: MAK 1 ppm (3 mg/m^3), 1999; Belgium: STEL 1 ppm (3.2 mg/m^3), 1993; Denmark: TWA 1 ppm (3 mg/m^3), 1999; Finland: STEL 1 ppm (3 mg/m^3), 1993; France: VLE 1 ppm (3 mg/m^3), 1999; the Netherlands: MAC 3 mg/m^3, 2003; Norway: TWA 1 ppm (3 mg/m^3), 1999; the Philippines: TWA 1 ppm (3 mg/m^3), 1993; Switzerland: MAK-W 1 ppm (3 mg/m^3), KZG-W 2 ppm (6 mg/m^3), 1999; Thailand: TWA 1 ppm (3 mg/m^3), 1993; Turkey: TWA 1 ppm (3 mg/m^3), 1993; United Kingdom: STEL 1 ppm (3.3 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 1 ppm (Ceiling Concentration). Several states have set guidelines or standards for chloroacetaldehyde in ambient air[60] ranging from 1.0 μ/m^3 (New York) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (North Dakota) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #2015 and OSHA Analytical Method 76.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.29$.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Irritation of skin, eyes, and mucous membrane, skin burns, eye damage, pulmonary edema, sensitization of skin, and respiratory system. Does have a mutagenic effect. LD_{50} = (oral-mouse) 21 mg/kg.

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause burns and permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: This chemical may cause mutations. It can cause skin allergy and an asthma-like lung allergy.

Points of Attack: Eyes, skin, respiratory system, lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests; Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact with liquids of >0.1% content or repeated or prolonged contact with liquids of <0.1% content. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)]; or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)]. *45 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or GmFOv(any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister); or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Polymerizable upon standing. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloroacetaldehyde you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is I.[19,20]

Spill Handling: Avoid inhalation of vapors. Do not touch spilled material, stop leak, use water spray to reduce vapors. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.9/1.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

US Environmental Protection Agency, (April 30, 1980). *Chloroacetaldehyde: Health and Environmental Effects Profile No. 40*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 70−72. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chloroacetaldehyde*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chloroacetaldehyde*. Trenton, NJ

Chloroacetic acid C:0740

Molecular Formula: $C_2H_3ClO_2$
Common Formula: $ClCH_2COOH$
Synonyms: Acetic acid, chloro-; Acide chloracetique (French); Acide monochloracetique (French); Acido cloroacetico (Spanish); Chloracetic acid; Chloroethanoic acid; MCA; Monochloracetic acid; Monochloressigsaeure (German); Monochloroacetic acid; Monochloroethanoic acid; NCI-C60231
CAS Registry Number: 79-11-8
RTECS® Number: AF8575000
UN/NA & ERG Number: UN1750 (liquid)/153; UN1751 (solid)/153
EC Number: 201-178-4 [*Annex I Index No.*: 607-003-00-1]
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R34; R50; Safety phrases: S1/2; S26; S36/37/39; S45; S61; S63 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Chloroacetic acid is a colorless to white crystalline solid. It has a strong vinegar-like odor and an odor threshold of 0.15 mg/m^3. Molecular weight = 94.50; Boiling point = 188°C; Freezing/Melting point = 63°C; Flash point = 126°C; Autoignition temperature $\geq$500°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. Monochloroacetic acid is used primarily as a chemical intermediate in the synthesis of sodium carboxymethyl cellulose; and such other diverse substances as ethyl chloroacetate, glycine, synthetic caffeine, sarcosine, thioglycolic acid, and various dyes. Hence, workers in these areas are affected. It is also used as an herbicide. Therefore, formulators and applicators of such herbicides are affected.
Incompatibilities: The solution in water is a strong acid. Contact with strong oxidizers, strong bases, and strong reducing agents can cause violent reactions. Chloroacetic acid decomposes on heating, producing toxic and corrosive hydrogen chloride, phosgene gases. Attacks metals in the presence of moisture.
Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.05 ppm/2 mg/m^3 inhalable fraction and vapor.
AIHA WEEL: 0.5 ppm TWA [skin].
Protective Action Criteria (PAC)*
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: **6.6** ppm
PAC-3: 20 ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.
Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 4 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden; TWA 1 ppm (4 mg/m^3); STEL 2 ppm (8 mg/m^3) [skin], 1999; United Kingdom: TWA 0.3 ppm (1.2 mg/m^3) [skin], 2000; the Netherlands: MAC-TGG 4 mg/m^3 [skin], 2003. This chemical can be absorbed through the skin, thereby increasing exposure.
Routes of Entry: Inhalation, ingestion, and skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.
Harmful Effects and Symptoms
Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe irritation and burns. Inhaling this chemical can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Chloroacetic acid can cause a feeling of anxiety, restlessness, blurred vision, a feeling of "pins and needles" in the limbs, muscle twitching, and/or hallucinations; may affect the cardiovascular system, central nervous system, and kidneys, resulting in heart problems, convulsions, and kidney damage. These effects may be delayed. Symptoms of exposure include irritation and pain in skin. If chloroacetic acid is inhaled the patient may exhibit difficulty in breathing. Vomiting may occur if the material is ingested. It can burn the skin, cornea, and respiratory tract. This material is very toxic. The probable lethal oral dose is 50−500 mg/kg of body weight, between one teaspoon and one ounce, for a 150-lb person. Chloroacetic acid is irritating to the skin, cornea, and respiratory tract and causes burns. It may severely damage skin and mucous membranes. Ingestion may interfere with essential enzyme systems and cause perforation and peritonitis. Burns to skin result in marked fluid and electrolyte loss. Death may follow if more than 3% of the skin is exposed to this material. Other health hazards include central nervous system depression and respiratory system depression.
Long Term Exposure: Repeated exposure may cause kidney damage and affect the lungs.
Points of Attack: Lungs, kidneys, central nervous system.
Medical Surveillance: Lung function tests, kidney function tests. Examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. If you are working with dry material wear dust-proof chemical goggles and face shield if you are working with the liquid, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/ MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with chloroacetic acid you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metal, combustibles, strong oxidizers, strong bases, and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The DOT label required for *solid* chloroacetic acid is "POISONOUS/TOXIC MATERIALS, CORROSIVE." The Hazard Class is 6.1 and the Packing Group is II. For chloroacetic acid, *solution*, the label is "POISONOUS/TOXIC MATERIALS, CORROSIVE." The Hazard Class is 6.1 and the Packing Group is II.[19,20]

Spill Handling: Stay upwind; keep out of low areas. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Neutralize spilled materials with crushed limestone, soda ash, or lime. Waste water containing chloroacetic acid can be treated with ammonia, ammonium salts, or amines followed by separation of suspended solids. Collect spilled powdered material in the most convenient and safe manner and deposit in sealed containers. Dike *large spills* far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is extremely hazardous to health, but firefighters may enter areas with extreme care. Full protective clothing including a self-contained breathing apparatus, coat, pants, gloves, boots and bands around legs, arms, and waist should be provided. No skin surface should be exposed. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chlorine and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria*

Document Priorities: Monochloroacetic Acid, Report PB-274,073. Rockville, MD, pp. 309−311

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 99−101. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chloroacetic Acid.* Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Chloroacetic Acid.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Chloroacetic Acid.* Trenton, NJ

2-Chloroacetophenone (Agent CN, WMD) C:0750

Molecular Formula: C_8H_7ClO

Common Formula: $C_6H_5COCH_2Cl$

Synonyms: Acetophenone, 2-chloro-; CAF; CAP; Chemical Mace; α-Chloroacetophenone; e-Chloroacetophenone; 1-Chloroacetophenone; Chloroacetophenone (DOT); Chloromethyl phenyl ketone; 2-Chloro-1-phenylethanone; α-Cloroacetofenona (Spanish); CN (military designation); Ethanone, 2-Chloro-1-phenyl-; MACE® (lacrimator); NCI-C55107; Phenacyl chloride; Phenyl chloromethyl ketone; Tear gas

CAS Registry Number: 532-27-4

RTECS® Number: AM6300000

UN/NA & ERG Number: UN1697/153

EC Number: 208-531-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); equivocal evidence: rat; no evidence: mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Chloroacetophenone (CN) is a combustible, colorless-to-gray solid. CN has a sharp, irritating odor, has been described as smelling like "apple blossoms." It may be dissolved in a solvent. Odor threshold = 0.015 ppm. Molecular weight = 154.60; Boiling point = 247°C; Specific gravity = 1.32; Freezing/Melting point = 56.5°C; Vapor pressure = 0.0054 mmHg at 20°C; Flash point = 117.7°C (cc). Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Chloroacetophenone is used as a chemical warfare agent (Agent CN) and as a principal ingredient in the riot control agent Mace®. It is also used as a pharmaceutical intermediate. The United States considers agent CN and its mixtures with various chemicals to be obsolete for military deployment.

Incompatibilities: CN reacts with water, forming hydrochloric acid. Keep away from water, steam, strong oxidizers. CN reacts slowly with metals, causing mild corrosion and may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.05 ppm/0.3 mg/m^3 TWA.

NIOSH REL: 0.05 ppm/0.3 mg/m^3 TWA.

ACGIH TLV®[1]: 0.05 ppm/0.32 mg/m^3 TWA, not classifiable as a human carcinogen.

NIOSH IDLH; 15 mg/m^3.

No TEEL available.

Australia: TWA 0.05 ppm (0.3 mg/m^3), 1993; Austria: MAK 0.05 ppm (0.3 mg/m^3), 1999; Belgium: TWA 0.05 ppm (0.32 mg/m^3), 1993; Denmark: TWA 0.05 ppm (0.3 mg/m^3), 1999; Finland: STEL 0.05 ppm (0.3 mg/m^3) [skin] 1993; France: VME 0.05 ppm (0.4 mg/m^3), 1999; the Netherlands: MAC-TGG 0.3 mg/m^3, 2003; Norway: TWA 0.05 ppm (0.3 mg/m^3), 1999; Switzerland: MAK-W 0.05 ppm (0.3 mg/m^3), 1999; United Kingdom: TWA 0.05 ppm (0.32 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards[60] for chloroacetophenone in ambient air ranging from 1.0 μg/m^3 (New York) to 3.0 μg/m^3 (Florida and North Dakota) to 6.0 μg/m^3 (Connecticut) to 7.0 μg/m^3 (Nevada) to 7.5 μg/m^3 (South Carolina).

Determination in Air: Tenax Gas chromatography[2]; Thermal desorption; Gas chromatography/Flame ionization detection; NIOSH II(5) P&CAM Method #291.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.93$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator (a "tear gas"). This chemical can be absorbed through the skin, thereby increasing exposure. This chemical irritates the eyes, skin, and respiratory tract. Eye contact can cause severe irritation, burns, and permanent damage. Breathing the vapor can cause lung irritation, coughing, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and skin allergy with itching and rash.

Points of Attack: Eyes, skin, respiratory system, lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Examination by a qualified allergist. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you do not have the equipment and training, do not enter the hot zone to rescue and/or decontaminate victims. If the victim cannot move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash—strip—wash—evacuate upwind and uphill: The approach is to immediately wash with water; then have the victim (not the first responder) remove all the victim's clothing; then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 min. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear indirect-vent, impact, and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *3 mg/m³:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100. *7.5 mg/m³*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *15 mg/m³:* Any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter); or any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area away from oxidizers, heat, water, and steam. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloroacetophenone requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

CN, when used as a weapon

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day	0.2/0.3
Night	0.9/1.5

Fire Extinguishing: This chemical is a combustible solid but does not readily ignite. In case of fire, *do not put out the fire*. CN vapor is so bad that the fire is safer than the unburned CN. If there is some reason that you have to put out the fire—for example, there are things you cannot let burn nearby—use water or ordinary foam. It is always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of CN canisters adjacent to a fire, cool the canisters with large amounts of water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. CN can give off toxic hydrogen chloride in a fire or when heated. Poisonous gases are produced in fire, including carbon monoxide and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Tear gas-containing waste is dissolved in an organic solvent and sprayed into an incinerator equipped with an afterburner and alkaline scrubber utilizing reaction with sodium sulfide in an alcohol—water solution. Hydrogen sulfide is liberated and collected by an alkaline scrubber.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 48—49

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: α-Chloroacetophenone*. Trenton, NJ

Schneider, A. L., (Ed.) (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C)*. Washington, DC: United States Coast Guard and the Department of Homeland Security.

Chloroacetyl chloride C:0760

Molecular Formula: $C_2H_2Cl_2O$

Common Formula: $ClCH_2COCl$

Synonyms: Acetyl chloride, chloro-; Chloroacetic acid chloride; Chloroacetic chloride; Chlorure de chloracetyle (French); Cloruro de cloroacetilo (Spanish); Monochloroacetyl chloride

CAS Registry Number: 79-04-9

RTECS® Number: AO6475000

UN/NA & ERG Number: UN1752/156

EC Number: 201-171-6 [*Annex I Index No.:* 607-080-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, C, N; Risk phrases: R14; R23/24/25; R29; R35; R48/23; R50; Safety phrases: S1/2; S7/8; S9; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chloroacetyl chloride is a colorless to yellowish liquid with a very pungent, extremely irritating, odor. Molecular weight = 112.95; Specific gravity (H_2O:1) = 1.42; Boiling point = 105°C; Freezing/Melting point = −22°C; Vapor pressure = 19 mmHg at 20°C. NFPA 704 M Rating System: Health 3, Flammability 1, Reactivity 1₩. Reacts violently with water.

Potential Exposure: Highly toxic by inhalation. Chloroacetyl chloride is used in the manufacture of acetophenone. It is used in the manufacture of a number of pesticides including: alachlor, allidochlor, butachlor, dimethachlor, formothion, mecarbam, metolachlor, propachlor. It is also used in the manufacture of pharmaceuticals, such as chlordiazepoxide hydrochloride, diazepam, lidocaine, mianserin.

Incompatibilities: Reacts violently with water, steam forming chloroacetic acid and hydrogen chloride gas. Reacts with alcohols, powdered metals, sodium amide, combustibles, and many organics, causing toxic fumes, fire, and explosion hazard. On contact with air it emits corrosive gas. Decomposes when heated forming phosgene gas. Corrosive to metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.05 ppm/0.2 mg/m^3 TWA.

ACGIH TLV®[1]: 0.05 ppm/0.23 mg/m^3 TWA; 0.15 ppm/0.69 mg/m^3 STEL [skin].

Protective Action Criteria (PAC)*

TEEL-0: 0.04 ppm

PAC-1: **0.04** ppm

PAC-2: **1.6** ppm

PAC-3: **52** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.05 ppm (0.2 mg/m^3), 1993; Austria: MAK 0.05 ppm (0.2 mg/m^3), 1999; Belgium: TWA 0.05 ppm (0.23 mg/m^3), 1993; Denmark: TWA 0.05 ppm (0.2 mg/m^3), 1999; France: VME 0.05 ppm (0.2 mg/m^3), 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; Norway: TWA 0.05 ppm (0.2 mg/m^3), 1999; Switzerland: MAK-W 0.05 ppm (0.24 mg/m^3), 1999; United Kingdom: LTEL 0.05 ppm (0.2 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.15 ppm [skin]. Some states have set guidelines or standards for chloroacetyl chloride in ambient air[60] ranging from 3.0 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: No test available.

Permissible Concentration in Water: No criteria set. Chloroacetyl chloride decomposes in water.

Routes of Entry: Skin absorption, skin and eye contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: A tissue corrosive and a lacrimator (causes discharge of tears). Chloroacetyl chloride can severely irritate the eyes and cause permanent damage. It is corrosive to the skin and respiratory tract. Corrosive on ingestion. Inhalation of vapor or aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The substance may affect the cardiovascular system. Exposure far above the PEL may cause death. Medical reports of the effects of acute exposures include: mild-to-moderate skin burns and erythema; lachrymation and mild eye burns; mild-to-moderate respiratory effects with cough, dyspnea, cyanosis, and mild gastrointestinal effects.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Should include attention to skin, eyes, and respiratory system in preplacement and regular physical examinations. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **4 h** (at least 4 h but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any* *detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, heat, and combustibles. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloroacetyl chloride must carry a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Soak up spill with quicklime, sodium/potassium chloride or absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.9/1.5
Night 1.5/2.4

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.5/0.8

Fire Extinguishing: This chemical is a nonflammable liquid. *Do not use water* or water-based extinguishers. Use extinguishing agent suitable for surrounding fire. This chemical decomposes in heat, producing phosgene, chlorine, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It may be discharged into sodium bicarbonate solution, then flushed to the sewer with water.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chloroacetyl Chloride*. Trenton, NJ.

Chloroanilines C:0770

Molecular Formula: $C_6H_4ClNH_2$

Synonyms: *m*-isomer: *m*-Aminochlorobenzene; 1-Amino-3-chlorobenzene; 3-Chloroaniline; 3-Chlorobenzeneamine; Orange GC base

Mixed isomers: Aminochlorbenzene; Benzeneamine, chloro-; Benzene chloride; Chlorbenzen; Chlorobenzol; MCB; Monochlorbenzene; Monochlorbenzol (German); Monochlorobenzene; NCI-C54886; Phenyl chloride; Phenylchloride

o-isomer: *o*-Aminochlorobenzene; 1-Amino-2-chlorobenzene; 2-Chloroaminobenzene; 2-Chloroaniline; Fast yellow GC base *p-isomer:* *p*-Aminochlorobenzene; 1-Amino-4-chlorobenzene; Benzeneamine, 4-chloro-; 4-Chloraniline; *p*-Chloroaminobenzene; 4-Chloro-1-aminobenzene; 4-Chloroaniline; 4-Chlorobenzenamine; 4-Chlorobenzeneamine; 4-Chlorophenylamine; *p*-Cloroanilina (Spanish)

CAS Registry Number: 95-51-2 (*o*-isomer); 108-42-9 (*m*-isomer); 106-47-8 (*p*-isomer); 27134-26-5 (mixed isomers); 20265-96-7 (hydrochloride)

RTECS® Number: BX0525000 (*o*-isomer); BX0350000 (*m*-isomer); BX0700000 (*m*-isomer)

UN/NA & ERG Number: UN2018 (solid)/152; UN2019 (liquid)/152

EC Number: 202-426-4 (*o-isomer*); 203-581-0 (*m-isomer*)]; 203-401-0 [*Annex I Index No.:* 612-137-00-9] (*p-isomer*); 243-656-5 (*hydrochloride*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*m- and p-isomers*): Animal, limited evidence; Human, inadequate evidence*, not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

p-isomer:

US EPA Hazardous Waste Number (RCRA No.): P024 (*p*-isomer).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents (*p*-isomer).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.46; Nonwastewater (mg/kg), 16 (*p*-isomer).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (20) (*p*-isomer).

Reportable Quantity (RQ): 1000 lb (454 kg) (*p*-isomer).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (*p-isomer*).

California Proposition 65 Chemical: Cancer 10/1/94; 5/15/98 (hydrochloride).

Canada, WHMIS, Ingredients Disclosure List 0.1% (*p*-isomer); 1.0% (*m-isomer*).

European/International Regulations: (*p-isomer*) Hazard Symbol: T, N; Risk phrases: R45; R23/34/25; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*o*-, *m*-, *isomer*); 3—Highly water polluting (*p-isomer*).

Description: The chloroanilines have the following properties:

m-isomer

Colorless to yellow liquid that may turn brown on exposure to air. Molecular weight = 127.57; Specific gravity (H_2O:1) = 1.216; Boiling point (decomposes) = 230°C; Melting point = −11°C; Vapor pressure = <0.1 mmHg at 20°C; Flash point = 118°C (cc); Autoignition temperature = >540°C. Slight solubility in water; solubility = 0.6%.

o-isomer

Colorless to yellow liquid that may turn brown on exposure to air. Molecular weight = 127.57; Specific gravity (H_2O:1) = 1.21; Boiling point = 208.7°C; Melting point = −2°C; Flash point = 108°C; Autoignition temperature = >500°C; solubility in water = 0.5% at 20°C.

p-isomer (see also P:0400)

The *p*-isomer is a colorless to pale yellow crystalline solid. Molecular weight = 127.6; Specific gravity (H_2O:1) = 1.4; Boiling point = 232°C; Melting point = 69.5−72.5°C; Vapor pressure = 0.015 mmHg at 20°C; Flash point = 120−123°C (oc); Autoignition temperature = 685°C. Hazard Identification (based on NFPA 704 M Rating System): *p-isomer* Health 3, Flammability 1, Reactivity 0. Soluble in hot water; solubility (cold) = 0.4% at 20°C.

Potential Exposure: RTECS Compound Description (*m*- and *o*-isomers): Tumorigen, Mutagen (*p*-isomer): Tumorigen, Mutagen, Primary Irritant. Chloroanilines are used to make dyes, other chemicals, insecticides, and many other industrial products.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. The aqueous solution of the *m*-isomer is a weak base. Incompatible with strong acids, organic anhydrides, isocyanates, aldehydes.

Permissible Exposure Limits in Air

m- and o-isomers

ACGIH TLV®[1]: 01 ppm TWA.

DFG MAK: [skin]; (*m*- and *p*-isomers) Danger of skin sensitization.

Poland: TWA 3 mg/m^3; STEL 10 mg/m^3 (99).

p-isomer (see also P:0400)

OSHA PEL: 0.1 mg/m^3 TWA[skin].

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

106-47-8

TEEL-0: 0.0025 ppm

PAC-1: 0.0075 ppm

PAC-2: 0.05 ppm

PAC-3: 250 ppm

DFG MAK: 0.1 mg/m^3, measured as the, inhalable fraction TWA; Peak Limitation Category II(2); [skin], danger of skin sensitization; Carcinogen Category 3; Pregnancy Risk Group C.

Austria: [skin], carcinogen, 1999; Poland: TWA 3 mg/m^3; STEL10 mg/m^3, 1999; Switzerland: [skin], carcinogen, 1999.

DFG MAK: [skin] Carcinogen Category 2.

The former USSR-UNEP/IRPTC joint project[43] has set MAC limits of 0.05 mg/m^3 in work-place air for the *m*-isomer and 0.3 mg/m^3 for the *p*-isomer, the MAC is 0.04 mg/m^3 on a temporary basis; 0.01 on an average daily basis. No standards were set for the *o*-isomer. This chemical can be absorbed through the skin, thereby increasing exposure. States which have set guidelines or standards for *p*-chloroaniline in ambient air[60] include Connecticut at 0.06 μg/m^3 and New York at 6.0 μg/m^3.

Permissible Concentration in Water: Limits in water bodies used for domestic purposes have been set by the former USSR-UNEP/IRPTC joint project[43] of 0.2 mg/L for the *m*- and *p*-isomers.

Determination in Water: Octanol−water coefficient: Log K_{ow} (all isomers) = 1.83−1.92.

Routes of Entry: Inhalation of vapor, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chloroanilines can affect you when breathed in and by passing through your skin. Exposure can lower the ability of the blood to carry oxygen (a condition called methemoglobinemia). This can cause headaches, trouble breathing, weakness, a bluish color to the nose and lips, collapse, and death. Contact can severely irritate and may burn the eyes. *o-isomer:* Irritates the eyes, skin, and respiratory tract. *m-isomer:* May affect the liver and kidneys. Exposure may result in death. The effects may be delayed. *p-isomer:* Irritates the eyes, skin, and respiratory tract. May affect the red blood cells, resulting in formation of methemoglobin and hemolysis. Exposure could cause headaches, trouble breathing, weakness, a bluish color to the nose and lips, loss of consciousness; and possible death.

Long Term Exposure: *o-isomer*: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidneys and also the blood system, resulting in forming of methemoglobin. *m-isomer*: The substance may have effects on the blood system, resulting in forming of methemoglobin. *p-isomer:* Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the spleen, liver, and kidneys, resulting in organ damage. Tumors have been detected in experimental animals but may not be relevant to humans. The methemoglobinemia described above can occur gradually over weeks instead of all at once.

Points of Attack: Blood, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: *Clothing:* Avoid skin contact with chloroaniline. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove, clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures to chloroaniline, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison (*p-isomer*): Store in a secure poison location. Prior to working with chloroaniline you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chloroanilines are required by DOT[19] to carry a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: *ortho- and meta-iomers:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *p-isomer:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *p-isomer:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrous oxides and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. *o-* and *m-isomers*: These chemicals are combustible liquids. Poisonous gases are produced in fire, including nitrous oxides and hydrogen chloride. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent, such as alcohol or benzene, and spray into a furnace equipped with afterburner and scrubber.[24] Alternatively, pour into a mixture of sand and soda ash and burn in a furnace with paper as a fuel. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 5, 64−70 (2-Chloroaniline)

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Chloroaniline*. Trenton, NJ

Chlorobenzene C:0780

Molecular Formula: C_6H_5Cl

Synonyms: Abluton T-30; Benzene chloride; Benzene, chloro-; Chlorbenzen; Chlorobenzol; Clorobenceno (Spanish); Clorobenceno (Spanish); KTI PMMA-standard 496K/950K; MCB; Monochlorbenzol (German); Monochlorobenzene; NCI-C54886; Phenyl chloride

CAS Registry Number: 108-90-7

RTECS® Number: CZ0175000

UN/NA & ERG Number: UN1134/130

EC Number: 203-628-5 [*Annex I Index No.:* 602-033-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; NTP: Carcinogenesis Studies (gavage); some evidence: rat (NTP: -TR-261,1985); equivocal evidence: rat; no evidence: mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U037.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 100 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (2); 8240 (5).

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA

Priority Substance List; Drinking Water Quality: 0.08 mg/L MAC.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R10; R20; R51/53; Safety phrases: S2; S24/25; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chlorobenzene is a colorless liquid with an almond-like odor. The odor threshold is between 0.1 and 3.0 μg/L.[35] Also reported in the literature at 0.68 and 0.741 ppm. Molecular weight = 112.56; Boiling point = 131−132°C; Freezing/Melting point = −45°C; Flash point = 28°C; Autoignition temperature = 593°C. Flammable limits are: LEL = 1.3%; UEL = 9.6%. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Chlorobenzene is used in the manufacture of aniline, phenol, and chloronitrobenzene; as an intermediate in the manufacture of dyestuffs and many pesticides, as a solvent and emulsifier.

Incompatibilities: Reacts violently with strong oxidizers, dimethyl sulfoxide, sodium powder, silver perchlorate, causing fire and explosion hazard. Attacks some plastics, rubber, and coatings. Decomposes on heating, producing phosgene and hydrogen chloride fumes.

Permissible Exposure Limits in Air

OSHA PEL: 75 ppm/350 mg/m^3 TWA.

NIOSH REL: None.

ACGIH TLV®[1]: 10 ppm/46 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans; BEI: 150 mg [total 4-chlorocatechol]/g creatinine in urine/end-of-shift; 25 mg[total *p*-chlorophenol]/g creatinine in urine/end-of-shift.

DFG MAK: 10 ppm/47mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Rislk Group C; BAT: 70 mg/g [total 4-chlorocatechol] creatinine in urine at the beginning of the next shift; BAT: 300 mg/g [total 4-chlorocatechol] creatinine in urine at end-of-shift.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 10 ppm

PAC-1: **10** ppm

PAC-2: **150** ppm

PAC-3: **400** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Arab Republic of Egypt: TWA 1 ppm, 1993; Australia: TWA 75 ppm (350 mg/m^3), 1993; Austria: MAK 50 ppm (230 mg/m^3), 1999; Belgium: TWA 75 ppm (345 mg/m^3), 1993; Denmark: TWA 10 ppm (46 mg/m^3), 1999; Finland: TWA 50 ppm (230 mg/m^3); STEL 75 ppm (345 mg/m^3), 1999; France: VME 10 ppm, 1999; Japan: 10 ppm (46 mg/m^3), 1999; the Netherlands: MAC-TGG 46 mg/m^3, 2003; Norway: TWA 25 ppm (115 mg/m^3), 1999; Poland: MAC (TWA) 50 mg/m^3; STEL 150 mg/m^3, 1999; Switzerland: MAK-W 50 ppm (230 mg/m^3), KZG-W 100 ppm (460 mg/m^3), 1999; Turkey: TWA 75 ppm (350 mg/m^3), 1993; United Kingdom: LTEL 50 ppm (230 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for Chlorobenzene in ambient air[60] ranging from 6.3 μg/m^3 (Massachusetts) to 1,167 μ/m^3 (New York) to 2,200 μg/m^3 (New York) to 3,500 μg/m^3 (Florida and North Dakota) to 6000 μg/m^3 (Virginia) to 7000 μg/m^3 (Connecticut) to 8,333 μg/m^3 (Nevada).

Determination in Air: Charcoal absorption followed by workup with CS_2 and analysis by gas chromatography. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 250 μg/L on an acute basis for chlorobenzenes as a class. *To protect saltwater aquatic life:* 160 μg/L on an acute basis and 129 μg/L on a chronic basis for chlorinated benzenes as a class. *To protect human health:* for the prevention of adverse toxicological effects, 488 μg/L; but to prevent adverse organoleptic effects, 20 μg/L. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes. The US EPA has set a lifetime health advisory of 0.3 mg/L (300 μg/L). Several states have set guidelines or standards for chlorobenzene in drinking water[61] ranging from 2 μg/L (New Jersey) to 30 μg/L (California) to 47 μg/L (Maine) to 60 μg/L (Arizona, Kansas, and Minnesota) to 600 μg/L (Vermont and Wisconsin).

Determination in Water: Gas chromatography (EPA Methods 601 and 602) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation, ingestion, eye and skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: The liquid can irritate and burn the skin. The vapor can irritate the eyes, nose, and throat. Chlorobenzene can affect you when breathed in and by passing through your skin. Exposure to high concentrations can cause you to become dizzy, lightheaded, and to pass out. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The effects may be delayed. Medical observation is indicated.

Long Term Exposure: May cause damage to the lungs, blood, nervous system, liver, and kidneys. Repeated exposure to the liquid may cause skin burns. Similar petroleum-based solvents cause brain damage, with reduced memory and concentration, personality changes, fatigue, sleep disturbances, reduced coordination.

Points of Attack: Respiratory system, eyes, skin, central nervous system, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure has occurred, the following may be useful: lung and kidney function tests. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Viton™ gloves, suits, Barricade™ coated suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h** (at least 4 h but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): polyvinyl alcohol gloves; Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* PD,PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chlorobenzene you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Chlorobenzene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flames. Sources of ignition, such as smoking and open flames are prohibited where Chlorobenzene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of Chlorobenzene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Chlorobenzene.

Shipping: Chlorobenzene must be labeled “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep Chlorobenzene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1980). *Chlorinated Benzenes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Chlorobenzene: Health and Environmental Effects Profile No. 42*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 72–75. New York: Van Nostrand Reinhold Co.

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Chlorobenzene*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency. (March 31, 1987). *Health Advisory: Chlorobenzene*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chlorobenzene*. Trenton, NJ

p-Chlorobenzotrichloride C:0790

Molecular Formula: $C_7H_4Cl_4$

Common Formula: $Cl_3C-C_6H_4-Cl$

Synonyms: Benzene, 1-chloro-4-(trichloromethyl)-; 4-Chlorobenzotrichloride; *p*-Chlorophenyltrichloromethane; 1-Chloro-4-(trichloromethyl)benzene; PCTC; *p*-α,α,α-Tetrachlorotoluene; *p*-Trichloromethylchlorobenzene

CAS Registry Number: 5216-25-1

RTECS® Number: XT8580000

UN/NA & ERG Number: UN1760/154

EC Number: 226-009-1 [*Annex I Index No.:* 602-093-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (α,α,α-tetrachlorotoluene) Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; DFG, Carcinogen Category 2.

California Proposition 65 Chemical: Cancer *(as p-*α,α,α-Tetrachlorotoluene) 1/1/90.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R21/22; R37/38; R48/23; R62; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: *p*-Chlorobenzotrichloride, an organochloride, is a flammable, water-white liquid. Molecular weight = 229.92; Specific gravity (H_2O:1) = 1.49; Boiling point = 254°C; Melting/Freezing point = 5–6°C; Flash point = >110°C; Autoignition temperature = 500–505°C. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 1, Reactivity 0. Decomposes in water.

Potential Exposure: Used in agrochemicals manufacture as an intermediate; reaction with HF yields chlorobenzotrifluoride as a major intermediate for several pesticides; for making pharmaceuticals, UV absorbers, and dyestuffs. This chemical is manufactured in high volume (exceeds 1 million pounds per annum) in the United States.

Incompatibilities: A halogenated aromatic compound. Keep away from strong oxidizers and reducing agents. Hydrolyzes to hydrochloric acid and benzoic acid in all forms of moisture.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] Carcinogen Category 2.

No numerical limits set. However, this chemical can be absorbed through the skin, thereby increasing exposure. Toxic by inhalation. A potential carcinogen: exposure should be kept to lowest feasible level.

Determination in Air: No test listed.

Routes of Entry: Inhalation, ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: A corrosive and lacrimator. May cause irritation by any route of exposure. Poisonous by inhalation. LD_{50} = (oral-rat) 820 mg/L.

Long Term Exposure: A skin sensitizer; may cause rash. A suspected human carcinogen, neuro-, and respiratory toxicant.[RTECS]

Points of Attack: Skin.

Medical Surveillance: Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a refrigerator. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Corrosive liquids, n.o.s., require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (February 24, 1983). *Chemical Hazard Information Profile Draft Report: p-Chlorobenzotrichloride*. Washington, DC

New York State Department of Health. (January 1986). *Chemical Fact Sheet: para-Chlorobenzotrichloride*. Albany, NY: Bureau of Toxic Substance Assessment

Chlorobenzotrifluoride C:0800

Molecular Formula: $C_7H_4ClF_3$

Common Formula: $ClC_6H_4CF_3$

Synonyms: (*p*-Chlorophenyl)trifluoromethane; *p*-Chlorotrifluoromethylbenzene; 4-Chlorotrifluoromethylbenzene; 1-Chloro-4-(trimethyl)-benzene; OXSOL 100®; α,α,α-Trifluoro-4-chlorotoluene; *p*-(Trifluoromethyl)chlorobenzene; *p*-Trifluoromethylphenyl chloride; Trifluoromethylphenyl chloride

CAS Registry Number: 98-56-6; 52181-51-8

RTECS® Number: XS9145000

UN/NA & ERG Number: UN2234/130

EC Number: 202-681-1

WGK (German Aquatic Hazard Class): 2—Water polluting (98-56-6).

Description: Chlorobenzotrifluoride is a colorless, highly flammable liquid. Molecular weight = 180.6; Boiling point = 139°C; Melting/Freezing point = −36°C; Flash point = 43°C (cc); Autoignition temp = >500°C; Flammable limits are: LEL = 0.9%; UEL = 10.5%. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 2, Reactivity 0. The pure *o*-isomer: Boiling point = 152°C; Flash point = 59°C. Hazard Identification (based on NFPA 704 M Rating System):

Health 2, Flammability 2, Reactivity 1. Slightly soluble in water; solubility = <1 mg/mL at 20°C.

Potential Exposure: This material is used in the manufacture of pharmaceuticals; dyes, dielectrics, and insecticides.

Incompatibilities: Strong oxidizers, such as permanganates and dichromates.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: No tests available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.70$.

Harmful Effects and Symptoms

Short Term Exposure: Causes local irritation to skin, eyes, and mucous membranes. May cause irritation by any route of exposure. The LD_{50} rat is 13 gm/kg (13,000 mg/kg) (insignificantly toxic).

Long Term Exposure: There is evidence that this chemical is a mutagen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or*† *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* HieF$^+$ (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF$^+$ (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chlorobenzotrifluoride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chlorobenzotrifluoride must be labeled "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific

recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including fluorine and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

Reference

New York State Department of Health. (January 1986). *Chemical Fact Sheet: para-Chlorobenzotrifluoride*. Albany, NY: Bureau of Toxic Substance Assessment

o-Chlorobenzylidenemalononitrile (Agent CS, WMD) C:0810

Molecular Formula: $C_{10}H_5ClN_2$

Common Formula: $ClC_6H_4CH{=}C(CN)_2$

Synonyms: *o*-Chlorobenzalmalononitrile; 2-Chlorobenzalmalononitrile; 2-Chlorobenzylidene malononitrile; CS* (military designation); β,β-Dicyano-*o*-chlorostyrene; Propanedinitrile[(2-chlorophenyl)methylene]

*CS1, CS2, CSX all contain *o*-Chlorobenzylidenemalononitrile (CS) as agent.

CAS Registry Number: 2698-41-1

RTECS® Number: OO3675000

UN/NA & ERG Number: UN2810 (CS)/153

EC Number: 220-278-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As a cyanide compound:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R28; R32; R50/53; Safety phrases: S1/2; S7/8; S23; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: *o*-Chlorobenzylidenemalonitrile is a combustible, white crystalline solid. Pepper-like odor. Molecular weight = 188.62; Boiling point = 310−315°C; Freezing/Melting point = 95°C; Vapor pressure = 0.00003 mmHg at 20°C. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. CS tear gas is used as a riot control agent and is also used as an agent in CS1, CS2, and CSX riot control and tear gases.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion. May be explosive if dust mixes with air.

Permissible Exposure Limits in Air

OSHA PEL: 0.05 ppm/0.4 mg/m^3 TWA.

NIOSH REL: 0.05 ppm/0.4 mg/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.05 ppm/0.39 mg/m^3 Ceiling Concentration [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 2 mg/m^3.

Protective Action Criteria (PAC)*

TEEL-0: 0.05 mg/m^3

PAC-1: **0.050** mg/m^3

PAC-2: **0.50** mg/m^3

PAC-3: **11** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Australia: TWA 0.05 ppm (0.4 mg/m^3) [skin], 1993; Belgium: STEL 0.05 ppm (0.4 mg/m^3) [skin], 1993; Denmark: TWA 0.05 ppm (0.4 mg/m^3) [skin], 1999; France: STEL 0.05 ppm (0.4 mg/m^3) [skin], 1999; the Netherlands: MAC 0.4 mg/m^3 [skin], 2003; Norway: TWA 0.05 ppm (0.4 mg/m^3), 1999; the Philippines: TWA 05 ppm (0.4 mg/m^3), 1993; Switzerland: MAK-W 0.05 ppm (0.4 mg/m^3) [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV®: Ceiling Concentration 0.05 ppm [skin]. Several states have set guidelines or standards for OCBM in ambient air[60] ranging from 3.0 μg/m^3 (Virginia) to 4.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada).

Determination in Air: Collection by charcoal tube, analysis by gas liquid chromatography. Use NIOSH Analytical Method P & CAM 304(II-5).

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator. Irritates the eyes, skin, and respiratory tract. OCBM is extremely irritating and acts on exposed sensory nerve endings (primarily in the eyes and upper respiratory tract). The signs and symptoms from exposure to the vapor are conjunctivitis and pain in the eyes, lacrimation; erythema of the eyelids; blepharospasms; irritation and running of the nose; burning in the throat; coughing and constricted feeling in the chest; and excessive salivation. Vomiting may occur if saliva is swallowed. Most of the symptoms subside after exposure ceases. Burning on the exposed skin is increased by moisture. With heavy exposure, vesiculation and erythema occur. Photophobia has been reported. LD_{50} = (oral-rat) 178 mg/kg.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Animal experiments indicate that OCBM has a relatively low toxicity. The systemic changes observed in human experiments are nonspecific reactions to stress. OCBM is capable of sensitizing guinea pigs; there also appears to be a cross-reaction in guinea pigs previously sensitized to 1-chloroacetophenone.

Points of Attack: Respiratory system, skin, and eyes.

Medical Surveillance: Consideration should be given to the eyes, skin, and respiratory tract in any placement or periodic evaluations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you do not have the equipment and training, do not enter the hot zone to rescue and/or decontaminate victims. If the victim cannot move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash—strip—wash—evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 min. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles.*

Respirator Selection: OSHA: *2 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: CS a "Toxic, liquids, organic, n.o.s." requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

CS, when used as a weapon

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.3/2.0

Fire Extinguishing: This chemical is a combustible solid. In case of fire, *do not put out the fire*. CS vapor is so deadly that the fire is safer than the unburned CS. If there is some reason that you have to put out the fire (for example, there are things you cannot let burn nearby) use water or ordinary foam. It is always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of CS canisters adjacent to a fire, cool the canisters with large amounts off water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. CS can give off toxic hydrogen cyanide, chlorine, and nitrogen oxides in a fire or when heated. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C)*. Washington, DC: United States Coast Guard and the Department of Homeland Security

Chlorobromomethane C:0820

Molecular Formula: CH_2BrCl

Synonyms: Bromochloromethane; Bromoclorometano (Spanish); CB; CBM; Halon 1011; Metane, bromochloro-; Methylene chlorobromide; Mil-B-4394-B; Mono-chloro-mono-bromo-methane

CAS Registry Number: 74-97-5

RTECS® Number: PA5250000

UN/NA & ERG Number: UN1887/160

EC Number: 200-826-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chlorobromomethane is a clear, colorless to pale yellow liquid with a chloroform-like odor. Odor threshold = 400 ppm. Molecular weight = 129.39; Specific gravity (H_2O:1) = 1.93; Boiling point = 68.3°C; Freezing/Melting point = −88°C; Vapor pressure = 115 mmHg at 20°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Drug, Mutagen. This compound is used in brominated flame retardants; a fire-extinguishing agent, and in organic synthesis.

Incompatibilities: Chemical active metals, such as calcium, powdered aluminum, zinc, magnesium. Liquid attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 200 ppm/1050 mg/m^3 TWA.
NIOSH REL: 200 ppm/1050 mg/m^3 TWA.
ACGIH TLV®[1]: 200 ppm/1060 mg/m^3 TWA.
NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)
TEEL-0: 200 ppm
PAC-1: 600 ppm
PAC-2: 2000 ppm
PAC-3: 2000 ppm
DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 200 ppm (1050 mg/m^3); STEL 250 ppm, 1993; Austria: MAK 200 ppm (1050 mg/m^3), 1999; Denmark: TWA 200 ppm (1050 mg/m^3), 1999; Finland: TWA 200 ppm (1050 mg/m^3); STEL 250 ppm (1315 mg/m^3), 1999; France: VME 200 ppm (1050 mg/m^3), 1993; the Netherlands: MAC-TGG 1050 mg/m^3, 2003; Norway: TWA 100 ppm (525 mg/m^3), 1999; Poland: TWA 1000 mg/m^3; STEL 1300 mg/m^3, 1999; Switzerland: MAK-W 200 ppm (1050 mg/m^3), KZG-W 400 ppm (2100 mg/m^3), 1999; Turkey: TWA 200 ppm (1050 mg/m^3), 1993; United Kingdom: TWA 200 ppm (1080 mg/m^3); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietman: ACGIH TLV®: TWA 200 ppm. Several states have set guidelines or standards for CBM in ambient air[60] ranging from 10.5–13 mg/m^3 (North Dakota) to 17.5 mg/m^3 (Virginia) to 21.0 mg/m^3 (Connecticut) to 25.0 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, followed by gas chromatography. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the skin and eyes. This chemical can irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms include disorientation, dizziness; irritation of eyes, throat and skin; headaches, anorexia, nausea, vomiting; abdominal pain; weakness, tremors, and convulsions; narcosis. LD_{50} = (oral-rat) 5000 mg/kg (slightly toxic).

Long Term Exposure: May cause liver and kidney damage, which may be progressive, skin irritation, and cracking. May affect the lungs and cause bronchitis to develop. May cause weight loss, memory impairment, paralysis. Skin contact can cause drying and cracking.

Points of Attack: Skin, liver, kidneys, respiratory system, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Serum bromine level. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **4 h** (at least 4 h but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Teflon™ gloves, suits, boots; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance can cause eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Chlorobromomethane must be stored to avoid contact with chemically active metals, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Bromochloromethane must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including hydrogen chloride and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate together with flammable solvent in furnace equipped with afterburner and alkali scrubber.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Chlorobromomethane*. Trenton, NJ

Chlorodifluorobromo-methane C:0830

Molecular Formula: $CBrClF_2$

Synonyms: Bromochlorodifluoromethane; Chlorodifluorobromomethane; Flugex 12B1; Fluorocarbon 1211; Freon 12B1; Halon 1211; R12B1

CAS Registry Number: 353-59-3

RTECS® Number: PA5270000

UN/NA & ERG Number: UN1974/126

EC Number: 206-537-9

Regulatory Authority and Advisory Bodies

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 3.0.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, CEPA Schedule I Toxic Substances (import/export, manufacturing, and processing restrictions).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Chlorodifluorobromomethane is a colorless gas or liquid under pressure. Molecular weight = 165.4; Boiling point = −4°C; Freezing/Melting point = −160.5°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Used as a refrigerant and fire extinguishing agent.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 12.5 ppm

PAC-1: 40 ppm

PAC-2: 250 ppm

PAC-3: 5000 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Contact with the liquid can cause frostbite. High exposure can cause dizziness, lightheadedness, and unconsciousness. Inhalation can cause irregular heartbeat.

Long Term Exposure: Can affect the heartbeat causing irregular rhythms and skipped beats.

Points of Attack: Heart.

Medical Surveillance: Special 24-h EKG (Holter monitor) for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Nonflammable gas. Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure sufficient oxygen (19%) exists. Store in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This chemical requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: *Gas:* If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including bromine, chlorine, and fluoride compounds. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Chlorodifluoro-monobromomethane*. Trenton, NJ

Chlorodifluoroethane C:0840

Molecular Formula: C_2H_5Cl

Common Formula: $ClCH_2CH_3$

Synonyms: CFC 142b; Chlorofluorocarbon 142b; 1,1,1-Chlorodifluoroethane; 1-Chloro-1,1-difluoroethane; α-Chloroethylidene fluoride; Chloroethylidene fluoride; 1,1,1-Difluorochloroethane; 1,1-Difluoro-1-chloroethane; Difluoro-1-chloroethane; Difluoromonochloroethane; Ethane, 1-chloro-1,1-difluoro-; FC-142b; Fluorocarbon 142b; Fluorocarbon FC 142b; Freon 142; Freon 142b; Genetron 101; Genetron 142b; Gentron 142B; HCFC-142B; Hydrochlorofluorocarbon 142b; Propellant 142b; R 142B

CAS Registry Number: 75-68-3

RTECS® Number: KH7650000; KH7630000 (chlorodifluoroethanes)

UN/NA & ERG Number: UN2517/115

EC Number: 200-891-8

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in aerosol sprays) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix B), Class II, Ozone Depletion Potential = 0.06.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chlorodifluoroethane is a flammable, colorless, nearly odorless gas. Molecular weight = 100.50; Specific gravity (H_2O:1) = 1.1; Boiling point = −9.5°C; Freezing/Melting point = −131°C; Flash point = flammable gas; Autoignition temperature = 632°C. The explosive limits are: LEL = 6.2%; UEL = 17.9%. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 2, Reactivity 1. Practically insoluble in water; solubility = 0.2% at 5°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector. Chlorodifluoroethane is used in refrigerants, solvents, as a propellent in aerosol sprays, and as an intermediate in the production of highly specialized fluoropolymers.

Incompatibilities: Oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates since vigorous reactions occur. Decomposes in heat to form phosgene, and hydrofluoric and hydrochloric acids.

Permissible Exposure Limits in Air

AIHA WEEL: 1000 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 10,000 ppm

PAC-2: 15,000 ppm

PAC-3: 25,000 ppm

DFG MAK: 1000 ppm/4200 mg/m^3 TWA; Peak Limitation II(8); Pregnancy Risk Group D, as 1-Chloro-1,1-difluoroethane (FC-142-b).

Austria: MAK 1000 ppm (4170 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; Russia: STEL 3000 mg/m^3, 1993; the Netherlands: MAC-TGG 8380 mg/m^3, 2003.

Determination in Air: No test available.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.58.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Chlorodifluoroethane can affect you when breathed in. Skin contact may cause frostbite. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause death. High exposure could cause irregular heartbeat, which could lead to death.

Short Term Exposure: Chlorodifluoroethane can affect you when breathed in. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause death. High exposure could cause irregular heartbeat, which could lead to death. Contact with the liquid may cause frostbite.

Long Term Exposure: Inhalation, rat, lowest published toxic concentration: 1000 ppm/6 h (3- to 15-days pregnant). Reproductive: Effects on fertility: Preimplantation mortality (e.g., reduction in number of implants per female; total number of implants per corpora lutea) [NTISOTS0555347].

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (halter monitor) to look for irregular heartbeat. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash affected parts in warm water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact-resistant chemical goggles when working with gas. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or*† *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high -efficiency particulate filter). *125 mg/m^3:* HieF† (any air-purifying, full-facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF[†] (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

[†] May need acid gas sorbent.

Storage: Flammable gas. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with Chlorodifluoroethane you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Chlorodifluoroethane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Detached or outside storage is preferred. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: 1-Chloro-1,1-difluoroethanes or Refrigerant gas, R-142b must be labeled “FLAMMABLE GAS.” They fall in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep Chlorodifluoroethane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases, including phosgene, hydrogen fluoride, hydrogen chloride, and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Chlorodifluoroethane*. Trenton, NJ

Chlorodifluoromethane C:0850

Molecular Formula: $CHClF_2$

Synonyms: Algeon 22; Algofrene 22; Algofrene type 6; Arcton 22; Arcton 4; CFC 22; Chlorofluorocarbon 22; Diaflon 22; Difluorochloromethane; Difluoromonochloromethane; Dymel 22; Electro-CF 22; Eskimon 22; F 22; FC 22; Flugene 22; Fluorocarbon 22; Forane 22; Forane 22 B; Freon; Freon 22; Frigen; Frigen 22; Genetron 22; HCFC-22; Hydrochlorofluorocarbon 22; Isceon 22; Isotron 22; Khaladon 22; Khladon 22; Methane, chlorodifluoro-; Monochlorodifluoromethane; Propellant 22; R-22; Refrigerant 22; Ucon 22; Ucon 22/Halocarbon 22

CAS Registry Number: 75-45-6

RTECS$^{®}$ Number: PA6390000

UN/NA & ERG Number: UN1018/126

EC Number: 200-871-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.[9]

Banned or Severely Restricted (in aerosol sprays) (UN).[13]

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9099; 8EHQ-0892-9107; 8EHQ-0892-9108; 8EHQ-0892-9117; 8EHQ-0892-9188.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix B), Class II, Ozone Depletion Potential = 0.05.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chlorodifluoromethane is a nonflammable, colorless, nearly odorless gas. Molecular weight = 86.47; Specific gravity (H_2O:1) = 1.21; Boiling point = −40.5°C; Freezing/Melting point = −146°C; Vapor pressure = 9.4 atm at 20°C; Autoignition temperature = 632°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 0.3% at 25°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Chlorodifluoromethane is used as an aerosol propellant, refrigerant, and low-temperature solvent. It is used in the synthesis of polytetrafluoroethylene (PTFE).

Incompatibilities: Reacts violently with alkalies and alkaline earth metals, powdered aluminum, sodium, potassium, and zinc, causing fire and explosion hazard. Moisture and rust cause slow decomposition, forming toxic gases. Attacks some plastics, rubber, and coatings. Decomposes in heat forming fumes of chlorine, hydrogen chloride, hydrogen fluoride, and phosgene. Attacks magnesium and its alloys.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.54 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1000 ppm/3500 mg/m^3 TWA; 1250 ppm/4375 mg/m^3 STEL.

ACGIH TLV®[1]: 1000 ppm/3540 mg/m^3 TWA, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 1250 ppm

PAC-2: 7500 ppm

PAC-3: 7500 ppm

DFG MAK: 500 ppm/1800 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group C.

Australia: TWA 1000 ppm (3500 mg/m^3); STEL 1250 ppm, 1993; Austria: MAK 500 ppm (1800 mg/m^3), 1999; Belgium: TWA 1000 ppm (3540 mg/m^3); STEL 1250 ppm, 1993; Denmark: TWA 500 ppm (1770 mg/m^3), 1999; Finland: TWA 1000 ppm (3500 mg/m^3); STEL 1250 ppm, 1999; France: VME 1000 ppm (3500 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; the Netherlands: MAC-TGG 3600 mg/m^3, 2003; Norway: TWA 500 ppm (1750 mg/m^3), 1999; Russia: TWA 1000 ppm; STEL 3000 mg/m^3, 1993; Sweden: NGV 500 ppm (1800 mg/m^3), KTV 750 ppm (2500 mg/m^3), 1999; Switzerland: MAK-W 500 ppm (1800 mg/m^3), 1999; United Kingdom: TWA 1000 ppm (3590 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for FC-22 in ambient air[60] ranging from 35.0 to 43.75 mg/m^3 (North Dakota) to 58 mg/m^3 (Virginia) to 70.0 mg/m^3 (Connecticut) to 83.3 mg/m^3 (Nevada).

Determination in Air: Charcoal tube;[2] Methylene chloride; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1018.

Permissible Concentration in Water: Russia/UNEP joint project[43] set a MAC of 10 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.1.

Harmful Effects and Symptoms

Short Term Exposure: Chlorodifluoromethane can affect you when breathed in. Inhalation can irritate the respiratory tract causing tightness in the chest and trouble breathing. Exposure can cause headache, nausea, dizziness and weakness, sleepiness, tremors, loss of coordination, cardiac arrhythmia (irregular heartbeat), coma, and asphyxiation, which could lead to death. Chlorodifluoromethane can irritate the nose, throat, and skin. It can also cause tightening in the chest and trouble breathing. Skin contact with the liquid can cause frostbite.

Long Term Exposure: Liver, kidney, spleen injury.

Points of Attack: Respiratory system, cardiovascular system, central nervous system, liver, kidneys, spleen.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heartbeat. Lung, liver, and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: Adrenergic agents are contraindicated.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 1000 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Nonflammable gas. Color Code—Green: General storage may be used. Prior to working with chlorodifluoromethane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorodifluoromethane must carry a "NONFLAMMABLE GAS" label. It falls in Hazard Class 2.2.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Liquid:* allow to evaporate. *Gas:* Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is nonflammable. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. On contact with fire, this chemical decomposes forming poisonous gases, including hydrogen fluoride, hydrogen chloride, phosgene, carbonyl fluoride, chloride fumes, and fluoride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return to vendor or send to licensed waste disposal company.[22]

References

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Chlorodifluoromethane*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

2-Chloroethyl vinyl ether C:0860

Molecular Formula: C_4H_7ClO

Common Formula: $ClCH_2CH_2OCH{=}CH_2$

Synonyms: 2-Chlorethyl vinyl ether; (2-Chloroethoxy)ethene; 2-Cloroetilo vinil eter (Spanish); Vinyl-β-chloroethyl ether; Vinyl-2-chloroethyl ether

CAS Registry Number: 110-75-8

RTECS® Number: KN6300000

UN/NA & ERG Number: UN1992/131

EC Number: 203-799-6

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as 2-chloroethyl vinyl ether (mixed).

US EPA Hazardous Waste Number (RCRA No.): U042.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.062; Nonwastewater (mg/kg), N/A.

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Chloroethyl vinyl ether is a highly flammable, colorless liquid. Molecular weight = 106.55; Boiling point = 108.7°C; Freezing/Melting point = −70°C; Flash point = 27°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: The compound finds use in the manufacture of anesthetics, sedatives, and cellulose ethers. The number of potentially exposed individuals is greatest for the following areas: fabricated metal products, wholesale trade, leather, rubber, and plastic, and chemical products.

Incompatibilities: Peroxidizable Compound; may form unstable peroxides that can cause explosive polymerization. Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Contact with oxidizing materials may cause fire or explosion hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.25 ppm

PAC-1: 0.75 ppm

PAC-2: 5 ppm

PAC-3: 25 ppm

Permissible Concentration in Water: No criteria have been developed for aquatic life or for the protection of human health.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Eye, skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact with skin or eyes may cause severe irritation. The oral LD_{50} for 2-Chloroethyl vinyl ether in rats is 250 mg/kg (moderately toxic). Primary skin irritation and eye irritation studies have also been conducted for 2-Chloroethyl vinyl ether. Dermal exposure to undiluted 2-chloroethyl vinyl ether did not cause even slight erythema. Application of undiluted 2-Chloroethyl vinyl ether to the eyes of rabbits resulted in severe eye injury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where 2-chloroethyl vinyl ether may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This material may be classified as Flammable liquids, toxic, n.o.s. This class requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of

spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire, including toxic chlorides. Use dry chemical or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Residues may be packaged in epoxy-lined drums and disposed of by high-temperature incineration with HCl scrubbing of effluent gases.

References

US Environmental Protection Agency. (April 30, 1980). *2-Chloroethyl Vinyl Ether: Health and Environmental Effects Profile No. 46*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (1980). *Chloralkyl Ethers: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 46−50

Chloroform C:0870

Molecular Formula: $CHCl_3$

Synonyms: Chloroforme (French); Cloroformo (Spanish); Formyl trichloride; Freon 20; Methane trichloride; Methane, trichloro-; Methenyl trichloride; Methyl trichloride; NCI-C02686; R 20 refrigerant; Refrigerant 20; TCM; Trichloroform; Trichloromethane

CAS Registry Number: 67-66-3; *(alt.)* 8013-54-5

RTECS® Number: FS9100000

UN/NA & ERG Number: UN1888

EC Number: 200-663-8 [*Annex I Index No.:* 602-006-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000.

Carcinogenicity: IARC[9]: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; Likely to produce cancer in humans.

Banned or Severely Restricted (In Pharmaceuticals) (many countries) (UN).[13]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 20,000 lb (9,080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U044; D022.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 6.0 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.046; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5).

Safe Drinking Water Act: Priority List (55 FR 1470).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical 1/1/87: Cancer; Developmental/Reproductive toxin 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI).

Mexico, Drinking Water Criteria, 0.03 mg/L.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R38; R40; R48/20/22; Safety phrases: S32; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chloroform is a noncombustible, clear, colorless liquid with a pleasant, sweet odor. The odor threshold is 12 ppm. Molecular weight = 119.37; Specific gravity (H_2O:1) = 1.5; Boiling point = 62°C; Freezing/Melting point = −63°C; Vapor pressure = 160 mmHg. Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility 0.5% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Chloroform was one of the earliest general anesthetics, but its use for this purpose has been abandoned because of toxic effects. Chloroform is widely used as a solvent (especially in the lacquer industry); in the extraction and purification of penicillin and other pharmaceuticals; in the manufacture of artificial silk, propellents, plastics, floor polishes, and fluorocarbons (R-22); and in sterilization of catgut. Chemists and support workers as well as hospital workers are believed to be at a higher risk than the general population. Chloroform is widely distributed in the atmosphere and water (including municipal drinking water primarily as a consequence of chlorination). A survey of 80 American cities by EPA found chloroform in every water system in levels ranging from <0.3 to 311 ppb.

Incompatibilities: Though nonflammable, chloroform decomposes to form hydrogen chloride, phosgene, and chlorine upon contact with a flame. Chloroform decomposes slowly in air and light. Reacts violently with strong caustics (bases), strong oxidants, chemically active metals (especially powders), such as aluminum, lithium, magnesium, potassium, and sodium, causing fire and explosion hazard. Attacks plastic, rubber, and coatings. Corrodes iron and other metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: 50 ppm/240 mg/m^3 Ceiling Concentration.

NIOSH REL: Carcinogen 2 ppm/9.78 mg/m^3 [60 min] STEL. NIOSH considers chloroform to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/49 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: 2 ppm

PAC-2: **64** ppm

PAC-3: **3200** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: Not appropriate

ERPG-2: 50 ppm

ERPG-3: 5000 ppm

DFG MAK: 0.5 ppm/2.5 mg/m^3 Peak Limitation Category II (2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C. Arab Republic of Egypt: TWA 10 ppm (50 mg/m^3), 1993; Australia: TWA 10 ppm (50 mg/m^3), carcinogen, 1993; Austria: MAK 10 ppm (50 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (49 mg/m^3), Carcinogen 1993; Denmark: TWA 2 ppm (10 mg/m^3), 1999; Finland: TWA 10 ppm (50 mg/m^3); STEL 20 ppm [skin] carcinogen, 1999; France: VME 5 ppm (25 mg/m^3), VLE 50 ppm (250 mg/m^3), carcinogen, 1999; India: TWA 10 ppm (50 mg/m^3), carcinogen, 1993; Japan: Occupational Exposure Limit 10 ppm (49 mg/m^3), 2B carcinogen, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Norway: TWA 2 ppm (10 mg/m^3), 1999; the Philippines: TWA 50 ppm (240 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, MAC (STEL) 225 mg/m^3, 1999; Russia: TWA 50 ppm, 1993; Sweden: NGV 2 ppm (10 mg/m^3), KTV 5 ppm (25 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 10 ppm (50 mg/m^3), KZG-W 20 ppm (100 mg/m^3), 1999; Thailand: TWA 50 ppm (240 mg/m^3), 1993; Turkey: TWA 50 ppm (240 mg/m^3), 1993; United Kingdom: TWA 2 ppm (9.9 mg/m^3) [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Russia set a MAC of 0.3 mg/m^3 for ambient air in residential areas. Several states have set guidelines or standards for chloroform in ambient air[60] ranging from 0 (North Dakota) to 0.04 μg/m^3 (Michigan and Rhode Island) to 0.43 μg/m^3 (Massachusetts and North Carolina) to 120 μ/m^3 (Pennsylvania) to 167 μg/m^3 (New York) to 250 μg/m^3 (Connecticut and South Carolina) to 500 μg/m^3 (Virginia) to 1190 μg/m^3 (Nevada) to 1200 μg/m^3 (Indiana).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography. See OSHA Analytical Method 5 and NIOSH Analytical Method #1003 for Hydrocarbons, halogenated, or OSHA Analytical Method 7.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 28,900 μg/L on an acute basis and 1240 μg/L on a chronic basis. *To protect saltwater aquatic life:* no value set due to insufficient data. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L.[6] Russia has set[35] a limit in surface water of 0.06 mg/L.

Some states have set standards and guidelines for chloroform in drinking water[61] ranging from 1 μg/L (Illinois) to 3 μg/L (Arizona) to 5 μg/L (Minnesota).

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation of vapors, ingestion, skin and eye contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: Chloroform irritates the eyes and contact can cause tearing, conjunctivitis, and permanent eye damage. Symptoms of acute chloroform exposure include fainting sensation, vomiting, dizziness, salivation, nausea, fatigue, and headache. Other symptoms are respiratory depression, coma, kidney damage, and liver damage. Chloroform is classified as moderately toxic. Probable oral lethal dose for humans is 0.5−5 g/kg (between 1 ounce and 1 pint) for a 150-lb person. The mean lethal dose is probably near 1 fluid ounce (44 g). It is a human suspected carcinogen. Also, it is a central nervous system depressant and a gastrointestinal irritant. It has caused rapid death attributable to cardiac arrest and delayed death from liver and kidney damage. A delayed reaction to high levels of chloroform or from administration of anesthetic to some individuals can develop in 3−5 days, causing drowsiness, nausea, and vomiting; kidney and liver damage; urine may contain acetone and bile pigmentation.

Long Term Exposure: Symptoms of chronic exposure include loss of appetite, hallucinations, moodiness, and physical and mental sluggishness. Repeated or prolonged contact with skin may cause skin drying, cracking, and dermatitis. May cause heart, thyroid, liver, and kidney damage. This substance is possibly carcinogenic to humans. It has been shown to cause liver, kidney, and thyroid cancer in animals. There is evidence that chloroform is a teratogen in animals.

Points of Attack: Liver, kidneys, heart, eyes, skin, central nervous system.

Medical Surveillance: Preplacement and periodic examinations should include appropriate tests for thyroid, liver, and kidney functions, and special attention should be given to the nervous system, the skin, and to any history of alcoholism. Expired air and blood levels may be useful in estimating levels of acute exposure. Special 24-h Holter monitor to detect irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2$/min): polyvinyl alcohol gloves; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h** (at least 4 h but <8 h of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2$/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride, Teflon™, polyurethane and VITON/chlorobutyl have been recommended as protective materials in the literature. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloroform, you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed dark bottles or cans in a cool, well-ventilated area.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is III.[19,20]

Spill Handling: Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills*: absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishing agents. Poisonous gases are produced in fire, including hydrogen chloride, phosgene, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

Where possible it should be recovered, purified by distillation, and returned to the supplier.

References

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Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 44−47 (1981) and 3, No. 5, 101−106 (1983). New York: Van Nostrand Reinhold Co.

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New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chloroform*. Trenton, NJ

Chloromethyl anilines C:0880

Molecular Formula: C_7H_8ClN

Common Formula: $C_6H_3Cl(CH_3)NH_2$

Synonyms: *3165-93-3:* Amarthol fast red TR base; Amarthol fast red TR salt; 2-Amino-5-chlorotoluene hydrochloride; Azanil red salt TRD; Azoene fast red TR salt; Azogene fast red TR; Azoic diazo component 11 base; Benzeneamine, 4-chloro-2-methyl-hydrochloride; Brentamine fast red TR salt; Chlorhydrate de 4-chloroorthotoluidine (French); 5-Chloro-2-aminotoluene hydrochloride; 4-Chloro-2-methylaniline hydrochloride; 4-Chloro-6-methylaniline hydrochloride; 4-Chloro-2-methylbenzenamine hydrochloride; 4-Chloro-2-toluidine hydrochloride; C.I. 37085; C.I. azoic diazo component 11; Clorhidrato de 4-cloro-*o*-toluidina (Spanish); Daito red salt TR; Devol red K; Devol red TA salt; Devol red TR; Diazo fast red TR; Diazo fast red TRA; Fast red 5CT salt; Fast red salt TR; Fast red salt TRA; Fast red salt TRN; Fast red TR salt; Hindasol red TR salt; Kromon green B; 2-Methyl-4-chloroaniline hydrochloride; Natasol fast red TR salt; NCI-C02368; Neutrosel red TRVA; Ofna-Perl salt RRA; Red base ciba IX; Red base IRGA IX; Red salt Ciba IX; Red salt IRGA IX; Red TRS salt; Sanyo fast red salt TR; UN1579

95-69-2: Amarthol fast red TR base; 2-Amino-5-chlorotoluene; *asym-m*-Chloro-*o*-toluidine; Asymmetric *m*-chloro-*o*-toluidine; Azoene fast red TR base; Azogene fast red TR; Azoic diazo component 11, base; Benzenamine, 4-chloro-2-methyl; Brentamine fast red TR base; 3-Chloro-6-aminotoluene; 5-Chloro-2-aminotoluene; 4-Chloro-2-methylaniline; 4-Chloro-6-methylaniline; 4-Chloro-2-methylbenzenamine; *p*-Chloro-*o*-toluidine; 4-Chloro-*o*-toluidine; 4-Chloro-2-toluidine; 4-Cloro-*o*-toluidina (Spanish); Daito red base TR; Deval red K; Deval red TR; Diazo fast red TRA; Fast red 5CT base; Fast red base TR; Fast red TR; Fast red TR11; Fast red TR base; Fast red TRO base; Kako red TR base; Kambamine red TR; 2-Methyl-4-chloroaniline; Mitsui red TR base; Red base Ciba IX; Red base IRGA IX; Red base NTR; Red TR base; Sanyo fast red TR base; *o*-Toluidine, 4-chloro-; Tulabase fast red TR

CAS Registry Number: 87-60-5 (3-chloro-*o*-); 95-69-2 (4-chloro-*o*-); 95-79-4 (5-chloro-*o*-); 95-81-8 (2-chloro-5-); 87-63-8 (6-chloro-*o*-); 615-65-6 (2-chloro-*p*-); 95-74-9 (3-chloro-*p*-; CAS: 95-74-9); 3165-93-3 (4-chloro-*o*-, HCl); 7149-75-9 (4 chloro-*m*-); 29027-17-6 (2-chloro-*m*-)

RTECS® Number: XU4760000 (3-chloro-*o*-; CAS: 87-60-5); XU5000000 (4-chloro-*o*-; CAS: 95-69-2); XU5075000 (5-chloro-*o*-; CAS: 95-79-4); XU5100000 (6-chloro-*o*-; CAS: 87-63-8); XU5110000 (2-chloro-*p*-; CAS: 615-65-6); XU5111000 (3-chloro-*p*-; CAS: 95-74-9); XU5250000 (4-chloro-*o*-, HCl; CAS: 3165-93-3)

UN/NA & ERG Number: UN2239 (chlorotoluidines)/153

EC Number: 201-756-6 (3-chloro-*o*-; CAS: 87-60-5); 202-441-6 [*Annex I Index No.:* 612-196-00-0] (4-chloro-*o*-; CAS: 95-69-2); 210-440-7 (2-chloro-*p*-; CAS: 615-65-6);

202-446-3 (3-chloro-*p*-; CAS: 95-74-9); 221-627-8 [*Annex I Index No.:* 612-196-00-0] (4-chloro-*o*-, HCl; CAS: 3165-93-3)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (*95-69-2*) Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 2000; IARC: (*95-79-4*) Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; NTP (*95-69-2 & 3165-93-3*): Reasonably anticipated to be a human carcinogen.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%. (4-chloro-*o*-; CAS: 95-69-2).

US EPA Hazardous Waste Number (RCRA No.): U049 (4-Chloro-*o*- HCl only) (3165-93-3).[4]

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. (4-Chloro-*o*- HCl only; CAS:3165-93-3).[4]

Reportable Quantity (RQ): 100 lb (45.4 kg). (4-chloro-*o*-HCl only; CAS:3165-93-3).[5]

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as *4-chloro-o-toluidine* (*95-69-2*).

European/International Regulations (4-chloro-*o*-toluidine; 95-69-2) and (4-chloro-*o*-toluidine HCl*;* 3165-93-3): Hazard Symbol: T, N; Risk phrases: R45; R23/24/25; R68; R50/53; Safety phrases: S53; S45; S60; S61.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Water polluting (*87-60-5 and 95-74-9 and 95-69-2*).

Description: The chloromethylanilines are colorless or white crystalline solids or liquids, some have a mild fishy odor. Molecular weight (all isomers) = 141.61. Hazard Identification (based on NFPA 704 M Rating System): *(87-60-5)* Health 2, Flammability 1, Reactivity 0. All are soluble in water and include:

Isomer	**Melting Point (°C)**	**Boiling Point (°C)**	**Flash Point (°C)**
3-chloro-o-	245	>113	–
4-chloro-o-	29	241	100
5-chloro-o-	26	237	160
6-chloro-o-	–	–	99
2-chloro-p- (liq.)	7	257	99
3-chloro-p-	26	238	100
2-chloro-5-	–	–	107

Potential Exposure: Most of the isomers are used in dyestuff manufacture. The 3-chloro-*para* isomer is used to kill birds. It is marketed as pelleted bait for control of bird populations.

Incompatibilities: Incompatible with oxidizers, strong acids, chloroformates, and acid anhydrides, isocyanates, aldehydes forming fire and explosive hazards.

Permissible Exposure Limits in Air

4-chloro-o-toluidine [95-69-2]

No TEEL available.

DFG MAK: [skin] Carcinogen Category 1; Germ Cell Mutation Category 3A.

5-chloro-o-toluidine [95-79-4]

No TEEL available.

DFG MAK: Carcinogen Category 3B.

Routes of Entry: Inhalation, skin contact, ingestion. These chemicals can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: Chloromethyl anilines can affect you when breathed in and by passing through your skin. Eye contact causes irritation and can lead to permanent damage. Skin contact can cause a rash and produce a burning feeling. Exposure can lower the ability of the blood to carry oxygen (methemoglobinemia) causing a bluish color of the skin, headaches, dizziness, nausea, and even death. They can damage the kidneys and bladder, causing painful, bloody urine.

Long Term Exposure: The methemoglobinemia condition described above may occur gradually from repeated exposure or all at once. Some of these chemicals like 4-chloro-2-methyl aniline and 5-chloro-2-methyl aniline are probable carcinogens in humans; they cause bladder and liver cancer in animals.

Points of Attack: Eyes, skin, kidneys, bladder, liver.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: Blood tests for methemoglobin levels. Kidney function tests. Urine tests for blood and for *n*-acetyl *p*-aminophenol.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids or solids wear indirect-vent, impact-resistant chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to chloromethyl anilines, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered, air-purifying respirator.

Where there is potential for high exposure to 3-chloro-2-methyl aniline exists, or to liquid form use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloromethyl anilines you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Choromethyl anilines are handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorotoluidines require a label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.[19]

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solid: Evacuate persons not wearing protective equipment from area of spill or leak until clean up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals may burn, but according to the state of New Jersey, do not readily ignite. Use dry chemical or carbon dioxide extinguishers. Poisonous gases are produced in fire, including chlorine, hydrogen chloride, nitrogen oxides, and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

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New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: 6-Chloro-2-Methyl Aniline*. Trenton, NJ

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New Jersey Department of Health and Senior Services. (May 1986). *Hazardous Substances Fact Sheet: 2-Chloro-3-Methyl Aniline*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: 4-Chloro-3-Methyl Aniline*. Trenton, NJ

Chloromethyl methyl ether C:0890

Molecular Formula: C_2H_5ClO

Common Formula: $ClCH_2OCH_3$

Synonyms: Chlorodimethyl ether; Chloromethoxymethane; CMME; α,α-Dichlorodimethyl ether; Dimethylchloroether;

Ether, chloromethyl methyl; Ether, dimethyl chloro; Ether methylique monochlore (French); Methane, chloromethoxy-; Methoxychloromethane; Methoxymethyl chloride; Monochlorodimethyl ether; Monochloromethyl methyl ether

CAS Registry Number: 107-30-2

RTECS® Number: KN6650000

UN/NA & ERG Number: UN1239/131

EC Number: 203-480-1 [*Annex I Index No.:* 603-075-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration).

Carcinogenicity: IARC[9]: (technical grade) Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP (*includes technical grades*): 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA: Human Carcinogen.

Banned or Severely Restricted (several countries) (UN).[13, 35]

Very Toxic Substance (World Bank).[15]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1006).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): U046.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Chloromethyl methyl ether (technical grade) Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R45; R11; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloromethyl methyl ether is a volatile, highly flammable, corrosive liquid with an ether-like odor. Molecular weight = 80.50; Specific gravity (H$_2$O:1) = 1.06; Boiling point = 58.8°C; Freezing/Melting point = −103.3°C; Vapor pressure = 192 mmHg at 20°C; Flash point = −17.8°C.[icsc] Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 3, Reactivity 2. Decomposes in water. Commercial chloromethyl methyl ether contains from 1 to 7% bis*(chloromethyl)ether*, a known cause of lung cancer in humans.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Chloromethyl methyl ether is a highly reactive methylating agent and is used in the chemical industry for synthesis of organic chemicals. Most industrial operations are carried out in closed process vessels so that exposure is minimized.

Incompatibilities: Forms explosive mixture with air. May be able to form unstable and explosive peroxides. Contact with oxidizers may cause fire and explosion. Decomposes on contact with water, forming hydrochloric acid and formaldehyde. Attacks various metals in presence of water.

Permissible Exposure Limits in Air

OSHA PEL: One of the thirteen OSHA-Regulated Carcinogens. A full OSHA Standard [1910.1006] has been adopted for this substance. See Code of Federal Regulations (CFR) 29,1926.1108.

NIOSH REL: Potential Occupational Carcinogen.

ACGIH TLV®[1]: A2, Suspected Human Carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 0.02 mg/m^3

PAC-1: 0.06 mg/m^3

PAC-2: **0.47** mg/m^3

PAC-3: **2.0** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

DFG MAK: Carcinogen Category 1, Confirmed Human Carcinogen.

Australia: carcinogen, 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; France: carcinogen, 1993; Russia: STEL 0.5 mg/m^3 [skin], 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. The Czech Republic has set a TWA of 0.003 mg/m^3.[35] Alberta, Canada set an airborne exposure limit of 0.005 ppm TWA and STEL of 0.015 ppm. Several states have set guidelines or standards for CMME in ambient air[60] ranging from 0 (North Dakota) to 0.02 ppb (Pennsylvania) to 0.03 μg/m^3 (New York) to 3.0 μ/m^3 (Virginia).

Determination in Air: See NIOSH II[1] P&CAM Method #220 or OSHA Analytical Method 10.

Permissible Concentration in Water: No criteria have been set for the protection of freshwater or saltwater aquatic life due to lack of data. For the protection of human health: preferably zero.[6]

Routes of Entry: Inhalation of vapor and possibly percutaneous absorption and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms of exposure include sore throat, coughing; shortness of breath; fever; chills, difficulty in breathing; bronchial secretions from pulmonary edema. The liquid causes severe irritation of eyes and skin; and vapor exposure of 100 ppm is severely irritating to eyes and nose. This level is dangerous to life in 4 h. Due to an increased death rate from respiratory cancer among exposed victims, it is a regulated carcinogen.

Long Term Exposure: There is evidence that this chemical caused lung cancer in humans, and has caused skin and lung cancer in animals. Lungs may be affected by repeated or prolonged exposure causing bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic medical examinations should include an examination of the skin and respiratory tract, including lung function tests and chest X-ray. Sputum cytology has been suggested as helpful in detecting early malignant changes; and in this connection a detailed smoking history is of importance. Possible effects on the fetus should be considered. Factors of increased risk: reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Those designed to supplement engineering controls and to prevent all skin or respiratory contact. Prevent skin contact. **4 h** (at least 4 h but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Full-body protective clothing and gloves should be used on entering areas of partial exposure. Those employed in handling operations should be provided with full-face, supplied-air respirators of continuous-flow or pressure-demand type. On exit from a regulated area, employees should be required to remove and leave protective clothing and equipment at the point of exit, to be placed in impervious containers as the end of the work shift for decontamination or disposal. Showers should be taken prior to dressing in street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloromethyl methyl ether, you should be trained on its proper handling and storage. Before entering confined space where chloromethyl methyl ether may be present, check to make sure that an explosive concentration does not exist. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloromethyl methyl ether requires a shipping label of "FLAMMABLE LIQUID, POISON." It falls in Hazard Class 6.1 (subsidiary risks: 3) and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spill:* absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Large spill: dike far ahead of *large spills* for later disposal. Flood with water. Rinse with sodium bicarbonate or lime solution. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3

Night 0.7/1.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200

Then: Protect persons downwind (miles/kilometers)

Day 1.5/2.4

Night 3.2/5.1

Fire Extinguishing: Chloromethyl methyl ether is a highly flammable liquid. Poisonous gases, including hydrogen chloride, are produced in fire. *Do not use water* or water-based extinguishers. Use dry chemical, carbon dioxide, aFFF. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated run-off enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1980). *Chloroalkyl Ethers: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Chloroalkyl Ethers: Health and Environmental Effects Profile No. 41*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chloromethyl Methyl Ether*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 51−54

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chloromethyl Methyl Ether*. Trenton, NJ

2-(4-Chloro-2-methyl-phenoxy) propionic acid C:0900

Molecular Formula: $C_{10}H_{11}ClO_3$

Synonyms: 2M-4CP; 2M4KHP; Acide 2-(4-chloro-2-methyl-phenoxy)propionique (French); Assassin; Banvel BP; Banvel P; BH Mecoprop; Ceridor; Chipco; Chipco turf herbicide MCPP; 2-(4-Chlor-2-methyl-phenoxy)-propionsaeure (German); 2-(4-Chloro-2-methylphenoxy)propanoic acid; α-(4-Chloro-2-methylphenoxy)propionic acid; (+)-α-(4-Chloro-2-methylphenoxy)propionic acid; (4-Chloro-2-methylphenoxy)propionic acid; 2-(4-Chloro-2-methylphenoxy)propionic acid; 4-Chloro-2-methylphenoxy-α-propionic acid; 2-(4-Chlorophenoxy-2-methyl)propionic acid; 2-(4-Chloro-*o*-tolyl)oxylpropionic acid; 2-(*p*-Chloro-*o*-tolyloxy)propionic acid; Cleaval; Clenecorn; Clovotox; CMPP; Compitox extra; *iso*-Cornox; *iso*-Cornox 64; Cornox plus; CR 205; Crusader; Docklene; EXP 419; Graslam; Harness; Harrier; Hedonal MCPP; Herrisol; Hymec; Hytane extra; Iotox; Kilprop; Liranox; 2-MCPP; MCPP; MCPP 2,4-D; MCPP-D-4; MCPP K-4; Mechlorprop; Mecobrom; Mecomec; Mecopeop; Mecoper; Mecopex; Mecoprop; Mecoturf; Mepro; Methoxone; 2-(2-Methyl-4-chlorophenoxy)propanoic acid; α-(2-Methyl-4-chlorophenoxy)propionic acid; 2-(2′-Methyl-4′-chlorophenoxy)propionic acid; 2-Methyl-4-chlorophenoxy-α-propionic acid; Musketeet; Mylone; N.B. Mecoprop; NSC 60282; Post-Kite; Propal; Propanoic acid, 2-(4-chloro-2-methylphenoxy)-; Propionic acid, 2-(4-chloro-2-methylphenoxy); Propionic acid, 2-(4-chloro-*o*-tolyl)oxy)-; Propionic acid, 2-(2-methyl-4-chlorophenoxy)-; Proponex-plus; Rankotex; RD 4593; Runcatex; Scotlene; Seloxone; Sel-oxone; Super green and weed; Supoertox; Swipe 560 EC; Terset; Tetralen-plus; U 46; U 46 KV-ester; U 46 KV-fluid; Verdone; VI-Par; Vipex; VI-Pex

CAS Registry Number: 93-65-2; *(alt.)* 7085-19-0

RTECS® Number: UE9750000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152

EC Number: 202-264-4 [*Annex I Index No.:* 607-049-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence, Animal Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.

US EPA, FIFRA 1998 Status of Pesticides: Unsupported.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R38; R41;R50/53; Safety phrases: S2; S13; S26; S37/39; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mecoprop is a colorless, odorless, crystalline solid. Molecular weight = 214.66; Freezing/Melting point = 93−95°C. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. It is a chlorophenoxy-herbicide, used to control many broadleaf weeds. A derivative of phenoxy aryloxyalkanoic acid.

Incompatibilities: A weak acid. Incompatible with strong bases and oxidizers.

Permissible Exposure Limits in Air: This chemical can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact irritates the eyes and skin. Irritates the respiratory tract. Exposure can cause headache, weakness, convulsions, muscle cramps, loss of coordination, unconsciousness, and death.

Long Term Exposure: There is limited evidence that the chemical affects human reproduction. Exposure may damage blood cells, causing anemia, and damage the kidneys. Although this chemical has not been identified as a carcinogen, several related compounds have shown limited evidence of cancer.

Points of Attack: Blood, kidney, nervous system.

Medical Surveillance: Examination of the nervous system. Complete blood count. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and strong bases.

Shipping: Phenoxy pesticides, solid, toxic, n.o.s., have a DOT label requirement of "POISONOUS/TOXIC MATERIALS." This chemical falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, alcohol, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References
New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: 2-(4-Chloro-2-Methylphenoxy) Propionic Acid*. Trenton, NJ
US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Chloromethyl phenyl isocyanate C:0910

Molecular Formula: C_8H_6ClNO
Common Formula: $OCN\text{-}C_6H_3 \cdot Cl \cdot CH_3$
Synonyms: 3-Chloro-4-methylphenyl isocyanate; Isocyanic acid, 3-chloro-*p*-tolyl ester
CAS Registry Number: 28479-22-3; *(alt.)* 51488-20-1
RTECS® Number: NQ8585000
UN/NA & ERG Number: UN2236/156
EC No: 249-050-7
Regulatory Authority and Advisory Bodies
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Chloromethyl phenyl isocyanate is a colorless to yellow liquid or beige, low-melting solid. Molecular weight = 167.59; Melting point = 143°C; Vapor pressure = Very low; Flash point ≥ 93°C. Soluble in water; solubility = 33 mg/L at 25°C. Insoluble in water.
Potential Exposure: This material is used in organic synthesis.
Incompatibilities: Acids, alkalis, and amines. Keep away from heat, light, and moisture. Do not store in temperatures above 30°C/86°F.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC) *Isocyanate-bearing waste (as CNs, n.o.s.)*
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Chloromethyl phenyl isocyanate can affect you when breathed in. Little is known about the health effects of chloromethyl phenyl isocyanate. However, organic isocyanates can irritate the eyes, skin, and respiratory tract and cause lung allergies.
Long Term Exposure: Although the long-term effects of this chemical are unknown, many isocyanates cause allergic reactions and asthma-like allergy.
Points of Attack: Respiratory system.
Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test.
First Aid: If chloromethyl phenyl isocyanate gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposure to chloromethyl phenyl isocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloromethyl phenyl isocyanate you should be trained on its proper handling and storage. Chloromethyl phenyl isocyanate must be stored to avoid contact with acids (such as hydrochloric and nitric), alkalis (such as sodium hydroxide and potassium hydroxide), and amines (like ammonia), since violent reactions occur. Store in tightly closed

containers in a cool, well-ventilated area away from heat, light, and moisture. Do not store at temperatures above 30°C/86°F. Sources of ignition, such as smoking and open flames, are prohibited where 3-Chloro-4-methyl phenyl isocyanate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloromethyl phenyl isocyanate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.[17]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chloromethyl phenyl isocyanate may burn, but does not readily ignite. Containers may explode in fire. Poisonous gases are produced in fire, including hydrogen cyanide, nitrogen oxides, and hydrogen chloride. Use dry chemical, CO_2, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1997). *Hazardous Substances Fact Sheet: 3-Chloro-4-Methyl Phenyl Isocyanate*. Trenton, NJ

1-Chloro-1-nitropropane C:0920

Molecular Formula: $C_3H_6ClNO_2$
Common Formula: $C_2H_5CHClNO_2$
Synonyms: 1,1-Chloronitropropane; Chloronitropropane; 1-Chloro-1-nitropropano (Spanish); Korax®; Korax 6®; Lanstan®; Propane, 1-chloro-1-nitro-
CAS Registry Number: 600-25-9
RTECS® Number: TX5075000
UN/NA & ERG Number: UN2810/153
EC Number: 209-990-0 [*Annex I Index No.:* 610-007-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/22; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloronitropropane is a flammable, colorless liquid with an unpleasant odor that causes tears (lachrimator). Molecular weight = 123.5; Specific gravity (H_2O:1) = 1.2; Boiling point = 142.7°C; Vapor pressure = 6 mmHg at 25°C; Flash point = 62°C (oc). Hazard Identification (based on NFPA 704 M Rating System): Health (unknown), Flammability 3, Reactivity 2. Slightly soluble in water; solubility = 0.6% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. This compound is used in the synthetic rubber industry, as a component in rubber cements, and as a fungicide.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause a fire and explosion hazard. May explode when exposed to heat.

Permissible Exposure Limits in Air

OSHA PEL: 20 ppm/100 mg/m^3 TWA.
NIOSH REL: 2 ppm/10 mg/m^3 TWA.
ACGIH TLV®[1]: 2 ppm/10 mg/m^3 TWA.
No TEEL available.
NIOSH IDLH: 100 ppm.

Australia: TWA 2 ppm (10 mg/m^3), 1993; Austria: MAK 20 ppm (100 mg/m^3), 1999; Belgium: TWA 2 ppm (10 mg/m^3), 1993; Denmark: TWA 2 ppm (10 mg/m^3), 1999; Finland: TWA 20 ppm (100 mg/m^3); STEL 30 ppm (150 mg/m^3), 1999; France: VME 2 ppm (10 mg/m^3), 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; the Philippines: TWA 20 ppm (100 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, 1999; Switzerland: MAK-W 2 ppm (10 mg/m^3), 1999; Turkey: TWA 20 ppm (100 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm. Several states have set guidelines or standards for chloronitropropane in ambient air[60] ranging from 10 μg/m^3 (North Dakota) to 150 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Chromosorb tube-108; Ethyl acetate; Gas chromatography/Flame ionization detection; See NIOSH II(5) Method #S-211.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: 1-Chloro-1-nitropropane can affect you when breathed in. Exposure can irritate and burn the eyes, skin, and cause respiratory tract irritation with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause damage to the heart, liver, and kidneys. Similar irritating substances can cause lung injury and bronchitis.

Points of Attack: In animals: respiratory system, lungs, liver, kidneys, cardiovascular system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. EKG. Lung function tests. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* Sa* (APF = 10) (any supplied-air respirator); *50 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode; or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]*. *100 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; requires eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 1-chloro-1-nitropropane you should be trained on its proper handling and storage. Before entering confined space where 1-chloro-1-nitropropane may be present, check to make sure that an explosive concentration does not exist. Store to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic, liquids, organic, n.o.s., requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is flammable. Poisonous gases, including nitrogen oxides and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s minimum for primary combustion; 1204°C, 1.0 s for secondary combustion) after mixing with other fuel. The formation of elemental chlorine may be prevented by injection of steam or using methane as a fuel in the process. Alternatively it may be poured over soda ash, neutralized and flushed into the sewer with large volumes of water.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 1-Chloro-1-Nitropropane*. Trenton, NJ

Chloropentafluoroethane C:0930

Molecular Formula: C_2ClF_5

Common Formula: ClF_2CCF_3

Synonyms: CFC-115; Chloropentafluoroethane; 1-Chloro-1,1,2,2,2-pentafluoromethane; Ethane, Chloropentafluoro-; F-115; FC 115; Flurocarbon 115; Freon 115; Genetron 115; Halocarbon 115; HCFC-115; Monocloropentafluoetano (Spanish); Pentafluoromonochloroethane; Propellent 115; R 115; Refrigerant 115

CAS Registry Number: 76-15-3; *(alt.)* 12770-91-1

RTECS® Number: KH7877500

UN/NA & ERG Number: UN1020/126

EC Number: 200-938-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 0.6.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chloropentafluoroethane is a colorless, odorless, nonflammable gas with an ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 154.47; Specific gravity (H_2O:1) = 1.3; Boiling point = −38°C; Freezing/Melting point = −106°C; Vapor pressure = 7.9 atm at 21°C; 6035 mmHg at 21°C; Relative vapor density (air = 1) = 5.28. Practically insoluble in water; solubility 0.006% at 20°C.

Potential Exposure: This material is used as a refrigerant, as a dielectric gas, and as a propellant in aerosol food preparations.

Incompatibilities: Keep away from strong oxidizers, strong bases (alkalis), alkaline earth metals (e.g., aluminum powder, sodium, potassium, zinc), and beryllium. Keep away from open flames; decomposes forming toxic fumes including hydrogen chloride and hydrogen fluoride.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.32 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1000 ppm/6320 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/6320 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 5000 ppm

PAC-3: 300,000 ppm

Australia: TWA 1000 ppm (6320 mg/m^3), 1993; Belgium: TWA 1000 ppm (6320 mg/m^3), 1993; Denmark: TWA 1000 ppm (6300 mg/m^3), 1999; France: VME 1000 ppm (6320 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; the Netherlands: MAC-TGG 6460 mg/m^3, 2003; Russia: STEL 3000 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (6400 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000 ppm. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 3000 mg/m^3 in work-place air. Several states have set guidelines or standards for FC-115 in ambient air[60] ranging from 0.1264 μg/m^3 (Connecticut) to 9,999 μg/m^3 (Virginia) to 63,200 μg/m^3 (North Dakota) to 151,000 μg/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chloropentafluoroethane can affect you when breathed in. Irritates the nose, throat, and lungs, causing coughing, chest tightness, wheezing, and shortness of breath. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause death. Chloropentafluoroethane may irritate the skin causing a rash or burning feeling on contact. Exposure may affect the heart, causing irregular heartbeat, which could lead to death. Rapid evaporation of liquid chloropentafluoroethane may cause frostbite of the eyes and skin.

Long Term Exposure: Similar very irritating substances can cause lung damage.

Points of Attack: Skin, central nervous system, cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 h EKG (Holter monitor) to look for irregular heartbeat. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 1000 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Green: General storage may be used. Prior to working with chloropentafluoroethane you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that sufficient oxygen (19%) exists. Store in tightly closed containers in a cool, well-ventilated area away from metals, including aluminum, zinc, and beryllium; and from open flames or temperatures above 52°C/125°F. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Chloropentafluoroethane must be labeled "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire, including fluorides, chlorides, phosgene, and acid gases. Use dry chemical or carbon dioxide extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Chloropentafluoroethane*. Trenton, NJ

Chlorophacinone C:0940

Molecular Formula: $C_{23}H_{15}ClO_3$

Synonyms: Afnor; Caid; Chlorfacinon (German); 2-(α-*p*-Chlorophenylacetyl)indane-1,3-dione; [(4-Chlorophenyl)-1-phenyl]-acetyl-1,3-indandion (German); 2-[(*p*-Chlorophenyl)phenylacetyl]-1,3-indandione; 2[2-(4-Chlorophenyl)-2-phenylacetyl]indan-1,3-dione; 2 [(4-Chlorophenyl)phenylacetyl)-1H-indene-1,3(2H)-dione; 1-(4-Chlorphenyl)-1-phenyl-acetyl indan-1,3-dion

(German); Clorofacinona (Spanish); Delta; Drat; 1,3-Indandione, 2-[(*p*-chlorophenyl)phenylacetyl]-; 1H-Indene-1,3(2H)-dione, 2-[(4-Chlorophenyl)phenylacetyl]-; Liphadione; LM 91; Microzul; Muriol; 2-[2-Phenyl-2-(4-chlorophenyl)acetyl]-1,3-indandione; Quick; Ramucide; Ranac; Ratomet; Raviac; Rozol; Topitox

CAS Registry Number: 3691-35-8

RTECS® Number: NK5335000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 223-003-0 [*Annex I Index No.*: 606-014-00-9]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R23; R27/28; R48/24/25; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlorophacinone is a highly toxic crystalline solid. Molecular weight = 374.83; Freezing/Melting point = 140°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0.

Potential Exposure: Agricultural Chemical. This material is an anticoagulant rodenticide. Those involved in its manufacture, formulation, and application are at risk.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

Permissible Concentration in Water: No criteria set. Fish Tox (ppb): 27.64016000 MATC (Maximum Acceptable Toxicant Concentration).

Determination in Water: Octanol−water coefficient: Log K_{ow} = 5.49.

Routes of Entry: Ingestion and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause burns to skin and eyes. Symptoms of exposure are similar to those of warfarin. Symptoms develop after a few days or a few weeks of repeated ingestion and include nosebleed and bleeding gums; pallor and sometimes a rash; massive bruises, especially of the elbows, knees, and buttocks; blood in urine and feces; occasionally paralysis from cerebral hemorrhage; and hemorrhagic shock and death. Chlorophacinone is highly toxic orally and by skin adsorption. The probable oral lethal dose for humans is less than 5 mg/kg to 50 mg/kg, or between a taste (less than 7 drops) and 1 teaspoonful for a 150-lb (70-kg) person. LD_{50} = (oral-rat) >5000 mg/kg; (oral-mouse) 1.06 mg/kg. Human Tox (ppb): 0.03500 (extra high).

Long Term Exposure: See above.

Points of Attack: Blood, cardiovascular system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Coumarin derivative pesticides, solid, toxic, n.o.s., require a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class is 6.1 and Packing Group I.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: dry chemicals, carbon dioxide, water spray or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration at high temperature with effluent gas scrubbing.[22]

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chlorophacinone*. Washington, DC: Chemical Emergency Preparedness Program

Chlorophenols, mono C:0950

Molecular Formula: C_6H_5ClO

Common Formula: C_6H_4ClOH

Synonyms: *m-isomer; m*-Chlorophenate; *m*-Chlorophenol; *m*-Clorofenol (Spanish)

o-isomer: o-Chlorophenol; *o*-Chlorphenol (German); *o*-Clorofenol (Spanish); Phenol, *o*-chloro-; Phenol, 2-chloro-

p-isomer: p-Chlorfenol (Spanish); *p*-Chlorophenate; *p*-Chlorophenol; Parachlorophenol

CAS Registry Number: 95-57-8 (*o*-isomer); 108-43-0 (*m*-isomer); 106-48-9 (*p*-isomer); 25167-80-0 (mixed isomers)

RTECS® Number: SK2625000 (*o*-isomer); SK2450000 (*m*-isomer); SK2800000 (*p*-isomer)

UN/NA & ERG Number: UN2020 (solid)/153; UN2021 (liquid)/153

EC Number: 202-433-2 (*o*-); 203-582-6 (*m*-); 203-402-6 (*p*-isomer; 246-691-4 (mixed isomers) [*Annex I Index No.:* 604-008-00-0 (all isomers and mixed)]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

o-isomer:

Reportable Quantity (RQ): 100 lb (45.4 kg) (*o*-isomer).

US EPA Hazardous Waste Number (RCRA No.): U048 (*o*-isomer).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents (*o*-isomer).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.44; Nonwastewater (mg/kg), 5.7 (*o*-isomer).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10) (*o*-isomer).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%. (chlorophenols).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (chlorophenols).

Canada, WHMIS, Ingredients Disclosure List (*m*-, *o*-, and *p*-isomers) 1%.

Mexico, Drinking Water Criteria: 0.03 mg/L (*o*-isomer).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/21/22; R51/53; Safety phrases: S2; S28; S61 (*all isomers*).

WGK (German Aquatic Hazard Class): 2—Water polluting (*o-, m-, and p-isomers*).

Description: All have a characteristic odor. Odor threshold = 1.24 ppm (pure). Molecular weight (all isomers) = 128.56.

m-isomer

Colorless (in pure state) to pink or amber (technical grade, due to impurities) crystalline solid or liquid. Boiling point = 214°C; Freezing/Melting point = 32.8°C; Specific gravity (H_2O:1) = 1.245; Vapor pressure = 5 mmHg at 70°C; Flash point = >112°C. Solubility in water = 2.6–2.8.5% at 20°C. Hazard Identification (based on NFPA 704 M Rating System): Health 2, Flammability 0, Reactivity 0.

o-isomer

White crystalline (needle-like) solid. Boiling point = 175.6°C; Freezing/Melting point = 9.3–9.8°C; Specific gravity (H_2O:1) = 1.3; Vapor pressure, Pa at 20°C = 230; Relative vapor density (air = 1) = 4.4; Flash point = 64°C (cc). Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 2, Reactivity 0. Solubility in water = 2.7% at 20°C.

p-isomer

White to straw-colored, needle-like crystalline solid. Boiling point = 218°C; Freezing/Melting point = 43°C; Vapor pressure = 10 mmHg at 20°C; Vapor density (air = 1) = 4.44; Flash point = 121°C (cc). Hazard Identification (based on NFPA 704 M Rating System): Health 3, Flammability 1, Reactivity 0. Solubility in water = 2.71% at 20°C.

Potential Exposure: Compound Description (*m*-isomer): Tumorigen, Mutagen (*o*-isomer): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; (*p*-isomer): Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Monochlorophenols are used in the manufacture of fungicides, slimicides, bactericides, pesticides, herbicides, disinfectants, wood and glue preservatives; in the production of phenolic resins; in the extraction of certain minerals from coal; as a denaturant for ethanol; as an antiseptic; as a disinfectant, and others.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizing agents can cause fire and explosion hazard. Heat produces hydrogen chloride and chlorine. Corrosive to aluminum, copper, and other chemically active metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

o-isomer

TEEL-0: 1.5 ppm

PAC-1: 5 ppm

PAC-2: 35 ppm

PAC-3: 75 ppm

m-isomer

TEEL-0: 0.3 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 250 mg/m^3

o- and *m*-isomers

Denmark: TWA 0.5 mg/m^3 [skin], 1999; Sweden: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3 [skin], 1999.

p-isomer

Protective Action Criteria (PAC)

p-isomer

TEEL-0: 250 mg/m^3

PAC-1: 400 mg/m^3

PAC-2: 400 mg/m^3

PAC-3: 400 mg/m^3

Denmark: TWA 0.5 mg/m^3 [skin], 1999; Poland: MAC (TWA) 1 mg/m^3; STEL 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3 [skin]1993; Sweden TWA 0.5 mg/m^3; STEL 1.5 mg/m^3 [skin] 1999.

These chemicals can be absorbed through the skin, thereby increasing exposure. Russia set limits in ambient air in residential areas of 0.01 mg/m^3 for the *m*- and *p*-chlorphenols and 0.02 mg/m^3 for 2-chlorophenol.

Determination in Air: Use NIOSH: (*o*-chlorophenol) P&CAM Method #337.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 4380 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* no criteria set due to insufficient data. *To protect human health:* 0.1 μg/L for the prevention of adverse effects due to organoleptic properties.[6]

The state of Kansas has set guidelines for chlorophenols in drinking water[61] of 0.1 μg/L for the *o*-isomer and 0.3 μg/L for the *p*-isomer.

Determination in Water: Gas chromatography (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = (*m*-isomer) 2.51; (*o*-isomer) 2.2; (*p*-isomer) 2.4.

Routes of Entry: Skin absorption, inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause severe irritation, burns to the nose and throat; headache, dizziness, vomiting, lung damage; muscle twitchings; spasms, tremors, weakness, staggering and collapse. Skin contact can cause severe irritation and burns. Can be absorbed through the skin to cause or increase the severity of symptoms listed above. Eye contact causes severe irritation. May cause burns. Ingestion can cause irritation, burns to the mouth and throat; low blood pressure; profuse sweating; intense thirst; nausea, abdominal pain; stupor, vomiting, red blood cell damage and accumulation of fluid in the lungs followed by pneumonia. May also cause restlessness and increased breathing rate followed by rapidly developing muscle weakness. Tremors, convulsions, and coma can promptly set in and will continue until death. Based on animal studies, the estimated lethal dose is between one teaspoon and one ounce for a 150-pound adult. *p-isomer*: The substance irritates the eyes, skin, and the respiratory tract. The substance may cause effects on the central nervous system and bladder.

Long Term Exposure: Skin sensitivity may develop. May have effects on the blood, heart, liver, lung, kidney. The state of New Jersey lists 2-chloro- a probable carcinogen in humans; and that it causes leukemia and soft tissue cancers in humans.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Kidney function tests. Examination by a qualified allergist; EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn.

Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to chlorophenols, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered, air-purifying respirator. Where there is potential for high exposure to chlorophenols, or to liquid form, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorophenols you should be trained on its proper handling and storage. Before entering confined space where chlorophenols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorophenols must carry a “POISONOUS/TOXIC MATERIALS” label.[19] They fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *o*-Chlorophenol is a combustible liquid/solid. *m*- and *p*-chlorophenols may burn, but do not readily ignite. Poisonous gases, including phenols and chlorides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors from 2-chloro- may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in admixture with flammable solvent in furnace equipped with afterburner and scrubber.[22]

References

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US Environmental Protection Agency. (April 30, 1980). *2-Chloropehnol: Health and Environmental Effects Profile No. 50*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 48−51 (1982) and 4, No. 6, 88−94 (1986) (2-Chlorophenol); 2, No. 6, 46−48 (1982) and 6, No. 5, 70−74 (1986) (3-Chlorophenol); 2, No. 6, 52−55 (1982) and 6, No. 5, 74−81 (1986) (4-Chlorophenol)

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Chlorophenols*. Albany, NY: Bureau of Toxic Substance Assessment

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 2-Chlorophenol*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 2-Chlorophenol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 3-Chlorophenol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 4-Chlorophenol*. Trenton, NJ

4-Chloro-*o*-phenylene-diamine C:0960

Molecular Formula: $C_6H_7ClN_2$
Common Formula: $ClC_6H_3(NH_2)_2$
Synonyms: 2-Amino-4-chloroaniline; 4-Chloro-1,2-benzenediamine; 4-Chloro-1,2-diaminobenzene; *p*-Chloro-*o*-phenylenediamine; 4-Chloro-1,2-phenylenediamine; 4-Cl-*o*-Pd; 1,2-Diamino-4-chlorobenzene; 3,4-Diamino-1-chlorobenzene; 3,4-Diaminochlorobenzene; NCI-C03292; Ursol olive 6G
CAS Registry Number: 95-83-0
RTECS® Number: SS8850000
UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151
EC Number: 202-456-8
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Sufficient Evidence, Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1998; NTP: 7th Report on Carcinogens; NCI: Clear evidence: mouse, rat[9]; a related chemical, 4-Chloro-*m*-phenylene-diamine (5131-60-2); NTP: Reasonably anticipated to be a human carcinogen.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
California Proposition 65 Chemical: Cancer 1/1/88.
WGK (German Aquatic Hazard Class): No value assigned.
Description: 4-Chloro-*o*-phenylene-diamine is a brown crystalline powder or leaflets from water; Freezing/Melting point = 67−70°C; also reported at 76°C.
Potential Exposure: This material has been patented as a hair dye component. It is believed to be used in production of photographic chemicals.
Incompatibilities: Strong oxidizers.
Permissible Exposure Limits in Air
No standards or TEEL available.
North Dakota has set a guideline for ambient air of zero concentration.[60]
Determination in Air: NIOSH Analytical Method #5013, Dyes.
Harmful Effects and Symptoms
Short Term Exposure: Can cause irritation of eyes, nose, skin, and mucous membranes.
Long Term Exposure: There is sufficient evidence that 4-chloro-*o*-phenylene-diamine is carcinogenic in experimental animals. In long-term feeding bioassays with technical grade 4-chloro-*o*-phenylene-diamine, rats developed tumors of the urinary bladder and fore-stomach. In mice, the compound induced hepatocellular carcinomas.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated place or a refrigerator.
Shipping: While not specifically cited by DOT, this may be classed as Dyes, solid, toxic, n.o.s. or as Toxic solids, organic, n.o.s. This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.2 and Packing Group III.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent paper dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous

waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Chlorophenyltrichlorosilane C:0970

Molecular Formula: $C_6H_4Cl_4Si$

Common Formula: $ClC_6H_4SiCl_3$

Synonyms: Chlorofeniltriclorosilano (Spanish); Chlorophenyl trichlorosilane; Trichloro (chlorophenyl) silane

CAS Registry Number: 26571-79-9

RTECS® Number: VV2650000

UN/NA & ERG Number: UN1753/156

EC Number: 247-817-0

Regulatory Authority and Advisory Bodies

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chlorophenyltrichlorosilane is a combustible, colorless to pale yellow liquid. Molecular weight = 245.99; Boiling point = 230°C; Flash point = 123.8°C. Decomposes in water.

Potential Exposure: Chlorophenyltrichlorosilane is used as an intermediate for manufacture of silicones.

Incompatibilities: Chlorophenyltrichlorosilane decomposes on contact with water, steam, or other forms of moisture producing hydrogen chloride and heat. Attacks metals in the presence of moisture. Some chlorosilanes can self-ignite in air. Contact with ammonia may cause the formation of a self-igniting product. Keep chlorophenyltrichlorosilane away from combustible materials, such as wood, paper, and oil. Chlorophenyltrichlorosilane reacts with α-ketoacids, forming heterocyclic compounds of quinoxalones.[NTP]

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Based on 15 other trichlorosilanes with the same TEELs

TEEL-0: 0.2 ppm

PAC-1: 0.6 ppm

PAC-2: 7.3 ppm

PAC-3: 33 ppm

Routes of Entry: Skin contact, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Chlorophenyltrichlorosilane can affect you when breathed in. Chlorophenyltrichlorosilane is a corrosive chemical. Contact can cause severe eye and skin burns. Inhalation can cause irritation of the lungs, causing coughing and/or shortness of breath. High exposures can cause pulmonary edema, a medical emergency which can be delayed for several hours. This can cause death.

Long Term Exposure: Can cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning work and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with chlorophenyltrichlorosilane you should be trained on its proper handling and storage. Chlorophenyltrichlorosilane should be stored to avoid contact with combustible materials, such as wood, paper, and oil. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive gases, including hydrogen chloride, can be produced.

Shipping: Chlorophenyltrichlorosilane requires a shipping label of "CORROSIVE."[19] It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Fire Extinguishing: Chlorophenyltrichlorosilane may burn, but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers. *Do not use water*. Poisonous gases are produced in fire, including chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Chlorophenyltrichlorosilane*. Trenton, NJ

Chloropicrin (Agent PS, WMD) C:0980

Molecular Formula: CCl_3NO_2

Synonyms: Acquinite; Chlor-O-Pic; Chloropicrine (French); Chlorpikrin (German); Clorpicrina (Spanish); Larvacide 100; Methane, trichloronitro-; Mycrolysin; Nitrochloroform; Nitrotrichloromethane; Pic-Chlor; Picfume; Picride; Profume A; PS (military designation); Trichlor; Trichloronitromethane

CAS Registry Number: 76-06-2

RTECS® Number: PB6300000

UN/NA & ERG Number: UN1580/154; UN1583 (Chloropicrin mixtures, n.o.s.)/154

EC Number: 200-930-9 [*Annex I Index No.:* 610-001-00-3]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Various Countries) (UN).[13,35]

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); no evidence: mouse; inadequate studies: rat.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: Priority List (55 FR 1470).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R22; R26; R36/37/38; Safety phrases: S1/2; S36/37; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloropicrin is a highly reactive, colorless, oily liquid with a sharp, penetrating odor that causes tears. Odor threshold = 1.1 ppm. Molecular weight = 164.38; Specific gravity (H_2O:1) = 1.66; Boiling point = 112.2°C; Freezing/Melting point = − 69.2°; Vapor pressure = 24 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3. Slightly soluble in water; solubility = 0.17% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. Chloropicrin is an important insecticide and is used in the manufacture of the dyestuff methyl violet and in other organic syntheses. It is used as a fumigant insecticide. It is a riot control and tear agent and has been used as a military poison gas. Some forms of tear gas also contain chloropicrin. Since tank trucks, tank cars, and tank vessels carry this throughout the world in large quantities, it is a potential problem.

Incompatibilities: Chloropicrin decomposes explosively when heated above 112°C. It can be dangerously self-reactive; and, may explode when heated under confinement or if shocked. Chloropicrin is stable except when it is heated to a high temperature; it explosively breaks down, releasing other poison gases including nitrogen oxides, nitrosyl chloride, chlorine, phosgene, and carbon monoxide. Liquid chloropicrin (PS) is unstable with high temperatures or severe shock, particularly when involving containers of greater than 30 gallons capacity. Chloropicrin reacts violently with aniline, sodium methoxide, and propargyl bromide; 2-bromopropyne and strong oxidizers. Violent reaction with reducing agents; aniline (especially in presence of heat), alcoholic sodium hydroxide. Quickly elevated temperatures, shock, contact with alkali metals or alkaline earth may cause explosions. It is a strong acid and will react violently with bases and alkali materials. Liquid attacks some plastics, rubber, and coatings. Chloropicrin reacts with iron, zinc, light metals including aluminum, magnesium, and alloys containing these metals. It reacts, sometimes violently, with some types of rubbers and plastics, as well as some chemicals including common sulfuric acid and bases. Contact with metals may evolve explosive hydrogen gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.72 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.7 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.7 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm/0.67 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC) PS*

TEEL-0: 0.05 ppm

PAC-1: **0.05** ppm

PAC-2: **0.15** ppm

PAC-3: **1.4** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: 0.1 ppm

ERPG-2: 0.3 ppm

ERPG-3: 1.5 ppm

DFG MAK: 0.1 ppm/0.68 mg/m^3 TWA; Peak Limitation Category I(1).

NIOSH IDLH: 2 ppm.

Australia: TWA 0.1 ppm (0.7 mg/m^3); STEL 0.3 ppm (2 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.7 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.67 mg/m^3); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.7 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.7 mg/m^3); STEL 0.3 ppm (2.1 mg/m^3), 1999; France: VME 0.1 ppm (0.7 mg/m^3), 1999; Japan: 0.1 ppm (0.67 mg/m^3), 1999; the Netherlands: MAC-TGG 0.7 mg/m^3, 2003; Norway: TWA 0.1 ppm (0.7 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.7 mg/m^3), 1993; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Russia: TWA 0.1 ppm, 1993; Switzerland: MAK-W 0.1 ppm (0.7 mg/m^3), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.7 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.68 mg/m^3); STEL 0.3 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for chloropicrin in ambient air[60] ranging from 7−20 μg/m^3 (North Dakota) to 11.7 μg/m^3 (Virginia) to 14 μg/m^3 (Connecticut) to 17 μg/m^3 (Nevada).

Determination in Air: When liquid chloropicrin enters water, it mixes very slowly, falling to the bottom, where it breaks down in less than a day. Nevertheless, warn pollution control authorities and advise shutting water intakes. Chloropicrin is very poisonous to fish.

Permissible Concentration in Water: California[61] has set guidelines for chloropicrin in drinking water of 50 μg/L on a taste basis and 37 μg/L on an odor basis.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.09.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Chlorpicrin was used as poison gas in WW1. Exposure causes intense tearing of the eyes, headache, nausea and vomiting, diarrhea, and cough. Contact can severely irritate the skin causing rash or burning sensation. Higher exposures can irritate and burn the lungs, causing a buildup of fluid (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 250 mg/kg (moderately toxic).

Long Term Exposure: Repeated exposure can damage the lungs, causing bronchitis. It may also damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: lung function tests. If symptoms develop or overexposure has occurred, the following may be useful: liver and kidney function tests. Consider chest X-ray following acute overexposure. NIOSH suggests the following tests: electrocardiogram, expired air, pulmonary function tests: forced vital capacity and forced expiratory volume (1 s), sputum cytology, and white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you do not have the equipment and training, do not enter the hot zone to rescue and/or decontaminate victims. If the victim cannot move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available), and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 min. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. The International Technical Information Institute recommends wearing Neoprene™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with chloropicrin you should be trained on its proper handling and storage. Before entering confined space where chloropicrin may be present, check to make sure that an explosive concentration does not exist. Chloropicrin must be stored to avoid contact with strong oxidizers, such as chlorine or chlorine dioxide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. High temperatures or severe shock may cause an explosion, particularly with containers having capacities of greater than 30 gallons. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chloropicrin must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.[19] A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Note: There is no specific information for "PS" Chloropicrin, used as a weapon in the current DOT tables.

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.6/1.4

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.2/1.9
Night 2.1/3.3

Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate the area of spill or leak.

Fire Extinguishing: Chloropicrin is a noncombustible liquid. However, in the case where a chloropicrin tank is adjacent to a fire, the tank will heat causing extremely high pressurization and explosion. Evacuate area. Even if the tank does not fail, the safety valve may open releasing chloropicrin, so evacuate. If necessary, fight fire from an explosion-resistant location. When heated, chloropicrin breaks down to poison gases like phosgene (another good reason to evacuate); and at high temperature it can violently break down into several poisonous gases, including hydrogen chloride and nitrous vapors. The danger from a heated chloropicrin tank is too great to risk a manned firefighting effort; if possible, an unattended fire monitor aimed at the upper part of the chloropicrin tank will cool the tank and may prevent tank failure. In general, it is best to use a spray or fog pattern rather than a solid stream to avoid spreading the burning fuel around. If there is a reason that you have to extinguish a fire near a chloropicrin tank, use a firefighting agent (water, ordinary foam, alcohol foam, or dry chemical) appropriate for that fuel. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s minimum for primary combustion; 1204°C, 1.0 s for secondary combustion) after mixing with other fuel. The formation of elemental chlorine may be prevented by injection of steam or using methane as a fuel in the process. Chloropicrin reacts readily with alcoholic sodium sulfite solutions to produce methanetrisulfonic acid (which is relatively nonvolatile and less harmful). This reaction has been recommended for treating spills and cleaning equipment. Although not specifically suggested as a decontamination procedure, the rapid reaction of chloropicrin with ammonia to produce guanidine ($LD_{50} = 500$ mg/kg) could be used for detoxification. The Chemical Manufacturers' Association has suggested two procedures for disposal of Chloropicrin: (a) Pour or sift over soda ash. Mix and wash slowly into large tank. Neutralize and pass to sewer with excess water. (b) Absorb on vermiculite. Mix and shovel into paper boxes. Drop into incinerator with afterburner and scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 17−19. New York: Van Nostrand Reinhold Co.

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chloropicrin*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0 (United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C))*. Washington, DC: United States Coast Guard and the Department of Homeland Security

Chloroplatinic acid C:0990

Molecular Formula: Cl_6H_2Pt

Common Formula: H_2PtCl_6

Synonyms: Dihydrogen hexachloroplatinate; Dihydrogenhexachloroplatinate (2-); Hexachloro dyhydrogen platinate; Hexachloroplatinic acid; Hexachloroplatinic (IV) acid; Hexachloroplatinic(4+) acid, hydrogen-; Hydrogen hexachloroplatinate(4+); Platinate, hexachloro-; Platinic chloride

CAS Registry Number: 16941-12-1

RTECS® Number: TP1500000

UN/NA & ERG Number: UN2507/154

EC Number: 241-010-7 [*Annex I Index No.*: 078-009-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R25; R35; R42/43; Safety phrases: S1/2; S22; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloroplatinic acid is a reddish-brown deliquescent solid. Molecular weight = 409.8; Freezing/Melting point = 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Chloroplatinic acid has many uses, among them are platinum plating, photography, and catalysis.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.002 mg[Pt]/m^3 TWA, soluble salts.

OSHA PEL: 0.002 mg[Pt]/m^3 TWA, soluble salts.

NIOSH REL: 0.002 mg[Pt]/m^3 TWA, soluble salts.

Protective Action Criteria (PAC)

TEEL-0: 0.0042 mg/m^3

PAC-1: 0.25 mg/m^3

PAC-2: 1.5 mg/m^3

PAC-3: 8.4 mg/m^3

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

NIOSH IDLH: 4 mg [Pt]/m^3.

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts).

Routes of Entry: Skin contact, inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chloroplatinic acid can affect you when breathed in. It is a highly corrosive chemical; contact can severely irritate and burn the eyes. Inhalation can irritate the respiratory tract. Exposure can cause severe allergies affecting the nose, skin, and lungs. Symptoms include sneezing, coughing, nose and throat irritation and nasal discharge. Irritation and even ulcers can develop in the nose. Once lung allergy develops, even very small future exposures cause cough, wheezing, chest tightness, and shortness of breath. Skin allergy with a rash and itching can also develop.

Long Term Exposure: Repeated exposure may lead to permanent lung damage (pulmonary fibrosis), skin allergy, asthma-like allergy.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.05 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode), *up to 0.1 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 4 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Solid chloroplatinic acid must carry a "CORROSIVE" label.[19] It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, CO_2, water spray, or foam extinguishers. Chloroplatinic acid may burn but does not readily ignite. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chloroplatinic Acid*. Trenton, NJ

Chloroprene C:1000

Molecular Formula: C_4H_5Cl

Common Formula: $H_2C{=}CCl{-}CH{=}CH_2$

Synonyms: 1,3-Butadiene, 2-chloro-; 2-Chlor-1,3-butadien (German); 1,3-Chlor-2-butadiene; 2-Chloro-1,3-butadiene; 2-Chlorobuta-1,3-diene; 2-Chlorobutadiene; Chloropren (German); β-Chloroprene; β-Cloropreno (Spanish); Neoprene™(polymerized product)

CAS Registry Number: 126-99-8

RTECS® Number: EI9625000

UN/NA & ERG Number: UN1991/131P

EC Number: 204-818-0 [*Annex I Index No.:* 602-036-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal sufficient evidence, human inadequate evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Sperm morphology—rat; Positive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 0.28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (50); 8240 (5).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 6/2/00.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R45; R11; R20/22; R36/37/38; R48/20; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chloroprene is a colorless, flammable liquid possessing a pungent odor. The odor threshold is 0.4 mg/m^3.[41] Molecular weight = 88.54; Specific gravity (H_2O:1) = 0.96; Boiling point = 59.4°C; Freezing/Melting point = − 130°C; Vapor pressure = 188 mmHg at 20°C; Flash point = − 20°C (oc). The explosive limits are: LEL = 1.9%; UEL = 11.3%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water; solubility = 0.03% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. The major use of chloroprene is in the production of artificial rubber (Neoprene™, duprene); polychloroprene elastomers. Chloroprene is extremely reactive, e.g., it can polymerize spontaneously at room temperatures; the process being catalyzed by light, peroxides, and other free-radical initiators. It can also react with oxygen to form polymeric peroxides and because of its instability, flammability, and toxicity, chloroprene has no end-product uses as such.

Incompatibilities: Can form unstable peroxides; chloroprene may polymerize on standing with fire or explosion hazard. Forms explosive mixture with air. Reacts with liquid or gaseous fluorine, alkali metals, metal powders, oxidizers, creating a fire or explosion hazard. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/90 mg/m^3 TWA [skin].

NIOSH REL: 1 ppm/3.6 mg/m^3 [15 min] Ceiling Concentration; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/36 mg/m^3 TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 1 ppm

PAC-2: 1 ppm

PAC-3: 300 ppm

DFG MAK: [skin] Carcinogen Category 2.

NIOSH IDLH: 300 ppm.

Australia: TWA 10 ppm (35 mg/m^3), [skin], 1993; Austria: MAK 10 ppm (36 mg/m^3), 1999; Belgium: TWA 10 ppm (36 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (3.6 mg/m^3), [skin], 1999; Finland: TWA 10 ppm (36 mg/m^3); STEL 20 ppm (72 mg/m^3), [skin], 1999; France: VME 10 ppm (36 mg/m^3), 1999; Hungary: TWA 10 mg/m^3; STEL 30 mg/m^3, 1993; the Netherlands: MAC-TGG 18 mg/m^3, [skin], 2003; Norway: TWA 1 ppm (3.6 mg/m^3), 1999; Poland: MAC (TWA) 2 mg/m^3; STEL, 16 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, 1993; Sweden: NGV 10 ppm (35 mg/m^3), KTV 15 ppm (60 mg/m^3), [skin], 1999; Switzerland: MAK-W 10 ppm (36 mg/m^3), KZG-W 20 ppm (72 mg/m^3), [skin], 1999; United Kingdom: TWA 10 ppm (37 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm [skin]. Russia set a MAC of 0.02 mg/m^3 in ambient air in residential areas on a momentary basis and 0.002 mg/m^3 on a daily average basis.[35] Several states have set guidelines or standards for chloroprene in ambient air[60] ranging from 2.5 μg/m^3 (Massachusetts) to 175 μg/m^3 (South Carolina) to 350 μg/m^3 (North Dakota) to 420−3500 μg/m^3 (North Carolina) to 800 μg/m^3 (Virginia) to 900 μg/m^3 (Connecticut) to 1070 μg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2 and analysis by gas chromatography. Use NIOSH Analytical Method #1002 or OSHA Analytical Method 112.[18]

Permissible Concentration in Water: A MAC in water bodies used for domestic purposes of 0.01 mg/L has been set by Russia.[35]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.12.

Routes of Entry: Inhalation of vapor, skin absorption, ingestion, and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Chloroprene irritates the eyes, skin, and respiratory tract. Chloroprene acts as a primary irritant on contact with skin, conjunctiva, and mucous membranes; and may result in dermatitis, conjunctivitis, and circumscribed necrosis of the cornea. Inhalation of high concentrations may result in dizziness, lightheadedness and unconciousness, anesthesia, and respiratory paralysis. Chloroprene may affect the central nervous system, kidneys, and liver. The LD_{50} oral rat is only 900 mg/kg (slightly toxic).

Long Term Exposure: Chronic exposure may produce damage to the lungs, nervous system, liver, kidneys, spleen, and myocardium. Because this is a mutagen, handle it as a possible cancer-causing substance—with extreme caution. It may also damage the developing fetus, cause spontaneous abortions, and interfere with sperm production. Repeated or prolonged contact with skin may cause dermatitis. Chronic exposure may cause alopecia. Chloroprene is a potential occupational carcinogen. Temporary hair loss has been reported during the manufacture of polymers.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: Preplacement and periodic examinations should include an evaluation of the skin, eyes, respiratory tract, and central nervous system. Liver and kidney function should be evaluated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton™ gloves, suits; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Engineering controls are recommended in NIOSH Criteria Document: 77-1210.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chloroprene you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Chloroprene must be stored to avoid contact with peroxides and other oxidizers, such as permanganates, nitrates, chlorates, and perchlorates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area at temperatures below 10°C/50°F. Sources of ignition, such as smoking and open flames, are prohibited where chloroprene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of chloroprene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of chloroprene. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Shipment of uninhibited chloroprene is FORBIDDEN. Inhibited chloroprene must bear the label of "FLAMMABLE LIQUID, POISON." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chloroprene is a flammable liquid. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. May react with itself without warning, blocking relief valves and leading to container explosions. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard: Occupational Exposure to Chloroprene*, NIOSH Document No. 77-210

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 47−49. New York: Van Nostrand Reinhold Co.
New Jersey Department of Health and Senior Services. (January 2004). *Hazardous Substances Fact Sheet: Chloroprene*. Trenton, NJ

3-Chloropropionitrile C:1010

Molecular Formula: C_3H_4ClN
Common Formula: $ClCH_2CH_2CN$
Synonyms: A13-28526; 1-Chloro-2-cyanoethane; 3-Chloropropanenitrile; 3-Chloropropanonitrile; β-Chloropropionitrile; 3-Chloropropionitrile; Propanenitrile, 3-chloro-; Propionitrile, 3-chloro-
CAS Registry Number: 542-76-7
RTECS® Number: UG1400000
UN/NA & ERG Number: UN3276 (Nitriles, toxic, n.o.s.)/151
EC Number: 208-827-0
Regulatory Authority and Advisory Bodies
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
US EPA Hazardous Waste Number (RCRA No.): P027.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
WGK (German Aquatic Hazard Class): No value assigned.
Description: 3-Chloropropionitrile is a combustible, colorless liquid with an acrid odor. Molecular weight = 89.53; Boiling point = 175−176°C (decomposes); Flash point = 76°C. Hazard Identification (based on NFPA-704 M Rating System): Flammability 2, Reactivity 1.
Potential Exposure: This material is used in pharmaceutical manufacture and in polymer synthesis.
Incompatibilities: Contact with strong oxidizers may cause a fire and explosion hazard.
Permissible Exposure Limits in Air
NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.
Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: 2.46 ppm
PAC-3: 12.5 ppm
Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.
Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.
Harmful Effects and Symptoms
Short Term Exposure: Symptoms of exposure include rapid and irregular breathing, anxiety, confusion, odor of bitter almonds (on breath or vomitus), nausea, vomiting (if oral exposure), irregular heartbeat, a feeling of tightness in the chest, bright pink coloration of the skin, sweating, protruding eyeballs, dilated pupils, unconsciousness followed by convulsions, involuntary urination and defecation, paralysis and respiratory arrest (heart will beat after breathing stops). Toxic effects are a result of systemic cyanide poisoning. Few poisons are more rapidly lethal. Average oral lethal dose for hydrogen cyanide is approximately 60−90 mg (corresponds to 200 mg of potassium cyanide). Cause of death is lack of oxygen to the body's cells (especially the brain and heart) as a result of the chemical inhibiting cell enzymes.
Medical Surveillance: Blood cyanide level.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.
Respirator Selection: *Up to 25 mg/m³:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-

pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where 3-chloropropionitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Stay upwind. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.1
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including cyanides, are produced in fire. Use alcohol foam extinguishers and water spray. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 3-Chloropropionitrile*. Washington, DC: Chemical Emergency Preparedness Program

o-Chlorostyrene C:1020

Molecular Formula: C_8H_7Cl

Common Formula: $ClC_6H_4CH{=}CH_2$

Synonyms: Benzene, 1-chloro-2-ethenyl-; 1-Chloro-2-ethenylbenzene; *o*-Chlorostyrene; 2-Chlorostyrene; Chlorostyrene

CAS Registry Number: 1331-28-8; 2039-87-4 (*o*-isomer)

RTECS$^{®}$ Number: WL4150000

UN/NA & ERG Number: UN1993 (Flammable liquids, n.o.s.)/128

EC Number: 218-026-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *o*-Chlorostyrene is a flammable, colorless liquid. Molecular weight = 138.60; Specific gravity (H_2O:1) = 1.1; Boiling point = 188.8°C; Freezing/Melting point = −63.3°C; Vapor pressure = 0.96 mmHg at 25°C; Flash point = 58.8°C. Practically insoluble in water.

Potential Exposure: In organic synthesis; in the preparation of specialty polymers.

Incompatibilities: Contact with elevated temperatures, strong oxidizers, strong bases, or acids may cause fire or explosion. May form peroxides; explosive polymerization may occur.

Permissible Exposure Limits in Air

o-isomer

OSHA PEL: None.

NIOSH REL: 50 ppm/285 mg/m^3 TWA; 75 ppm/428 mg/m^3 STEL.

ACGIH TLV®[1]: 50 ppm/283 mg/m^3 TWA; 75 ppm/425 mg/m^3 STEL.

No TEEL available.

Australia: TWA 50 ppm (285 mg/m^3); STEL 75 ppm (430 mg/m^3), 1993; Austria: MAK 50 ppm (285 mg/m^3), 1999; Belgium: TWA 50 ppm; STEL 75 ppm, 1993; France: VME 50 ppm (285 mg/m^3), 1999; the Netherlands: MAC-TGG 285 mg/m^3, 2003; Norway: TWA 25 ppm (140 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (215 mg/m^3), KZG-W 100 ppm (430 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 75 ppm. Several states have set guidelines or standards for chlorostyrene in ambient air[60] ranging from 2.85−4.30 mg/m^3 (North Dakota) to 4.8 mg/m^3 (Virginia) to 5.7 mg/m^3 (Connecticut) to 6.79 mg/m^3 (Nevada).

Determination in Air: No method listed by NIOSH.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.6.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *o*-Chlorostyrene can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes and skin. LD_{50} (50% kill) = 3810 μL/kg, oral, rat.

Long Term Exposure: Repeated exposures may damage the liver and kidneys. Animal studies show hematuria (blood in the urine), proteinuria, acidosis, enlarged liver, jaundice.

Points of Attack: Eyes, skin, liver, kidneys, central nervous system, peripheral nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with *o*-chlorostyrene you should be trained on its proper handling and storage. Before entering confined space where *o*-chlorostyrene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chlorostyrene is not specifically cited by DOT[19] in its Performance-Oriented Packaging Standards. Based on its flash point, it may be classified as Flammable liquids, n.o.s. (UN 1993). In this case it falls in Hazard Class 3, Packing Group III. The label requirement would be "FLAMMABLE LIQUID."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. The heat of fire produces poisonous gases, including hydrogen chloride, chlorine, and phosgene. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: o-Chlorostyrene*. Trenton, NJ

Chlorosulfonic acid C:1030

Molecular Formula: $ClHO_3S$

Synonyms: Acido clorosulfonico (Spanish); Chlorosulfuric acid; Chlorosulphonic Acid*;* *p*-Chloro-*o*-toluidine hydrochloride; 4-Chloro-*o*-toluidine, hydrochloride; Monochlorosulfuric acid; Sulfonic acid, monochloride; Sulfuric chlorohydrin

CAS Registry Number: 7790-94-5

RTECS® Number: FX5730000

UN/NA & ERG Number: UN1754/137

EC Number: 232-234-6 [*Annex I Index No.:* 016-017-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R35; R37; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chlorosulfonic acid is a highly corrosive, colorless to yellow, slightly cloudy, fuming liquid with a sharp odor. Molecular weight = 115.52; Boiling point = 155°C; Freezing/Melting point = − 80°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2₩. Reactive with water.

Potential Exposure: Used to make pesticides, detergents, pharmaceuticals, dyes, resins, sulfonated oils; intermediate for dyes and pharmaceuticals; and pesticides. Although no military designation has been assigned, chlorosulfonic acid may have been used as a choking/pulmonary agent.

Incompatibilities: Explosively reacts with water, forming sulfuric and hydrochloric acid and dense fumes. Dangerously reactive, avoid contact with all other material. Strong oxidizer and strong acid; violent reaction with bases, reducing agents; combustibles, acids (especially sulfuric acid), alcohols, diphenyl ether, finely divided metals, silver nitrate. Contact with phosphorous may cause fire and explosions. Forms explosive material with ethyl alcohol. Attacks many metals; reaction with steel drums forms explosive hydrogen gas, which must be periodically relieved.

Permissible Exposure Limits in Air

AIHA WEEL: 0.1 mg/m^3, Ceiling.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 mg/m^3.

PAC-1: **0.1** mg/m^3

PAC-2: **4.4** mg/m^3

PAC-3: **25** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

United Kingdom: 1 mg/m^3 TWA, 2000. Due to its highly corrosive nature, all contact with this material should be reduced to the lowest possible level.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Skin or eye contact can cause severe irritation, burns, and permanent eye damage. Irritates the respiratory tract causing coughing, wheezing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} (50% kill): 4779 mg/m^3/4 h, inhalation, rat.

Long Term Exposure: Can cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex™ and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—White Stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorosulfonic acid you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, acids, bases, alcohols, metal powders, and organic combustible materials. It is preferable to store this chemical under nitrogen. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This chemical requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." Chlorosulfonic acid is in DOT/UN Hazard Class 8 and Packing Group I.[19,20] A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Chlorosulfonic acid, used as a weapon—not listed in current DOT tables.

UN1754 Chlorosulfonic acid.

when spilled on land

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

when spilled in water

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.8/2.8

Fire Extinguishing: Chlorosulfonic acid does not burn but can readily ignite combustible materials on contact and will increase fire activity. Poisonous gases, including hydrogen chloride and sulfur oxides, are produced in fire. Decomposes explosively on contact with water. Use dry chemical, carbon dioxide, or foam extinguishers. *Do not use water*. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (1998). *Hazardous Substances Fact Sheet: Chlorosulfonic Acid*. Trenton, NJ

Chlorothalonil C:1040

Molecular Formula: $C_8Cl_4N_2$

Common Formula: $C_6Cl_4(CN)_2$

Synonyms: BB Chlorothalonil; 1,3-Benzenedicarbonitrile,2,4,6,6-tetrachloro-; Bombardier; Bravo; Bravo 500; Bravo 6F; Bravo-W-75; Chiltern Ole; Chlorothalonil; Chlorthalonil (German); Contact 75; DAC 2787; Daconil; Daconil 2787 fungicide; Daconil 2787 W; Daconil F; Daconil M; Daconil Turf; Dacosoil; 1,3-Dicyanotetrachlorobenzene; Exotherm; Exotherm termil; Forturf; Grouticide 75; Impact Excel; Isophthalonitrile, tetrachloro; Jupital; Metatetrachlorophthalodinitrile; NCI-C00102; Nopcocide; Nopcocide 54DB; Nopcocide *n*-96; Nopcocide *n*-40-D; Nopcocide *n*-96-S; Nuocide; Power chlorothalonil 50; Repulse; Siclor; Sipcam UK Rover 5000; Sweep; Ter-Mil; 2,4,5,6-Tetrachloro-1,3-benzenedicarbonitrile; 2,4,5,6-Tetrachloro-1,3-dicyanobenzene; Tetrachloroisophthalonitrile; *m*-Tetrachlorophthalodinitrile; Tetrachlorophthalodinitrile, *m*-; Thalonil; TPN; TPN (Pesticide); Tripart Faber; Tripart Ultrafaber

CAS Registry Number: 1897-45-6

RTECS® Number: NT2600000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 217-588-1 [*Annex I Index No.:* 608-014-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R26; R37; R40; R41; R43; R50/53; Safety phrases: S1/2; S28; S36/37/39; S45; S60; S61.

As a cyanide compound

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures.

California Proposition 65 Chemical: Cancer 1/1/89.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26; R37; R40; R41; R43; R50/53; Safety phrases: S1/2; S28; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chlorothalonil is a combustible, white, odorless, crystalline solid. Molecular weight = 265.9; Specific gravity (H_2O:1) = 1.8; Boiling point = 350°C; Freezing/Melting point = 260°C; Vapor pressure = 1×10^{-3} mmHg at 20°C. Based on the NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Chlorothalonil is a broad-spectrum fungicide; used as fungicide in coatings; caulk, wood preservative, and antifouling systems. Therefore, people involved in its manufacture, formulation, and application can be exposed.

Incompatibilities: Contact with strong oxidizers may cause a fire and explosion hazard. Thermal decomposition may include fumes of hydrogen cyanide.

Permissible Exposure Limits in Air

NIOSH REL: Danger of sensitization of the skin; Carcinogen level 3B.

Protective Action Criteria (PAC)
TEEL-0: 3 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 30 mg/m^3

DFG MAK: Danger of sensitization of the skin; Carcinogen level 3B.

Austria: Suspected: carcinogen, 1999.

Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.

Permissible Concentration in Water: A 10-day health advisory for a 10-kg child has been calculated by EPA to be 0.25 mg/L. A long-term health advisory for a 10-kg child was calculated to be 0.15 mg/L and for a 70-kg adult was calculated to be 0.525 mg/L. The estimated excess cancer risk associated with lifetime exposure to drinking water containing 0.525 mg/L of chlorothalonil is 3.5×10^{-4}.

Determination in Water: Analysis of chlorothalonil is by a gas chromatographic (GC) method applicable to the determination of certain chlorinated pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using an electron capture detector. The method detection limit has not been determined for chlorothalonil, but it is estimated that the detection limits for analytes included in this method are in the range of 0.01−0.1 μg/L. Octanol−water coefficient: Log $K_{ow} = 4.4$. Fish Tox = 4.41591000 ppb MATC (Maximum Acceptable Toxicant Concentration) (HIGH).

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Johnson et al. (1983) reported that chlorothalonil exposure resulted in contact dermatitis in 14 of 20 workers involved in woodenware preservation. The wood preservative used by the workers consisted mainly of "white spirit," with 0.5% chlorothalonil as a fungicide. Workers exhibited erythema and edema of the eyelids, especially the upper eyelids, and eruptions on the wrist and forearms. Results of patch test conducted with 0.1% chlorothalonil in acetone were positive in 7 of 14 subjects. Reactions ranged from a few erythematous papules to marked papular erythema with a brownish hue without infiltration.

Wilson et al. (1985) gave chlorothalonil (98.1% pure with less than 0.03% hexachlorobenzene) to Fischer 344 rats (60/sex/dose) in their diet at dose levels of 0, 40, 80, or 175 mg/kg/day. Males were treated for 116 weeks, while females received the chemical for 129 weeks. Survival among the various groups was comparable. In both sexes, at the high dose level, there were significant decreases in body weights. In addition, there were also significant increases in blood urea nitrogen and creatinine, while there were decreases in serum glucose and albumin levels. In both sexes, there were dose-dependent increases in kidney carcinomas and adenomas at doses above 40 mg/kg/day. In the high-dose females, there was also a significant increase in stomach papillomas. The data show that, in the Fischer 344 rat, chlorothalonil is a carcinogen.

The oral LD_{50} (50% kill) rat is 10 g/kg. LC_{50} (50% kill) = 310 mg/m^3/1 h, inhalation, rat.

Short Term Exposure: Irritates the eyes, skin, respiratory tract. Inhalation can cause coughing, phlegm, and/or tightness in the chest.

Long Term Exposure: Repeated or prolonged contact with skin may cause nose bleeding, skin sensitization and dermatitis with skin rash. May affect the kidneys and gastrointestinal tract. This chemical causes cancer of the kidneys in animals. Human Tox = 45.69190 ppb CHCL (Chronic Human Carcinogen Level) (INTERMEDIATE).

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: Complete blood count (CBC). Lung function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20−30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *Where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorothalonil you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorothalonil is not cited specifically in DOT's Performance-Oriented Packaging Standards.[19] However, hazardous pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 1380.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen cyanide, hydrogen chloride, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit operating at 850°C equipped with off-gas scrubbing equipment.

References

Johnson, I.R., 2000a. Chlorothalonil technical: Acute dermal toxicity study in rats. Central Toxicology Laboratory Report ID CTL/CR3537. GB Biosciences Corporation (affiliated with zeneca Agrochemicals). DPR Vol. 275−388 186262

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chlorothalonil*. Trenton, NJ

US Environmental Protection Agency. (August 1987). *Chemical Hazard Information Profile: Chlorothalonil*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Wilson, N.; Killeen, J., Ignatoski, J. (1985) A Tumorigenicity Study of Technical Chlorothalonil in Rats: Document No. 099-5TX-80-0234-008. Unpublished study prepared by SDS Biotech Corp. 2369p. MRID 00146945

o-Chlorotoluene C:1050

Molecular Formula: C_7H_7Cl

Common Formula: $CH_3C_6H_4Cl$

Synonyms: Benzene, 1-chloro-2-methyl-; 2-Chloro-1-methylbenzene; 2-Chlorotoluene; 1-Methyl-2-chlorobenzene; 2-Methylchlorobenzene; Toluene, *o*-chloro-; *o*-Tolylchloride

meta-isomer

1-Chloro-3-methylbenzene; 3-Chloro-1-methylbenzene; 3-Chlorotoluene; *m*-Methylchlorobenzene; 1-Methyl-3-chlorobenzene; 3-Methylchlorobenzene; *m*-Tolyl chloride; *meta*-Chlorotoluene; *meta*-Tolyl chloride; Toluene, *m*-chloro-

para-isomer

1-Chloro-4-methylbenzene; 4-Chloro-1-methylbenzene; 4-Chlorotoluene; *p*-Methylchlorobenzene; 1-Methyl-4-chlorobenzene; 4-Methylchlorobenzene; *p*-Tolyl chloride; *para*-Chlorotoluene; *para*-Tolyl chloride; Toluene, *p*-chloro-

CAS Registry Number: 95-49-8;108-41-8 (3-Chlorotoluene); 106-43-4 (4-Chlorotoluene)

RTECS® Number: XS9000000

UN/NA & ERG Number: UN2238 (Chlorotoluenes)/129

EC Number: 202-424-3 (2-, 3-, and 4-chlorotoluene) [*Annex I Index No.:* 602-040-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: (2-, 3-, and 4-chlorotoluene) Hazard Symbol: Xn, N; Risk phrases: R20; R51/53; Safety phrases: S2; S24/25; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *o*-Chlorotoluene is a flammable, colorless liquid with an aromatic odor. The odor threshold = 0.32 ppm. Molecular weight = 126.59; Boiling point = 160°C; Freezing/Melting point = − 35°C; Vapor pressure = 4 mmHg at 25°C; Flash point = 52°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Practically insoluble in water; solubility = 0.009% at 25°C.

Potential Exposure: Compound Description: Primary Irritant. *o*-Chlorotoluene is widely used as a solvent and intermediate in the synthesis of dyes, synthetic rubber; pharmaceuticals; and other organic chemicals. Used as an insecticide, bactericide.

Incompatibilities: Incompatible with acids, alkalis, oxidizers, reducing materials, water.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 50 ppm/250 mg/m^3 TWA; 75 ppm/375 mg/m^3 STEL.

ACGIH TLV®[1]: 50 ppm TWA.

Protective Action Criteria (PAC)
TEEL-0: 50 ppm
PAC-1: 75 ppm
PAC-2: 400 ppm
PAC-3: 400 ppm

This chemical can be absorbed through the skin, thereby increasing exposure.

Australia: TWA 50 ppm (250 mg/m^3); STEL 75 ppm, 1993; Austria: MAK 50 ppm (250 mg/m^3), 1999; Belgium: TWA 50 ppm (259 mg/m^3); STEL 75 ppm (388 mg/m^3), 1993; Denmark: TWA 50 ppm (285 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (260 mg/m^3); STEL 75 ppm (390 mg/m^3), [skin], 1999; France: VME 50 ppm (250 mg/m^3), 1999; Norway: TWA 25 ppm (125 mg/m^3), 1999; the Netherlands: MAC-TGG 250 mg/m^3, [skin], 2003; Russia: STEL 10 mg/m^3, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 50 ppm (250 mg/m^3), [skin], 1999; United Kingdom: TWA 50 ppm (264 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, KORE, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for chlorotoluene in ambient air[60] ranging from 2.5−3.75 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 5.0 mg/m^3 (Connecticut) to 5.95 mg/m^3 (Nevada).

Determination in Air: No methods listed by NIOSH or OSHA.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 3450 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the eyes and skin. Inhalation can irritate the respiratory tract, causing coughing and/or shortness of breath. High exposure can cause dizziness, loss of coordination, convulsions, and coma. Vasodilatation, labored respiration, and narcosis have been observed in test animals.

Long Term Exposure: May affect the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys. Prolonged or repeated contact may cause dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Kidney function tests. Examination by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Barricade™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full face-piece powered-air-purifying respirators.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with *o*-chlorotoluene you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chlorotoluenes must carry a "FLAMMABLE LIQUID" label. They fall in Hazard Class 3 and Packing Group II.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: o-Chlorotoluene*. Trenton, NJ

Chloroxuron C:1060

Molecular Formula: $C_{15}H_{15}ClN_2O_2$

Common Formula: $(CH_3)_2NCONHC_6H_4OC_6H_4Cl$

Synonyms: C 1983; *N*′-[4-(4-Chlorophenoxy)phenyl]-*N*,*N*-dimethylurea; 3-[*p*-(*p*-Chlorophenoxy)phenyl-1,1]-dimethylurea; 3-[4-(4-Chlorophenoxy)phenyl]-1,1-dimethylurea; Chloroxifenidum; Ciba 1983; Cloroxuron (Spanish); Norex; Tenoran®; Urea, 3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethyl-; Urea, *N*′-[4-(4-chlorophenoxy)phenyl]-*N*,*N*-dimethyl-

CAS Registry Number: 1982-47-4

RTECS® Number: YS6125000

UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151

EC Number: 217-843-7

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chloroxuron is a combustible, colorless crystalline solid. Molecular weight = 290.77; Freezing/Melting point = 15.5°C; Vapor pressure = 3.9×10^{-9} mmHg at 20°C. Practically insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of chloroxuron for use as a selective pre- and early postemergency herbicide in soybeans, strawberries, various vegetable crops, and ornamentals. It is a root- and foliage-absorbed herbicide selective in leek, celery, onion, carrot, and strawberry.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

Determination in Water: Octanol–water coefficient: Log K_{ow} = 3.98. Fish Tox: 49.75254000 ppb MATC (INTERMEDIATE).

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Slightly irritating to eyes and skin. The LD_{50} oral (dog) is 10 mg/kg (highly toxic). The LD_{50} oral (rat) is 3700 mg/kg. Chloroxuron is stated to be highly toxic to humans by ingestion and under certain conditions, it can form carcinogenic dimethylnitrosamine. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Long Term Exposure: No data available. Human Tox: 35.00000 ppb; Health Advisory (INTERMEDIATE).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing

material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloroxuron you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Phenyl urea pesticides, solid, toxic, require a label of "POISONOUS/TOXIC MATERIALS." This compound falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 3000.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. Poisonous gases are produced in fire, including oxides of nitrogen and carbon, and corrosive fumes of chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit with effluent gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Chloroxuron*. Washington, DC: Chemical Emergency Preparedness Program

Chlorpyrifos C:1070

Molecular Formula: $C_9H_{11}Cl_3NO_3PS$

Synonyms: Brodan; α-Chlorpyrifos 48EC (a); Chlorpyrifos-ethyl; Clorpirifos (Spanish); Detmol U.A.; *O*,*O*-Diaethyl-*O*-3,5,6-trichlor-2-pyridylmonothiophosphat (German); *O*,*O*-Diethyl; *O*,*O*-Dimethyl *O*-(3,5,6-trichloro-2-pyridinyl) phosphorothioate; Dowco® 179; Dursban®; Dursban® 4; Dursban® 5G; Dursban® F; EF 121; ENT 27311; Eradex; Global Crawling insect bait; Lorsban®; Murphy Super Root Guard; Phosphorothioic acid, *O*,*O*-diethyl *O*-(3,5,6-trichloro-2-pyridinyl) ester; 2-Pyridinol, 3,5,6-trichloro-, *O*-ester with *O*,*O*-diethyl phosphorothioate; Pyrinex; Spannit®; Talon®; *O*-3,5,6-Trichloro-2-pyridyl phosphorothioate; Twinspan®

CAS Registry Number: 2921-88-2

RTECS® Number: TF6300000

UN/NA & ERG Number: (organophosphorus pesticides, solid, toxic)/152

EC Number: 220-864-4 [*Annex I Index No.:* 015-084-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

Canada, Drinking Water Quality MAC = 0.09 mg/L.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R50/53; Safety phrases: S1/2; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chlorpyrifos is a colorless crystalline compound (liquid at 43°C and commercial formulations may be combined with combustible liquids) with a mild mercaptan odor. The odor is also described as like natural gas. Boiling point = (decomposes) 160°C; Molecular weight = 350.59; Specific gravity (H_2O:1) = 1.40 (liquid at 43°C); Freezing/Melting point = 42.2°C; Vapor pressure = 0.00003 mmHg at 25°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Above 130°C this chemical may undergo violent exothermic decomposition. The substance decomposes on heating at approximately 160°C and on burning, producing toxic and corrosive fumes including hydrogen chloride, nitrogen oxides, phosphorous oxides, sulfur oxides. Reacts with strong acids, strong bases, causing hydrolysis. Attacks copper and brass. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.2 mg/m^3 TWA; 0.6 mg/m^3 STEL.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued. (2000).

Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 20 mg/m^3

Australia: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; Belgium: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; Denmark: TWA 0.2 mg/m^3, [skin], 1999; Finland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Norway: TWA 0.2 mg/m^3, 1999; Poland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, 1999; United Kingdom: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for chlorpyrifos in ambient air[60] ranging from 2−6 μg/m^3 (North Dakota) to 3.0 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides, or OSHA Analytical Method 62.

Permissible Concentration in Water: Mexico[35] has set a limit of 3.0 μg/L in coastal waters and 0.03 mg/L in estuaries. Russia set a MAC of 5.0 μg/L in water bodies used for fishery purposes.

Determination in Water: Fish Tox = 0.3666 ppb MATC (Low); Octanol−water coefficient: Log $K_{ow} = 4.97$.

Routes of Entry: Skin absorption, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: May cause eye and skin irritation. Cholinesterase inhibitor. Exposure at high levels may result in death. The effects may be delayed. The LD_{50} rat is 82 mg/kg (moderately toxic). Chlorpyrifos can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic organophosphate chemical. Exposure can cause rapid severe poisoning with headache, sweating, nausea and vomiting, diarrhea, loss of coordination, and possible death.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Chlorpyrifos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 20 ppb; Health Advisory (INTERMEDIATE).

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: *Clothing:* Avoid skin contact with chlorpyrifos. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures over *0.2 mg/m³*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a pesticide cartridge. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorpyrifos you should be trained on its proper handling and storage. Chlorpyrifos must be stored to avoid contact with strong bases, or acids, or acid fumes since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat.

Shipping: Organophosphorus pesticides, solid, toxic n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Absorb liquid containing chlorpyrifos in vermiculite, dry sand, earth, or similar material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 6070.

Fire Extinguishing: Chlorpyrifos may burn but does not readily ignite. Poisonous gases are produced in fire, including hydrogen chloride, nitrogen oxides, phosphorous oxides, sulfur oxides, and organic sulfides. Use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Heat above 130°C may cause violent exothermic reaction. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is 50% hydrolyzed in aqueous MeOH solution at pH 6 in 1930 days; and in 7.2 days at pH 9.96. Spray mixtures of <1% concentration are destroyed with an excess of 5.25% sodium hypochlorite in <30 min at 100°C; and in 24 h at 30°C. Concentrated (61.5%) mixtures are essentially destroyed by treatment with 100:1 volumes of the above sodium hypochlorite solution and steam in 10 min.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Chlorpyrifos*. Trenton, NJ

Chlorthiophos C:1080

Molecular Formula: $C_{11}H_{15}Cl_2O_3PS_2$

Synonyms: Celamerck S-2957; Cela S-2957; Celathion; CM S 2957; *O*-[Dichloro(methylthio)phenyl] *O*,*O*-diethyl phosphorothioate (3 isomers); *O*,*O*-[Diethyl-*O*-2,4,5-dichloro(methylthio)phenyl]thionophosphate; ENT 27,635; NSC 195164; OMS 1342

CAS Registry Number: 21923-23-9

RTECS® Number: TF1590000

UN/NA & ERG Number: UN3018 (organophosphorus pesticides, liquid, toxic)/152

EC Number: 244-663-6 [015-115-00-1]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture: Germany, Malaysia) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chlorthiophos is a yellowish-brown liquid. Boiling point = 153−158°C at 13 mmHg, and crystallizes at less than 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide and acaricide (now discontinued in some cases).

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.35 mg/m^3
PAC-1: 1 mg/m^3
PAC-2: 7.8 mg/m^3
PAC-3: 7.8 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: The LD_{50} oral (rabbit) is 20 mg/kg, which is in the highly toxic class.

Symptoms of Chlorthiophos exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Chlorthiophos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: *Clothing:* Avoid skin contact with this chemical. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection: Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a pesticide cartridge. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chlorthiophos you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. have a DOT label requirement of "POISONOUS/TOXIC MATERIALS." Chlorthiophos falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Chlorthiophos*. Washington, DC: Chemical Emergency Preparedness Program

Choking/Lung/Pulmonary agents

The major chemical warfare agents in this category are listed below along with their record number for quick access.

Ammonia see A:0950
Bromine see B:0660
Chlorine, agent CL see C:0670
Chlorosulfonic acid see C:1030
Diphosgene, agent DP see P:0550
Hydrogen chloride see H:0430
Methyl bromide see M:0720
Methyl isocyanate see M:1010
Nitric oxide Agent NO see N:0350
Osmium tetroxide see O:0140
Phosgene, agent CG see P:0550
Red phosphorous, agent RP see P:0610
Sulfur trioxide see S:0810
Sulfuryl fluoride see S:0820
Titanium tetrachloride, agent FM see T:0580
Zinc oxide, agent HC see Z:0140

Chromic acetate C:1090

Molecular Formula: $C_6H_9CrO_6$

Common Formula: $Cr(C_2H_3O_2)_3$

Synonyms: Acetato cromico (Spanish); Acetic acid, chromium(3+) salt; Chromic acetate(III); Chromium acetate; Chromium(III) acetate; Chromium triacetate

CAS Registry Number: 1066-30-4

RTECS® Number: AG2975000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 213-909-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR 401.15 Section 307 Toxic Pollutants.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chromic acetate is a gray-green powder or blue-green pasty mass. Molecular weight = 229.15 (anhydrous), 247.16 (hydrate); Specific gravity (H_2O:1) = 1.30; Boiling point = 100°C (aqueous solution). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Chromic acetate is used to fix certain textile dyes, to harden photographic emulsions in tanning, and as a catalyst.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause irritation of the eyes, nose, and throat. Eye and skin contact may cause irritation, redness, and tearing. Skin allergy sometimes occurs, with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms.

Long Term Exposure: Repeated or prolonged skin contact may cause skin sensitization, irritation, and dermatitis. Some chromium compounds can cause a sore or hole in the septum dividing the nose. Chromic acetate is a carcinogen—handle with extreme caution. May cause lung or throat cancer; birth defects; miscarriage; skin allergy with redness, itching, and rash.

Points of Attack: Eyes, skin.

Medical Surveillance: If illness occurs or overexposure is suspected, medical attention is recommended. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chromic acetate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where Chromic acetate is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic acetate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilute and stir in excess soda ash. Let stand, neutralize liquid and flush to sewer. Dispose of sludge in landfill.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 43–45 (1981) and 5, No. 6, 43–45

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chromic Acetate*. Trenton, NJ

Chromic(VI) acid C:1100

Molecular Formula: $H_2Cr_2O_7$

Common Formula: H_2CrO_4 ($CrO_3 \cdot H_2O$)

Synonyms: Acide chromique (French); Acido cromico (Spanish); Chromic(6+) acid; Chromic(VI) acid; Chromic anhydride; Chromium anhydride; Chromium trioxide

ester: Acido cromico (Spanish); Chromic(VI) acid; Chromic acid ester; Chromic acid, solid; Chromic acid, solution, chromic anhydride; Chromic trioxide; Chromium oxide; Chromium(VI) oxidemonochromium oxide; Chromium trioxide; Chromium(6 +) trioxide; Chromium trioxide, anhydrous; Monochromium trioxide; Puratronic chromium trioxide

CAS Registry Number: 7738-94-5; 11115-74-5 (ester)

RTECS® Number: GB2450000; GB6650000

UN/NA & ERG Number: UN1463 (solid)/141; UN1755 (solution)/154

EC Number: 231-801-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium VI compounds: 0.1%.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds (ester).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants (ester).

Reportable Quantity (RQ): 10 lb (4.54 kg) (ester).

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chromic acid is dark purplish-red odorless flakes or crystalline powder. Molecular weight = 100.00 mg [CrO_3]; Boiling point = 250°C (decomposes); Freezing/Melting point = 197°C (decomposes). Often used in aqueous solution. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0, Oxidizer. Highly soluble in water. It may also be formulated as $H_2CrO_4(CrO_3 \cdot H_2O)$.

Potential Exposure: Chromic acid is used in chromium plating, medicine, ceramic glazers, and paints.

Incompatibilities: A strong oxidizer. Aqueous solution is strongly acidic. Reacts with acetic acid, acetic anhydride, acetone, anthracene, chromous sulfide, diethyl ether, dimethyl formamide, ethanol, hydrogen sulfide, methanol, naphthalene, camphor, glycerol, potassium ferricyanide, pyridine, turpentine, combustibles, organics, and other easily oxidized materials (such as paper, wood, sulfur, aluminum, and plastics). Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

As chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

Protective Action Criteria (PAC)

includes ester

TEEL-0: 0.113 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 1.18 mg/m^3

PAC-3: 34 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; Carcinogen.

Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Several states have set guidelines or standards for chromic acid in ambient air[60] ranging from zero (North Carolina) to 0.001 μg/m^3 (Massachusetts) to 1.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* Hexavalent chromium 50 μg/L according to EPA.[6]

US EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption, or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Chromic acid can affect you when breathed in. It can also pass into inner layers of the skin. Chromic acid should be handled as a carcinogen with extreme caution. *Inhalation:* May be poisonous. Dust may cause severe irritation to the nose, throat, and lungs, causing coughing; shortness of breath. May cause flu-like symptoms including chills, muscle ache, headache, fever. High exposure may cause nausea, salivation, vomiting, cramps, diarrhea, chest pains, cough, a buildup of fluids in the lungs (pulmonary edema) and possible death. Pulmonary edema is a medical emergency and may be delayed from 1 to 2 days following exposure. *Skin:* May cause severe irritation and thermal and acid burns, especially if skin is wet. *Eyes:* May cause severe irritation, burns, pain, and possible blindness. *Swallowed:* May be poisonous. May cause severe burns of the mouth, throat, and stomach; vomiting; watery or bloody diarrhea. Damage to kidneys and liver; collapse; and convulsions can result.

Long Term Exposure: May cause lung cancer, birth defects, miscarriage, kidney and liver damage, skin allergy and ulcers, injury to the nasal septum (may cause a hole in the nose), discoloration of teeth, bronchitis, lung allergy.

Points of Attack: Blood, respiratory system, liver, kidneys, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests; pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: exam of the mouth and larynx. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Specific engineering controls are recommended in NIOSH Criteria Documents: #73-11021 (chromic acid) and #76-129 [chromium(VI)].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. (Chromic acid) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chromic acid you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetone, combustible, organic or other readily oxidizable material (such as paper, wood, sulfur, aluminum, and plastics). Sources of ignition, such as smoking and open flames, are prohibited where Chromic acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A storage hazard; sealed containers may burst from carbon dioxide release. Store in tightly closed containers in a dry, cool, well-ventilated place with nonwood floors. Keep away from combustible materials; alcohols; and acetone. Where possible, automatically transfer chromic acid from drums or other storage containers to process containers. Containers may explode in fire. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chromic acid, solid must be labeled "OXIDIZER, CORROSIVE." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, soda ash, CO_2, water spray, or foam extinguishers. Chromic acid may ignite other combustible materials, such as paper and wood. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chemical reduction to chromium(III) can be followed by landfill disposal of the sludge.[22]

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 2, 21−22 (1982) and 3, No. 3, 60−62

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Chromic Acid*. Trenton, NJ

Chromic chloride C:1110

Molecular Formula: Cl_3Cr
Common Formula: $CrCl_3$
Synonyms: Chromium chloride; Chromium(III) chloride (1:3); Chromium chloride (III) anhydrous; Chromium chloride, anhydrous; Chromium sesquichloride; Chromium trichloride; C.I. 77295; Cloruro cromico (Spanish); Puratronic chromium chloride; Trichlorochromium
CAS Registry Number: 10025-73-7
RTECS® Number: GB5425000
UN/NA & ERG Number: UN3077/171
EC Number: 233-038-3
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA *(insoluble salts)*: Not Classifiable as to human carcinogenicity; Cannot be Determined.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1/10,000 lb (0.454/4540 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Chromic chloride is a highly corrosive, blue or greenish to black crystalline solid. Molecular weight = 158.35; Boiling point (decomposes) = 1300°C; Freezing/Melting point = 1152°C (dissociates above 1300°C). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water (reaction).
Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector. Chromic chloride is used for production of solutions of basic chlorides and as a catalyst for polymerization of olefins and other organic reactions; in chromizing; in the manufacture of chromium metal and compounds; as a textile mordant; in tanning; in corrosion inhibitors; and as a waterproofing agent. A nutritional supplement.
Incompatibilities: Reacts with water and strong oxidizers. Contact with strong acids or acid fumes may produce highly toxic chloride fumes. May attack certain steels, causing pitting attack and stress corrosion.
Permissible Exposure Limits in Air
OSHA PEL: 0.5 mg[Cr]/m^3 TWA.
NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.
ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 25 mg Cr(III)/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.35 mg/m^3
PAC-1: 1 mg/m^3
PAC-2: 7.8 mg/m^3
PAC-3: 7.8 mg/m^3
DFG MAK: [skin] danger of skin sensitization.
Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]
Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L.[6]
US EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62]
Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water.
The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.
Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Chromic chloride is highly corrosive. Irritates and burns the eyes and skin. Inhalation can irritate the respiratory tract, causing coughing and wheezing. It displays high dermal toxicity and moderate oral toxicity. The oral toxicity (rat) is given as 1870 mg/kg.
Long Term Exposure: It causes histologic fibrosis of the lungs. Signs for exposure to chromic chloride as for other chromium compounds include dermatitis; ulcers of the upper respiratory tract and inflammation of the larynx,

lungs, gastrointestinal tract, and nasal passages. Repeated skin contact can cause sensitization and dermatitis.

Points of Attack: Eyes, skin, lungs.

Medical Surveillance: Examination by a qualified allergist. Lung function tests. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m*^{3}: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m*^{3}*:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m*^{3}*:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m*^{3}*:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents and water.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Do not touch spilled material. Avoid inhalation. Wear full protective clothing and proper respiratory protection. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic chloride itself does not burn. It reacts with water, so use in flooding quantities only. Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate as chromium hydroxide. Dewater the sludge and dispose of the compacted sludge in single-purpose dumps.[22]

Reference

US Environmental Protection Agency. (September 1998). *Chemical Hazard Information Profile: Chromic Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Chromic sulfate C:1120

Molecular Formula: $Cr_2O_{12}S_3$

Common Formula: $Cr_2(SO_4)_3$

Synonyms: Chromic sulphate; Chromium sulfate; Chromium (3+) sulfate; Chromium(III) sulfate; Chromium sulphate; C. I.77305; Dichromium sulfate; Dichromium sulphate; Dichromium trisulfate; Dichromium trisulphate; Sulfato cromico (Spanish); Sulfuric acid, chromium(3 +) salt

CAS Registry Number: 10101-53-8

RTECS® Number: GB7200000

UN/NA & ERG Number: UN3077/171

EC Number: 233-253-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (insoluble salts): Not Classifiable as to human carcinogenicity; Cannot be Determined.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Chromic sulfate is a peach-colored solid or red to violet, odorless powder. Molecular weight = 392.18. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: This compound is used in green paints, inks, dyes, and ceramics.

Incompatibilities: This chemical has weak oxidizing and reducing properties. Keep away from strong oxidizers (perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine). When heated this chemical decomposes to chromic acid.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1.89 mg/m^3

PAC-1: 5.66 mg/m^3

PAC-2: 9.43 mg/m^3

PAC-3: 94.3 mg/m^3

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation of dust or mist, skin, contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chromic sulfate can affect you when breathed in. Skin contact may cause irritation, especially if repeated or prolonged. Skin allergy sometimes occurs with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms. Eye contact may cause irritation and burns.

Long Term Exposure: May cause skin allergy. Some chromium compounds can cause an ulcer in the septum separating the nose. It is uncertain whether this chemical has this effect.

Points of Attack: Eyes, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with chromic sulfate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and sources of heat.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic sulfate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return to supplier where possible. Where this is not practical, the material should be encapsulated and buried in a specially-designated chemical landfill.

References

New Jersey Department of Health and Senior Services. (January 1996). *Hazardous Substances Fact Sheet: Chromic Sulfate*. Trenton, NJ

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 62−65

Chromium C:1130

Molecular Formula: Cr

Synonyms: Chrome; Chromium, elemental; Chromium metal; Cromo (Spanish); Elemental chromium

CAS Registry Number: 7440-47-3 (elemental)

RTECS® Number: GB4200000 (elemental)

DOT ID and ERG Number: UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-157-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (metallic chromium and chromium [III] compounds) Human Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3; [chromium(VI)], *carcinogenic to humans*, Group 1, 1997; NTP: Known to be a human carcinogen; EPA *(inhalation)*: Human Carcinogen; Known human carcinogen; EPA *(oral)*: Cannot be Determined; NTP: Known to be a human carcinogen.

US EPA Genetox Program, Inconclusive: Carcinogenicity—mouse/rat.

Banned or Severely Restricted (many countries, many categories) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): D007.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 2.77; Nonwastewater (mg/kg), 0.86 as chromium, total dust.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (70); 7190 (500); 7191 (10).

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List; Drinking Water Quality, 0.05 mg/L MAC.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Chromium may exist in one of three valence states in compounds, [II (+2)], [III (+3)], and [VI (+6)]. The most stable oxidation state is trivalent chromium; Hexavalent chromium is a less stable state. Chromium (element) blue-white to steel-gray, lustrous, brittle, hard, odorless solid. Elemental: Molecular weight = 52.00; Specific gravity (H_2O:1) = 7.14; Boiling point = 2642°C; Melting point = 1900°C. Hazard Identification (based on Ignition temperature of dust cloud = unknown; Minimum explosive concentration = 0.23 oz/ft^3.[USBM] NFPA-704 M Rating System): [dust] Health 0, Flammability 1, Reactivity 0. Insoluble in water. Noncombustible solid in bulk form, but finely divided dust burns rapidly if heated in a flame. Relative explosion hazard of dust: Strong.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Chromium metal is used in stainless and other alloy steels to impart resistance to corrosion, oxidation, and for greatly increasing the durability of metals; for chrome plating of other metals.

Incompatibilities: Chromium metal (especially in finely divided or powder form) and insoluble salts react violently with strong oxidants, such as hydrogen peroxide, causing fire and explosion hazard. Reacts with diluted hydrochloric and sulfuric acids. Incompatible with alkalis and alkali carbonates.

Permissible Exposure Limits in Air

Chromium metal

OSHA PEL: 1 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 250 mg Cr/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 250 mg/m^3

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg[Cr]/m^3, 1999; Finland: TWA 0.01 mg/m^3, 1999; France: VME 0.5 mg/m^3, 1999; Japan: 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 1 mg/m^3, 1993; Poland: TWA 0.5 mg/m^3, 1999; Sweden: NGV 0.5 mg/m^3, 1999; United Kingdom: TWA 0.5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for chromium in ambient air[60] ranging from zero (North Carolina) to 0.00009 μg/m^3 (Rhode Island) to 0.068 μg/m^3 (Massachusetts) to 0.07−0.39 μg/m^3 (Montana) to 0.12 μg/m^3 (Pennsylvania) to 0.167 μg/m^3 (Virginia) to 2.5 μg/m^3 (Connecticut) to 5.0 μ/m^3 (North Dakota) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: *For the protection of freshwater aquatic life*: Trivalent chromium: not to exceed e 1.08 In (hardness) + 3.48] μg/L. Hexavalent chromium: 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. *For the protection of saltwater aquatic life*: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, eye, and skin contact.

Harmful Effects and Symptoms

Chromium can affect you when breathed in. Chromium metal ore has been reported to cause lung allergy. Chromium fumes can cause "metal fume fever," a flu-like illness lasting about 24 h with chills, aches, cough, and fever. Chromium particles can irritate the eyes. The above cautions apply to chromium metal. Since chromium is a reasonably reactive metal, thought must be given to the actions of combined chromium and particularly to the presence or absence of carcinogenic effects in various chromium compounds. A table of differentiation between noncarcinogenic and carcinogenic chromium(VI) compounds has been presented by NIOSH as shown below. NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than chromium(VI) compounds be reduced to 0.001 mg/m^3 and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for noncarcinogenic chromium(VI) be reduced to 0.025 mg/m^3 averaged over a work shift of up to 10 h per day, 40 h per week, with a ceiling level of 0.05 mg/m^3 averaged over a 15-min period. It is recommended further that chromium(VI) in the workplace be considered carcinogenic, unless it has been demonstrated that only the noncarcinogenic chromium(VI) compounds mentioned below are present. The NIOSH Criteria Documents for chromic acid and chromium(VI) should be consulted for more detailed information.

Short Term Exposure: Chromium particles can irritate the eyes. Chromium fumes can cause "metal fume fever" a flu-like illness, lasting about 24–36 h with chills, aches, cough, and fever.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Chromium metal ore has been reported to cause lung allergy.

Points of Attack: Chromium metal and insoluble salts: respiratory system and lungs.

Medical Surveillance: Preemployment physical examinations should include a work history to determine past exposure to chromic acid and hexavalent chromium compounds; exposure to other carcinogens; smoking history; history of skin or pulmonary sensitization to chromium, history or presence of dermatitis; skin ulcers; or lesions of the nasal mucosa and/or perforation of the septum; and a chest X-ray. Periodic examinations and evaluation should be made of skin and respiratory complaints especially in workers who demonstrate allergic reactions. Chest X-rays should be taken yearly for workers over age 40, and every 5 years for younger workers. Blood, liver, lungs, and kidney function should be evaluated periodically. Urine test for chromates. This test is most accurate shortly after exposure. Regulatory exams are required for carcinogens by OSHA 1910.1002-1016.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4–12 h following exposure: it may last less than 36 h.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Respirators should be used in areas where dust, fumes, or mist exposure exceeds Federal standards of where brief concentrations exceed the TWA, and for emergencies. Dust, fumes, and mist filter-type respirators or supplied air respirators should be supplied to all workers exposed, depending on concentration of exposure. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, chromium(VI).

Respirator Selection: *Up to 2.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator) *up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter*; or any self-contained breathing apparatus with a full face-piece; or any supplied-air respirator with a full face-piece. *Up to 250 mg/m^3:* Any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* Any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus. *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green (metal, not powder): General storage may be used. Prior to working with chromium you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area. Chromium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where chromium is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: For metal powder, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall in Hazard Class 4.2 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromium metal as dust/powder is combustible. The powder may explode in the air. In case of fire in the surroundings: all extinguishing agents allowed. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is a viable alternative to disposal for chromium in plating wastes; tannery wastes; cooling tower blowdown water; and chemical plant wastes.

References

National Institute for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Chromic Acid*, NIOSH Publication No. 73-11021

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National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Inorganic Chromium Compounds*, Report PB-276,678. Rockville, MD, pp. 136−142

US Environmental Protection Agency. (1980). *Chromium: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Chromium: Health and Environmental Effects Profile No. 51*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 40−41 (1980) and 3, No. 3, 65−68

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Chromium Metal*. Albany, NY: Bureau of Toxic Substance Assessment

US Public Health Service. (October 1987). *Toxicological Profile for Chromium*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Chromium*. Trenton, NJ

Chromium carbonyl C:1140

Molecular Formula: C_6CrO_6
Common Formula: $Cr(CO)_6$
Synonyms: Chromium hexacarbonyl; Hexacarbonyl chromium.
CAS Registry Number: 13007-92-6
RTECS® Number: GB5075000
UN/NA & ERG Number: UN3077/171
EC Number: 235-852-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: [chromium(VI)], *carcinogenic to humans*, Group 1; NTP: [chromium(VI) compounds] Known to be a human carcinogen; The German MAK value is 3B. This value is for *in vitro* animal studies yielding evidence of carcinogenic effects. These effects are not sufficient for classification if this material is in one of the other categories.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chromium carbonyl is a colorless crystalline substance which sinters (forms a coherent mass without melting) at 90°C. Molecular weight = 220.06; Freezing/Melting point = 110°C (decomposes). Boiling point = explodes (in lieu of boiling) at 210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water; possible reaction.

Potential Exposure: Chromium carbonyl is used as a catalyst for hydrogenation, isomerization, water—gas shift reaction, and alkylation of aromatic hydrocarbons; gasoline additive to increase octane number; preparation of chromous oxide, CrO.

Incompatibilities: Violent reaction on contact with oxidizers. Decomposed by chlorine and fuming nitric acid; sensitive to heat and light (undergoes photochemical decomposition). Many carbonyls react with water, forming toxic and flammable vapors.

Permissible Exposure Limits in Air

OSHA PEL: None.
NIOSH REL: None.
ACGIH TLV®[1]: None for *organic* chromium compounds. However, based on its formula and synonym (chromium *hexa*carbonyl): 0.01 mg(Cr)/m^3 TWA [listed under "certain water insoluble forms" hexavalent chromium inorganic compounds]. A1: Confirmed Human Carcinogen *as hexavalent chromium compounds* (*certain water insoluble forms*).
DFG MAK: Carcinogen level 3B.
Protective Action Criteria (PAC)
TEEL-0: 0.0212 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 60 mg/m^3
PAC-3: 63.5 mg/m^3
DFG MAK: Carcinogen Category 3B.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: *For the protection of freshwater aquatic life*: Trivalent chromium: not to exceed e[1.08 In (hardness) + 3.48] μg/L. Hexavalent chromium: 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. *For the protection of saltwater aquatic life*: Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* Hexavalent chromium 50 μg/L (US EPA).[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA has recently proposed a maximum drinking water level of 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Highly toxic. Emits toxic fumes of CO when heated. Thought to be carcinogenic.

Short Term Exposure: LD_{50} = (oral-rat) 230 mg/kg (moderately toxic). May cause eye and skin irritation. May cause skin sensitization. May cause chrome ulcers, deep lesions of the skin, usually on breaks in the skin, often found on hand and lower forearm. Ingestion may cause digestive tract irritation. Inhalation may cause irritation of the respiratory tract.

Long Term Exposure: May cause cancer in humans. May cause lung damage. Chronic exposure to water-insoluble hexavalent chromium compounds has been shown to be associated with lung cancer and gastrointestinal tract tumors.

Medical Surveillance: Preemployment physical examinations should include a work history to determine past exposure to chromic acid and hexavalent chromium compounds; exposure to other carcinogens; smoking history; history of skin or pulmonary sensitization to chromium; history or presence of dermatitis; skin ulcers; or lesions of the nasal mucosa and/or perforation of the septum; and a chest X-ray. Periodic examinations and evaluation should be made of skin and respiratory complaints especially in workers who demonstrate allergic reactions. Chest X-rays should be taken yearly for workers over age 40, and every 5 years for younger workers. Blood, liver, lungs, and kidney function should be evaluated periodically. Urine test for chromates. This test is most accurate shortly after exposure. Regulatory exams are required for carcinogens by OSHA 1910.1002-1016.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area or in a refrigerator. Protect from light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chromium carbonyl is not specifically cited by the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent paper dampened with 60−70% acetone to pick up remaining material. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromium carbonyl is a flammable compound and extreme care should be used in firefighting both due to the carcinogenic nature of the material and the emission of CO as a decomposition product. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Chromium nitrate C:1150

Molecular Formula: CrN_3O_9
Common Formula: $Cr(NO_3)_3$

Synonyms: Chromic nitrate; Chromium(III) nitrate; Chromium (3+) nitrate; Chromium trinitrate; Nitric acid, chromium(3+) salt; Nitrato cromico (Spanish)
nonahydrate: Chromium nitrate nonahydrate; Chromic nitrate nonahydrate; Chromium trinitrate nonahydrate; Nitric acid, chromium (3 +) salt, nonahydrate

CAS Registry Number: 13548-38-4; 7789-02-8 (nonahydrate); 10103-47-6; 17135-66-9

RTECS® Number: GB6280000

UN/NA & ERG Number: UN2720/141

EC Number: 236-921-1(trinitrate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Chromium(III) compounds, National Pollutant Release Inventory (NPRI); CEPA Priority Substance List (as chromium compounds).

WGK (German Aquatic Hazard Class): 2—Water polluting (CAS 7789-02-8).

Description: Chromium nitrate is a crystalline substance, variously stated to be green brown or purple and existing in various hydrated forms. Molecular weight = 238.03; 400.21 (nonahydrate); Freezing/Melting point = 60−100°C, depending on the degree of hydration. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Mutagen (nonhydrate). Chromium nitrate is used in the preparation of chrome catalysts, in textile printing operations, and as a corrosion inhibitor.

Incompatibilities: This chemical is a strong oxidizer. Contact with reducing agents, fuels, ethers, and other flammable and combustible materials cause a fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

Protective Action Criteria (PAC)
TEEL-0: 2.29 mg/m^3
PAC-1: 6.87 mg/m^3
PAC-2: 11.4 mg/m^3
PAC-3: 114 mg/m^3
nonahydrate
TEEL-0: 3.85 mg/m^3
PAC-1: 11.5 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 192 mg/m^3

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA has recently proposed a maximum drinking water level of 0.1 mg/L.[62]

Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water.

The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Skin contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chromium nitrate can affect you when breathed in. Chromium nitrate may cause mutations. Handle with extreme caution. Skin contact may cause irritation, especially if repeated or prolonged. Skin allergy sometimes occurs, with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms. Eye contact may cause irritation.

Long Term Exposure: May cause genetic changes; birth defects; skin allergy with rash and itching.

Points of Attack: Irritation of eyes; sensitization dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If chromium nitrate gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Chromium nitrate must be stored to avoid contact with strong reducing agents, fuels, and ether since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Chromium nitrate must be labeled “OXIDIZER.” It falls in Hazard Class 5.1 and Packing Group III.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep chromium nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Chromium nitrate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Poisonous gases are produced in fire, including nitrogen oxides and chromium oxide fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate chromium as the hydroxide. Dewater the sludge and dispose of in single-purpose dumps.[22]

Reference

New Jersey Department of Health and Senior Services. (May 2001 1987). *Hazardous Substances Fact Sheet: Chromium Nitrate*. Trenton, NJ

Chromium(III) oxide C:1160

Molecular Formula: Cr_2O_3

Synonyms: Anadomis green; Anidride cromique (French); Casalis green; Chrome green; Chrome oxide; Chromia; Chromic acid; Chromic oxide; Chromium(3 +) oxide; Chromium(III) oxide; Chromium sesquioxide; Chromium (3 +) trioxide; C.I. 77288; C.I. Pigment green; Dichromium trioxide; Green chromic oxide; Green cinnabar; Green GA; Green rouge; Leaf green; Levanox; Oil green; Oxido de cromo (Spanish); Ultramarine green

CAS Registry Number: 1308-38-9; 20770-05-2 (hydroxide)

RTECS® Number: GB6475000

UN/NA & ERG Number: UN3086 (toxic solids, oxidizing, n.o.s.)/141

EC Number: 215-160-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (insoluble salts): Not Classifiable as to human carcinogenicity; Cannot be Determined.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical’s infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Chromium(III) compounds, n.o.s; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Chromium oxide is a bright green, odorless powder. Molecular weight = 151.00; Freezing/Melting point = 2266°C (−25°C). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Chromium(III) oxide is used as a paint pigment, a fixative for certain textile dyes; in the manufacture of chromium; and a catalyst.

Incompatibilities: A strong oxidizer. Contact with reducing agents, organics, and combustibles may be violent.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.731 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 36.5 mg/m^3

PAC-3: 36.5 mg/m^3

chromium(III) oxide hydroxide

TEEL-0: 0.817 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 40.9 mg/m^3

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L (EPA).[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA’s maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation of dust or mist, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. Skin allergy may occur with itching, redness, and/or an eczema-like rash. Persons allergic to other chromium compounds may be more likely to develop skin allergy to this chemical.

Long Term Exposure: There is limited evidence that chromium(III) oxide is a teratogen in animals, and until further testing is done, it should be treated as a possible teratogen in humans. Chromium(III) oxide has been tested and has *not* been shown to cause cancer in animals (NJ Department of Health, 5/1988). Skin allergy may develop from repeated exposure to this chemical.

Points of Attack: Irritation of eyes; sensitization dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Chromium(III) oxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Chromium(III) oxide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), glycerol, and oxygen difluoride, since violent reactions occur. A regulated, marked area should be established where chromium(III) oxide is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solids, oxidizing, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS, OXIDIZER." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Chromium(III) oxide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Chromium (III) Oxide*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Chromium(III) Oxide*. Revised Version #2. Albany, NY: Bureau of Toxic Substance Assessment

Chromium potassium sulfate C:1170

Molecular Formula: $CrKO_8S_2$

Common Formula: $CrK(SO_4)_2$

Synonyms: Chrome alum; Chrome potash alum; Chromic potassium sulfate; Chromic potassium sulphate; Chromium potassium sulfate; Chromium potassium sulphate; Crystal chrome alum; Potash alum; Potassium chromic sulphate; Potassium chromium alum; Potassium disulphatochromate (III); Sulfuric acid, chromium(3 +) potassium salt

CAS Registry Number: 10141-00-1 (anhydrous); 7788-99-0 (dodecahydrate)

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

RTECS® Number: GB6845000 (anhydrous); GB6850000 (dodecahydrate)

EC Number: 233-401-6 [chromium potassium bis (sulphate)]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA: Not Classifiable as to human carcinogenicity; Cannot be Determined.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical’s infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Chromium(III) compounds, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Chromium potassium sulfate is a crystalline compound whose color may range from violet-red to black. Molecular weight = 287.3; Freezing/Melting point = 89°C; Soluble in water.

Potential Exposure: This material is used in tanning of leather; dyeing of fabrics; manufacture of glues and gums, chromium salts; ink, photographic emulsions, and ceramics.

Incompatibilities: Contact with magnesium, aluminum may cause fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

Protective Action Criteria (PAC)

dodecahydrate

TEEL-0: 4.8 mg/m^3

PAC-1: 14.4 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 240 mg/m^3

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA.[6]

US EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA’s maximum drinking water level (MCL) is 0.1 mg/L.[62]

Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water.

The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, eyes, skin.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to mouth, nose, throat, and lungs. *Skin:* May cause irritation, redness and sores. Allergic reaction may occur in sensitive individuals. *Eyes:* May cause irritation. *Ingestion:* Large quantities may cause stomach irritation and nausea.

Long Term Exposure: Repeated skin contact may give rise to allergic sensitization.

Points of Attack: Skin.

Medical Surveillance: Examination by a qualified allergist. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Keep away from heat.

Shipping: Toxic solid, inorganic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Use extinguisher appropriate for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Chromium Potassium Sulfate*. Albany, NY: Bureau of Toxic Substance Assessment

Chromium trioxide C:1180

Molecular Formula: CrO_3

Synonyms: Anhydride chromique (French); Chrome (trioxyde de) (French); Chromic acid mg[CrO_3]; Chromic(VI) acid; Chromic anhydride; Chromic trioxide; Chromium oxide; Chromium(VI) oxide; Chromium trioxide; Chromium(6+) trioxide; Chromsaeureanhydrid (German); Chromtrioxid (German); Monochromium oxide; Monochromium trioxide; Puratronic chromium trioxide

CAS Registry Number: 1333-82-0; *(alt.)* 12324-05-9; *(alt.)* 12324-08-2

RTECS® Number: GB6650000

UN/NA & ERG Number: UN1463 (anhydrous)/141

EC Number: 215-607-8 [*Annex I Index No.*: 024-001-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

OSHA Table Z-1-A Air Contaminant as chromic acid and chromates mg[CrO_3].

Banned or Severely Restricted (Some countries) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List.

European/International Regulations: Hazard Symbol: O, T, N; Risk phrases: R46; R9; R24/25; R26; R35; R42/43; R62; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chromium trioxide is a dark-red crystalline substance. It is odorless. Molecular weight = 100.00; Boiling point = (decomposes below BP) at 250°C; Freezing/Melting point = 196°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3 (Oxidizer). It is deliquescent. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Chromium trioxide is used in plating and metal treatment, as a corrosion inhibitor; and as an oxidant; in aluminum anodizing; dye, ink, and paint manufacturing; tanning; engraving; and photography.

Incompatibilities: Chromium trioxide is a strong oxidizer. The solution in water is a strong acid. Reacts violently with bases and is corrosive. Contact with reducing agents, fuels, organic chemicals, flammable and combustible materials, causing fire and explosion hazard. This chemical decomposes above 250°C to chromic oxide and oxygen with increased fire hazard. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

As chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.00962 mg/m^3

PAC-1: 0.00962 mg/m^3

PAC-2: 0.01 mg/m^3

PAC-3: 28.8 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Austria: carcinogen, 1999; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.05 mg/m^3, VLE 0.1 mg/m^3, carcinogen, 1999; Japan: EOL 0.05 mg [Cr]/m^3, 1999; Norway: TWA 0.02 mg/m^3, 1999; Poland: TWA 0.1 mg[Cr]/m^3; STEL 0.3 mg[Cr]/m^3, 1999; Russia: STEL 0.01 mg/m^3 [skin] 1993; Switzerland: TWA 0.02 mg/m^3, carcinogen, 1999; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed human carcinogen. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μg/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* Hexavalent chromium 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Extremely corrosive to skin.

Short Term Exposure: *Inhalation:* Human exposure to concentrations between 0.18 and 1.4 mg/m^3 of acid mist for 2 weeks produced irritation of the nose; after 4 weeks, ulcers of the nose developed; and after 8 weeks, holes formed in the tissue separating the nostrils with bleeding, discharge or formation of a crust in the inner nose. Additional effects noted in humans exposed to unknown concentrations are irritation of the throat, voice-box, lungs; asthmatic attacks, headache, wheezing, coughing, shortness of breath, and painful breathing. Chromic trioxide can cause severe allergic lung reaction. *Skin:* Direct contact will produce severe irritation of the skin. Sensitization from such contact can occur and result in severe dermatitis from very small exposures at a later time. *Eyes:* Can cause severe irritation, burns, and possible loss of vision. *Ingestion:* Swallowing of chromic acid solutions can result in severe irritation and damage to the mouth, throat, and stomach.

Long Term Exposure: Prolonged exposure to chromic acid mist can result in perorations (holes) of the nasal septum (tissue separating the nostrils); lung irritation with symptoms similar to asthma and liver damage. Repeated or prolonged contact with skin may cause dermatitis and chrome ulcers or "chrome holes." May cause skin sensitization, allergy, irritation, and rashes. Repeated or prolonged inhalation exposure may cause asthma-like reactions. Wearing away of the surfaces of teeth has been noted in workers exposed to chromic acid mist for a prolonged time. This substance is carcinogenic to humans. It has been shown to cause lung and throat cancers. There is limited evidence that this chemical is a teratogen in animals. May cause kidney and liver damage.

Points of Attack: Skin, lungs, kidney, liver.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before first exposure and every 6−12 months, a medical history and exam is recommended, with very careful attention to the nose, skin, lungs, and voice box. If you notice skin, nose, or lung effects, seek prompt medical attention. Also check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin contact. (as chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. AIHA recommends polyvinyl chloride for solutions of Chromium(VI) oxide in water as a protective material. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with chromium(VI) oxide you should be trained on its proper handling and storage. Chromium(VI) oxide must be stored to avoid contact with reducing agents and organic chemicals since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from fuels and other flammable and combustible materials. Do not store chromium(VI) oxide on wood floors because prolonged contact with wood can produce a fire hazard. Protect from excess moisture to minimize rusting of containers. A regulated, marked area should be established where chromium(VI) oxide is handled, used, or stored. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chromic acid, solid, must be labeled "OXIDIZER, CORROSIVE." It falls in Hazard Class 5.1 and Packing Group II.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep chromium(VI) oxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Chromium(VI) oxide itself does not burn but it will increase the intensity of a fire since it is an oxidizer. The substance decomposes above 250°C to chromic oxide and oxygen with increased fire hazard. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reduce to Cr(III). If material cannot be recovered and recycled, dispose of sludge in a chemical waste landfill.[22]

Reference

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 47−49

New Jersey Department of Health and Senior Services. (April 1998). *Hazardous Substances Fact Sheet: Chromium (VI) Oxide*. Trenton, NJ

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Chromic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

Chromosulfuric acid C:1190

Molecular Formula: $CrO_{4x}S_x$

Common Formula: $Cr(SO_4)_x$

Synonyms: Basic chromic sulfate; Basic chromic sulphate; Basic chromium sulfate; Basic chromium sulphate; Chromium hydroxide sulfate; Chromium sulfate; Chromium sulfate, basic; Chromium(III) sulfate, hexahydrate; Chromium sulphate; Chronisulfat (German); Koreon; Monobasic chromium sulfate; Monobasic chromium sulphate; Neochromium; Sulfuric acid, chromium salt; Sulfuric acid, chromium salt, basic

CAS Registry Number: 14489-25-9; 15005-90-0 (hexahydrate)

RTECS® Number: WS6985000

UN/NA & ERG Number: UN2240/154

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): D007.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 5.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 2.77; Nonwastewater (mg/kg), 0.86 as chromium, total dust.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (70); 7190 (500); 7191 (10).

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as chromium(III) compounds, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List as chromium compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chromosulfuric acid is a dark green powder. Molecular weight = 724.4; Highly soluble in water (reactive).

Potential Exposure: Chromosulfuric acid is used in chrome plating; paint, ink, and glaze manufacturing; tanning, catalyst preparation; and as a fixative in textile dyeing.

Incompatibilities: Violent reaction with water. Incompatible with caustic materials, ammonia, aliphatic amines, alkanolmines, isocyanates, epichlorohydrin.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

No TEEL available.

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed e[1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L. EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62]

Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Chromosulfuric acid is a corrosive chemical, and skin or eye contact can cause severe irritation and burns. Inhalation can irritate the respiratory tract causing coughing and wheezing. Skin allergy sometimes occurs with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms.

Long Term Exposure: May cause skin allergy with itching and rash. Some related chromium compounds are known carcinogens. Although this chemical has not been identified as a carcinogen, it should be handled with extreme caution.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or

P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with chromosulfuric acid you should be trained on its proper handling and storage. Chromosulfuric acid must be stored to avoid contact with water and other incompatible materials listed above since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials.

Shipping: Chromosulfuric acid requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group I.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep Chromosulfuric acid out of confined spaces, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromosulfuric acid may burn but does not readily ignite. It will increase the intensity of a fire since it is an oxidizer. Use dry chemical or CO_2 extinguishers. Use water spray to keep fire-exposed containers cool, but do not get water inside containers. Poisonous gases are produced in fire, including sulfur oxides and chromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (September 1996). *Hazardous Substances Fact Sheet: Chromosulfuric Acid*. Trenton, NJ

Chromous chloride C:1200

Molecular Formula: Cl_2Cr

Synonyms: Chromium chloride; Chromium(2+) chloride; Chromium(II) chloride; Chromium dichloride; Cloruro cromoso (Spanish)

CAS Registry Number: 10049-05-5

RTECS® Number: GB5250000

UN/NA & ERG Number: Not regulated

EC Number: 233-163-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Chromium(II) compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chromous chloride is a white-to-blue solid or lustrous needles which turn blue in water. Molecular weight = 122.90; Boiling point = 1300°C; Melting point = 824°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Mutagen. It is used in metal alloys and metal finishing; textile treatment, including mothproofing, waterproofing, printing; dying; leather tanning; making photographic chemicals; and green pigments for various uses.

Incompatibilities: Very hygroscopic. The substance is a strong reducing agent. Reacts with oxidizers. Reacts with water, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

Chromous chloride may reduce the oxygen content of air in confined spaces.

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH: 0.5 mg[Cr]/m^3 TWA; Limit exposures to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix C.

Protective Action Criteria (PAC)

TEEL-0: 1.18 mg/m^3

PAC-1: 3.55 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G.[58]

Permissible Concentration in Water: See "Chromium" entry.

Routes of Entry: Inhalation, eyes and/or skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact may cause damage. Inhalation can cause coughing and/or shortness of breath. May cause pulmonary irritation. Moderately toxic to humans. Between 1 oz and 1 lb may be fatal. LD_{50} = (oral-rat) 1870 mg/kg.

Long Term Exposure: May cause skin allergy. Chrome ulcers or sores of the skin or nasal septum; holes in the nasal septum, sometimes with bleeding may result. May cause lung damage.

Points of Attack: Skin, lungs.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with chromous chloride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: The DOT does not set out any specific label requirements or maximum shipping quantities for chromous chloride.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid solution: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromous chloride may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chromous salts, chromic salts, and fumes of chromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Chromous Chloride*. Trenton, NJ

Chromyl chloride C:1210

Molecular Formula: Cl_2CrO_2

Common Formula: CrO_2Cl_2

Synonyms: Chlorure de chromyle (French); Chromic oxychloride; Chromium chloride oxide; Chromium, dichlorodioxo-; Chromium dioxychloride; Chromium dioxychloride dioxide; Chromium oxychloride; Chromylchlorid (German); Chromyl chloride; Dioxodichlorochromium; Oxychlorure chromique (French)

CAS Registry Number: 14977-61-8

RTECS® Number: GB5775000

UN/NA & ERG Number: UN1758 (chromium oxychloride)/137

EC Number: 239-056-8 [*Annex I Index No.:* 024-005-00-2]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, T, C, N; Risk phrases: R49; R46; R8; R35; R43; R50/53; Safety phrases: S50/53; S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Chromyl chloride is a dark red fuming liquid with a musty, burning odor. Molecular weight = 154.90; Specific gravity (H_2O:1) = 1.91 at 25°C; Boiling point = 117°C; Freezing/Melting point = −96.5°C; Vapor pressure = 20 mmHg at 25°C. Soluble in water (decomposes).

Potential Exposure: Compound Description: Tumorigen, Mutagen. Chromium oxychloride is used in making chromium complexes and dyes; and used in various organic oxidation and chlorination reactions.

Incompatibilities: Contact with water is violent and forms hydrochloric, chromic acids, and chlorine gas. A powerful oxidizer. Reacts violently with acetone, alcohol, ammonia, ether, fuels, organic solvents, moist phosphorus, phosphorus trichloride, sodium azide, sulfur, reducing agents, turpentine. Contact with nonmetal halides, such as disulfur dichloride, phosphorus trichloride; and phosphorus tribromide; nonmetal hydrides, such as hydrogen sulfide; hydrogen phosphide; and urea, causes a danger of fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.001 mg[CrO_3]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, tert-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.025 ppm/0.16 mg/m^3 TWA.

No TEEL available.

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 1.

NIOSH IDLH: Not determined.

Austria: Suspected: carcinogen, 1999; Belgium: TWA 0.025 ppm (0.16 mg/m^3), 1993; Finland: carcinogen, 1999; Japan: 0.05 mg[Cr]/m^3, 1999; the Netherlands: MAC-TGG 0.15 mg/m^3, 2003; Norway: TWA 0.5 mg[Cr]/m^3, 1999; Switzerland: MAK-W 0.5 mg[Cr]/m^3, 1999; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.025 ppm.

This chemical can be absorbed through the skin, thereby increasing exposure. Some states have set guidelines or standards for chromyl chloride in ambient air[60] ranging from 1.5 μg/m^3 (North Dakota) to 4.0 μg/m^3 (Nevada) to 15.0 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: This material reacts with water, but to the extent that it affects the chromium content of water see the following. For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* Hexavalent chromium 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Chromium chloride can affect you when breathed in and by passing through your skin. Chromium chloride should be handled as a carcinogen, with extreme caution. Eye contact can cause severe damage with this corrosive chemical. Skin contact can cause deep ulcers or an allergic rash or severe irritation.

Long Term Exposure: May cause cancer of the lungs and throat; birth defects, fetus damage, possible miscarriage; skin allergy, with itching and rash; lung allergy with cough, wheezing, and difficult breathing; kidney damage; damage to the bone (septum) in the nose.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: urine test for chromates. This test is most accurate shortly after exposure. Examination of the nose and skin. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. If any skin bumps or blisters develop, seek medical attention promptly. If not treated early, "chrome ulcers" can develop which can last for years. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. (as chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with Chromium chloride you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Chromium chloride must be stored to avoid contact with water since violent reactions occur, releasing poisonous materials including chromic acid, hydrogen chloride, chromic chloride, and chlorine. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials, ammonia, alcohol and turpentine, and other incompatible materials listed above.

Shipping: Chromium chloride must carry a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1758 (Chromium chloride) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water*: Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: Chromium chloride does not burn, but it will increase the intensity of a fire since it is an oxidizer. Extinguish surrounding fire with dry chemicals or CO_2. *Do not use water* to control a small fire. Poisonous gases are produced in fire, including chromic acid, hydrogen chloride, chromic chloride, and chlorine. Vapors may travel to a source of ignition and flash back. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire especially if water gets in them. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US DHHS NIOSH and US DOL OSHA. (1981−1995). *NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards*. Supplements I−IV. DHHS (NIOSH) Publication Nos. 81−123; 88−118. Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Chromium Oxychloride*. Trenton, NJ

Chrysene C:1220

Molecular Formula: $C_{18}H_{12}$

Synonyms: A13-00867; 1,2-Benzofenantreno (Spanish); 1,2-Benzophenanthrene; Benzo(a)phenanthrene; 1,2-Benzphenanthrene; Benz(a)phenanthrene; Criseno (Spanish); 1,2,5,6-Dibenzonaphthalene

CAS Registry Number: 218-01-9

UN/NA & ERG Number: UN3077/171

RTECS® Number: GC0700000

EC Number: 205-923-4 [*Annex I Index No.*: 601-048-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1998. *Note*: Coal-tar, polynuclear aromatic compounds, and other materials which are known to be a human carcinogens; may contain chrysene.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as polynuclear aromatic hydrocarbons (PAH).

US EPA Hazardous Waste Number (RCRA No.): U050.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA (Section 313): as polycyclic aromatic compounds (PAC); Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as chrysene and coal tar pitch volatiles.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Chrysene is a combustible, white[2] (when pure), red, or blue, fluorescent crystalline solid. Odorless. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 228.28[2]; Boiling point = 448°C at 760 mmHg[2]; Freezing/Melting point = 254°C[2]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Almost never found by itself, chrysene is found in gasoline and diesel exhaust as well as in cigarette smoke; and in coal tar; coal tar pitch; creosote. It is used in organic synthesis.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air: As coal tar pitch volatiles.

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 80 mg/m^3

DFG MAK: Category 1, human carcinogen.

Guidelines for chrysene concentration in ambient air[60] have been set at zero by North Dakota and at 3.0 μg/m^3 by Virginia.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: In view of the carcinogenicity of polynuclear aromatic hydrocarbons, the concentration in water is preferably zero as noted by EPA.[6] Kansas[61] gives a guideline for chrysene in drinking water of 0.029 μg/L.

Determination in Water: Extraction with methylene chloride may be followed by measurement by ultraviolet or by HPLC/flame spectrometry or by gas chromatography and mass spectrometry as reviewed in the ATSDR document referenced below. Octanol−water coefficient: Log K_{ow} = 5.59.

Routes of Entry: Inhalation, skin contact, ingestion. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: Chrysene can affect you when breathed in and by passing through your skin. Chrysene should be handled as a carcinogen—with extreme caution. Skin contact may cause a rash. If skin in exposed to sunlight, a "sunburn" can occur. Sunlight exposure on skin contaminated with coal tar chemicals such as chrysene can cause rash and later, pigment changes. Persons who smoke cigarettes may be at increased lung cancer risk with this chemical. This can be significantly reduced by stopping smoking, as well as by reducing exposures.

Long Term Exposure: May cause cancer of the skin and kidneys; birth defects; miscarriage; dermatitis, changes in skin pigment. May cause bronchitis with phlegm and/or shortness of breath. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials; and are carcinogenic (Category 1) in animal studies.

Points of Attack: Skin, respiratory system, bladder, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: complete blood count; chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria; liver, kidney, and bladder function tests recommended for coal tar pitch volatiles.[2] Monthly, carefully look at any skin areas that are exposed. Any growth (like a mole) that increases in size or shows changes in color should be examined by a physician. Skin cancer is curable when detected early. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with chrysene you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Chrysene is not specifically cited in DOT's Performance-Oriented Packaging Standards.[19] However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Coal tar pitch volatiles are combustible but may not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chrysene may be destroyed by permanganate oxidation, by high-temperature incinerator with scrubbing equipment, or by microwave plasma treatment.

References

US Public Health Service. (October 1987). *Toxicological Profile for Chrysene*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

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US EPA. (April 1975). *Identification of Organic Compounds in Effluents from Industrial Sources*, EPA-560/3-75-002

Eller, P. M., & Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. DHHS (NIOSH) Publication No. 98−119. Cincinnati, OH: National Institute for Occupational Safety and Health

NIOSH/OSHA. 1981−1995. *Occupational Health Guidelines for Chemical Hazards*. Supplements I−IV. DHHS (NIOSH) Publication Nos. 81−123; 88−118. Washington, DC

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Chrysene*. Trenton, NJ

C.I. Basic green 1 C:1230

Molecular Formula: $C_{27}H_{34}N_2O_4S$

Common Formula: $C_{27}H_{33}N_2 \cdot HSO_4$

Synonyms: Brilliant Green; Ethyl Green; Emerald Green; Malachite Green G

CAS Registry Number: 633-03-4

RTECS® Number: BP6825000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: C.I. Basic Green 1 is a metallic green, odorless crystal or powder. Molecular weight = 482.69; Melting point = 210°C. Soluble in water.

Potential Exposure: C.I. Basic Green 1 is used in dyeing silk, wool, leather, jute, and cotton; manufacturing green ink; as staining constituent of bacteriological media; indicator, an intestinal anthelmintic; a wound antiseptic; treatment of mycotic infections; agricultural fungicide (not registered as a pesticide in the United States).

Incompatibilities: Oxidizing agents, reducing agents, anionics, and aqueous solutions of bentonite. Keep away from moisture.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

It is classified as very toxic; probable lethal dose is 50−500 mg/kg in humans (between 1 teaspoon and 1 oz for a 150-lb person). It is a skin irritant. Ingestion causes diarrhea and abdominal pain.

Short Term Exposure: C.I. Basic green can irritate and burn the skin and eyes. Ingestion causes nausea, vomiting, diarrhea, and abdominal pain. It is classified as very toxic; probable lethal dose is 50−500 mg/kg in humans (between 1 teaspoon and 1 oz for a 150-lb person).

Long Term Exposure: Skin contact can cause drying and cracking.

Points of Attack: Skin.

Medical Surveillance: There are no special tests for this substance.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location.

Shipping: Dyes, solid, toxic, n.o.s. require a DOT shipping label reading "POISONOUS/TOXIC MATERIALS" for Packing Group II. The Hazard Class is 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. For small fires use dry chemical, carbon dioxide, water spray, or foam. For large fires use water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear self-contained (positive-pressure if available) breathing apparatus and full protective clothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: C.I. Basic Green 1*. Washington, DC: Chemical Emergency Preparedness Program

C.I. Direct red 28 C:1240

Molecular Formula: $C_{32}H_{24}N_6O_6S_2 \cdot 2Na$
Synonyms: Atlantic Congo red; Atul Congo red; Azocard red Congo; Benzo Congo red; Brasilamina Congo 4B; C.I. 22120; C.I. Direct red 28; C.I. Direct red 28, disodium salt; Congo red; Cotton red L; Diacotton Congo red; Direct red 28; Erie Congo 4B; Hispamin Congo 4B; Kayaku Congo red; Mitsui Congo red; Peeramine congo red; Sugai congo red; Tertrodirect red C; Trisulfon congo red; Vondacel red Cl
CAS Registry Number: 573-58-0
UN/NA & ERG Number: UN3143 (Dyes, solid, corrosive, n.o.s. [or] Dye intermediates, solid, corrosive, n.o.s.)/151
EC Number: 209-358-4 [*Annex I Index No.:* 611-027-00-8]
Regulatory Authority and Advisory Bodies

California Proposition 65 Chemical: Cancer (benzidine-based dyes) 10/1/92.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R63; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: C.I. Direct red 28(Congo Red) is an odorless, brownish-red powder. Molecular weight = 698.72. Melting point = 359°C. Soluble in water; solubility = 25 g/L at 25°C.
Potential Exposure: It is used as an indicator dye, a biological stain; a diagnostic aid in medicine; and a dye for fabric and paper.
Incompatibilities: Contact with oxidizers may cause fire and explosion hazard. Incompatible with strong acids; reducing agents.
Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: Use NIOSH Analytical Method #5013, Dyes.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact may cause irritation. Exposure can cause nausea, vomiting, and diarrhea; and increase the formation of platelets; and increasing the ability of the blood to clot.
Long Term Exposure: While this chemical has not been designated a carcinogen, the parent compound, benzidine, causes bladder cancer. May decrease fertility in males. May cause skin allergy with itching and rash. *EC Labeling:* Restricted to professionals. Toxic; (R45) May cause cancer; (R63) Possible risk of harm to the unborn child; (S53) Avoid exposure: obtain special instructions before use; (S45) In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
Points of Attack: Skin, blood.
Medical Surveillance: Complete blood count (CBC). Evaluation by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is a potential for over-exposure: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).
Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, reducing agents, and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: Dyes, solid, corrosive, n.o.s. [or] Dye intermediates, solid, corrosive, n.o.s. have a label requirement of "CORROSIVE." This chemical is in DOT/UN Hazard Class 8.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including ammonia, carbon monoxide, nitrogen, and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: C.I Direct red 28*. Trenton, NJ

C.I. Food red 15 C:1250

Molecular Formula: $C_{28}H_{31}N_2O_3 \cdot Cl$

Synonyms: 11411 Red; Acid brilliant pink B; ADC rhodamine B; Aizen rhodamine BH; Aizen rhodamine BHC; Akiriku rhodamine B; Ammonium, [9(*o*-Carboxyphenyl)-6-(diethylamino)-3H-xanthen-3-ylidene]diethyl-, chloride; Basic violet 10; Calcozine red BX; Calcozine rhodamine BXP; 9-*o*-Carboxyphenyl-6-diethylamino-3-ethylimino-3-isoxanthrene, 3-ethochloride; [9-(*o*-Carboxyphenyl)-6-(diethylamino)-3-xanthen-3-ylidene]diethylammonium chloride; Cerise toner X 1127; C.I. 45170; C.I. basic violet 10; Cosmetic brilliant pink bluish D concentrate; D and C red No. 19; Diabasic rhodamine B; Edicol supra rose B; Edicol Supra Rose BS; Eriosin rhodamine B; Ethanaminium *n*-[9-(2-carboxyphenyl)-6-(diethylamino)-3H-xanthern-3-ylidene]-*N*-ethyl-, chloride; FD and C red No. 19; Flexco red 540; Hexacol rhodamine B extra; Ikada rhodamine B; Japan red 213; Japan red No. 213; Mitsui rhodamine BX; Red No. 213; Rheonine B; Rhodamine B; Rhodamine B 500; Rhodamine B 500 hydrochloride; Rhodamine BA; Rhodamine BA export; Rhodamine B extra; Rhodamine B extra M 310; Rhodamine B extra S; Rhodamine BN; Rhodamine BS; Rhodamine BX; Rhodamine BXL; Rhodamine BXP; Rhodamine FB; Rhodamine lake red B; Rhodamine O; Rhodamine S; Rhodamine, tetraethyl-; Sicilian Cerise toner A 7127; Symulex magenta F; Symulex rhodamine B toner F; Takaoka rhodamine B; Tetraethyldiamino-*o*-carboxyphenyl-xanthenyl chloride; Tetraethylrhodamine; Xanthylium, 9-(2-carboxyphenyl)-3,6-bis(diethylamino)-, chloride

CAS Registry Number: 81-88-9

RTECS® Number: BP3675000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Group 3, 1998.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, On DSL List; WHMIS Classification D2A, D2B.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R40; Safety phrases: S/36/37; S/45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: C.I. Food red 15 is a green crystalline or red-violet powdered solid. Molecular weight = 479.1. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: It is used as a color additive in drugs, foods, cosmetics, and fabric dyes. It is also used as a tracing agent in water pollution studies.

Incompatibilities: Reducing agents and oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.4 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 50 mg/m^3

Determination in Air: Use NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin, eyes, and respiratory tract. Eye or skin contact can cause burns and permanent damage. Can cause headaches, difficult breathing, and chest tightness.

Long Term Exposure: May cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If

this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with C.I. Food red 15 you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Dyes, solid, toxic, n.o.s. require a DOT shipping label reading "POISONOUS/TOXIC MATERIALS" for Packing Group II. The Hazard Class is 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide, nitrogen oxides, hydrogen chloride, and ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: C.I. Food Red*. Trenton, NJ

Cisplatin C:1260

Molecular Formula: $Cl_2H_6N_2Pt$

Common Formula: $Pt(NH_3)_2Cl_2$

Synonyms: CDDP; DDP; *cis*-Diamminedichloroplatinum; *cis*-Platinous diaminodichloride; *cis*-Platinum

CAS Registry Number: 15663-27-1

RTECS® Number: TP2450000

UN/NA & ERG Number: UN3249/151

EC Number: 239-733-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2A, 1998; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 10/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cisplatin is a white powder or yellow crystalline solid; Freezing/Melting point = 270°C (decomposes). Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and administration of this anticancer chemotherapy agent. Contact with water causes decomposition.

Incompatibilities: Aluminum reacts with cisplatin and decreases the drug's effectiveness. Do not use any aluminum equipment to prepare or administer cisplatin.

Permissible Exposure Limits in Air

As platinum, soluble salts

ACGIH TLV®[1]: 1 mg/m^3 (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt.

OSHA PEL: None (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt.

NIOSH REL: 1 mg/m^3 (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt.

No TEEL available.

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

NIOSH IDLH: 4 mg [Pt]/m^3.

Determination in Air: Use NIOSH II[7] Method #S191, (IV) #7300, Elements.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact with the skin or eyes can cause irritation with possible loss of vision. Inhalation can irritate the nose and throat. Exposure to high levels can cause tintinus (ringing in the ears) and possible hearing loss. LD_{50} = (oral-rat) 25.8 mg/kg (highly toxic).

Long Term Exposure: Cisplatin is a probable carcinogen in humans—handle with extreme caution. It has been shown to cause lung and skin cancer in animals. It may damage the developing fetus and may damage the testes (male reproductive glands). Repeated exposure to high levels can cause the same side effects seen in patients. These include kidney damage, hearing loss, low blood cell count, and nausea and committing. Exposure may cause anemia. May damage the nervous system causing numbness and weakness in the hands and feet. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Points of Attack: Skin, lungs, nervous system, bone marrow, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: examination of the nervous system; Audiogram (hearing test); Complete blood count (CBC); Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood levels of cisplatin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA platinum as soluble salts as Pt: *up to 0.05 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 4 mg/m^3:* SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained reathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cisplatin you should be trained on its proper handling and storage. A regulated, marked area should be established where cisplatin is handled, used, or stored in manufacturing and packaging operations. Store cisplatin in sealed vials or tightly closed containers in a cool, well-ventilated area away from aluminum.

Shipping: Cisplatin is not specifically cited in DOT's Performance-Oriented Packaging Standards[19] but Medicine, solid, toxic, n.o.s. requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Reference

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Cisplatin*. Trenton, NJ

Clopidol C:1270

Molecular Formula: $C_7H_7Cl_2NOP$ 842

Synonyms: Clopindol; Coccidiostat C; Coyden®; 3,5-Dichloro-2,6-dimethyl-4-pyridinol; 3,5-Dichloro-4-pyridnol; Farmcoccid; Lerbek®; Methylchloropindol; Methylchlorpindol; Metilchlorpindol

CAS Registry Number: 2971-90-6

RTECS® Number: UU7711500

UN/NA & ERG Number: UN3249/151

EC Number: 221-008-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Clopidol is a white to light brown powder. Molecular weight = 192.1; Freezing/Melting point ≥320°C. Insoluble in water.

Potential Exposure: Those engaged in formulation, application, or manufacture of this veterinary antibiotic.

Incompatibilities: Noncombustible solid, but dust may explode in cloud form. Contact with strong oxidizers may cause a fire or explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3, total dust; 5 mg/m^3 TWA, respirable fraction; 20 mg/m^3, total dust STEL.

ACGIH TLV®[1]: 10 mg/m^3; Not classified as a human carcinogen.

No TEEL available.

Several states have set guidelines for clopidol in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust, Method #0600 (respirable).

Harmful Effects and Symptoms

Short Term Exposure: Clopidol may cause irritation of eyes, skin, nose, and throat. Clopidol has a low order of toxicity. Rats fed 15 mg/kg/day for 2 years showed no ill effects. LD_{50} = (oral-rat) 18 g/kg (slightly toxic).

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with clopidol you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Medicine, solid, toxic, n.o.s. requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Extinguish fire using an agent suitable for the type of surrounding fire; Clopidol itself does not burn. Poisonous gases are produced in fire, including hydrogen chloride and organic nitrogens. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Clopidol*. Trenton, NJ

Coal dust C:1280

Molecular Formula: $C_{3n}H_{4n}$

Common Formula: $(C_3H_4)_n$

Synonyms: Anthracite coal dust; Bituminous coal dust; Coal facings; Lignite coal dust; Sea coal

RTECS® Number: GF8281000

UN/NA & ERG Number: UN1361/133

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Description: Coal dust is a combustible dark brown-black solid dispersed in the air. Properties vary depending on type of coal.

Potential Exposure: Compound Description: Tumorigen. Those involved in the mining, preparation, delivery, or use of powdered coal.

Incompatibilities: Keep dust away from strong oxidizers. The dust can act as a reducing agent. Slightly explosive when exposed to flame.

Permissible Exposure Limits in Air [SiO_2 = quartz]

OSHA PEL: 2.4 mg/m^3 TWA (containing less than 5% SiO_2), respirable fraction; 10 mg/m^3/(%% SiO_{2+2}) TWA (containing more than 5% SiO_2), respirable fraction.

ACGIH TLV®[1]: 2 mg/m^3 TWA (containing less than 5% SiO_2), respirable fraction; 0.1 mg/m^3 TWA (containing more than 5% SiO_2), respirable fraction; 0.9 mg/m^3 TWA Bituminous and 0.4 mg/m^3 TWA for Anthracite, not classifiable as a human carcinogen.

United Kingdom: LTEL 2 mg/m^3 (respirable), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 2 mg/m^3 TWA (containing less than 5% SiO_2), respirable fraction.

Determination in Air: Coal dust may be determined gravimetrically: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0600, Particulates NOR (respirable). See also Method #7500. See also OSHA Analytical Method ID-142. No TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long Term Exposure: The inhalation of coal dust may cause coal workers’ pneumoconiosis (CWP), chronic bronchitis, decreased pulmonary function, emphysema. This can result in reduction in ventilatory capacity, pulmonary hypertension, and premature death.

Points of Attack: Respiratory system.

Medical Surveillance: Preplacement and annual physical examinations should be performed with emphasis on the respiratory system including chest X-rays.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear thick working gloves and safety glasses.[24]

Respirator Selection: Use NIOSH/MSHA-approved dust respirator.

Storage: Color Code—Yellow Stripe [*dust* (*strong reducing agent*)]: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this material you should be trained on its proper handling and storage. Store in a cool, well-ventilated area away from strong oxidizers and open flame. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Carbon, animal, or vegetable origin requires a shipping label of “SPONTANEOUSLY COMBUSTIBLE.” It falls in Hazard Class 4.2 and Packing Group III.[19] The letter “I” identifies proper shipping names which are appropriate for describing materials in international transportation. An alternate proper shipping name may be selected when only domestic transportation is involved.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Remove to containers which are readily disposable to land reclamation or dumps. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste.

Fire Extinguishing: This chemical is a combustible solid. Coal dust is explosive when exposed to flame. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases can be produced in fire, including carbon monoxide. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use land reclamation or dumps.[24]

Coal tar pitch and volatiles C:1290

Synonyms: *8001-58-9:* AWPA No. 1; Brick oil; Coal tar creosote; Coal tar distillate; Coal tar oil; Creosota de alquitran de hulla (Spanish); Creosote, coal tar; Creosote, from coal tar; Creosote oil; Creosote P1; Creosotum; Cresylic creosote; Dead oil; Heavy oil; Liquid pitch oil; Naphthalene oil; Preserv-*o*-Sote; Tar oil; Wash oil

Note: Synonyms vary depending upon the specific compound that are covered as separate records (e.g. acridine, anthracene, benzo(a)pyrene, chrysene, pyrene, phenanthrene). NIOSH considers coal tar, coal tar pitch, and creosote to be coal tar products.

CAS Registry Number: 65996-93-2 (coal tar pitch); 8007-45-2 (coal tar); 65996-92-1 (coal tar distillate); 8001-58-9 (coal tar creosote)

RTECS® Number: GF8655000 (coal tar pitch); GF8600000 (coal tar); GF8617500 (coal tar distillate); GF8615000 (coal tar creosote)

UN/NA & ERG Number: UN2713 (Acridine)/153; see also UN1999 (coal tar)/130; UN1136/128 (coal tar distillate); UN1993 (coal tar creosote)/128

EC Number: 266-028-2 [*Annex I Index No.:* 648-055-00-5] (pitch, coal tar, high-temp); 232-361-7 [*Annex I Index No.:* 648-081-00-7] (tar, coal); 266-027-7 [*Annex I Index No.:* 648-047-00-1] [distillates (coal tar)]; 232-287-5 [*Annex I Index No.:* 648-101-00-4] (creosote); 232-361-7 [*Annex I Index No.:* 648-081-00-7] (coal tar pitch).

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: (coal tar pitch) 11th Report on Carcinogens, 2004, Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1.[9]

creosotes (8001-58-9)

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2A; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Banned or Severely Restricted (coal tar oils) (UN).[35]

FDA—over-the-counter drug (coal tar creosote).

US EPA, FIFRA, 1998 Status of Pesticides: Supported (coal tar creosote).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U051.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: *(if present as coke oven emissions*) Cancer 2/27/87; (creosotes) 10/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations [*65996-93-2; (The residue from the distillation of high temperature coal tar. A black solid with an approximate softening point from 30°C to 180°C/86°F to 356°F. Composed primarily of a complex mixture of three or more membered condensed ring aromatic hydrocarbons*)]; [*8007-45-2 (The by-product from the destructive distillation of coal. Almost black semisolid. A complex combination of aromatic hydrocarbons, phenolic compounds, nitrogen bases and thiophene.)*]; [*65996-92-1 (The distillate from coal tar having an approximate distillation range of 100−450°C/212−842°F. Composed primarily of two to four membered condensed ring aromatic hydrocarbons, phenolic compounds, and aromatic nitrogen bases.)*]: Hazard Symbol: T; Risk phrases: R45; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters. [Coal tar pitch, softening point >80°C, ground to grain size <1 cm.]; 2 [Coal tar pitch, softening point >80°C, molten or pieces (grain size >1 cm.)].

Description: The term "coal tar products," as used by NIOSH, includes coal tar and two of the fractionation products of coal tar, creosote and coal tar pitch, derived from the carbonization of bituminous coal. Coal tar, coal tar pitch, and creosote derived from bituminous coal often contain identifiable components which by themselves are carcinogenic, such as benzo(a)pyrene, benzanthracene, chrysene, and phenanthrene. Other chemicals from coal tar products, such as anthracene, carbazole, fluoranthene, and pyrene, may also cause cancer, but these causal relationships have not been adequately documented. Also, the research chemical methylcholanthrene [CAS: 56-49-5], a powerful carcinogen, fits this category. Boiling point = >260°C; Melting point = 250-180°C; Flash point = 207°C (coal tar pitch); 74°C (creosote oil); Autoignition temperature = >510°C. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Human Data (coal tar pitch volatiles); Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector (coal tar creosote). The coke-oven plant is the principal source of coal tar. The hot gases and vapors produced during the conversion of coal to coke are collected by means of a scrubber, which condenses the effluent into ammonia, water, crude tar, and other by-products. Crude tar is separated from the remainder of the condensate for refining and may undergo further processing. Employees may be exposed to pitch and creosote in metal and foundry operations; when installing electrical equipment; in construction, railway, utility; and briquette manufacturing.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; BEIp issued.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)

Coal tar pitch volatiles

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 80 mg/m^3

Protective Action Criteria (PAC)

Coal tar, aerosol

TEEL-0: 0.4 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 500 mg/m^3

Protective Action Criteria (PAC)

Coal tar creosote

TEEL-0: 0.2 mg/m^3

PAC-1: 35 mg/m^3

PAC-2: 80 mg/m^3

PAC-3: 80 mg/m^3

DFG MAK: Category 1, human carcinogen.

Denmark: TWA 0.2 mg/m^3, 1999: France: VME 0.2 mg/m^3, 1999: United Kingdom: LTEL 0.14 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for coal tar pitch volatiles in ambient air[60] ranging from zero (North Carolina) to 0.0161 μg/m^3 (Kansas) to 0.48 μg/m^3 (Pennsylvania) to 2.0 μg/m^3 (Connecticut and Virginia) to 5.0 μg/m^3 (Nevada).

Determination in Air: Collection on a filter, extraction, column chromatography; spectrophotometric measurement. Benzene solubility may be determined by collection of particulates on a filter, ultrasonic extraction with benzene, evaporation and gravimetric determination. Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Determination in Water: No method established. Octanol−water coefficient: Log K_{ow} = about 6.0.

Routes of Entry: Inhalation, skin and eye contact.

Harmful Effects and Symptoms

Based on a review of the toxicologic and epidemiologic evidence presented, it has been concluded that some materials contained in coal tar pitch, and therefore, in coal tar, can cause lung and skin cancer; and perhaps cancer at other sites. Based on a review of experimental toxicologic evidence, it is also concluded that creosote can cause skin and lung cancer. While the evidence on creosote is not so strong as that on pitch (in part because of difficulties in chemical characterization of such mixtures), the conclusion on the carcinogenic potential of creosote is supported by information on the presence of polynuclear aromatic hydrocarbons, and imputations and evidence of the carcinogenicity of such hydrocarbons. The overwhelming scientific evidence in the record supports the finding that coke oven emissions are carcinogenic. This finding rests on epidemiological surveys as well as animal studies and chemical analyses of coke oven emissions. Coke oven workers have an increased risk of developing cancer of the lung and urinary tract. In addition, observations of animals and of human populations have shown that skin tumors can be induced by the products of coal combustion and distillation. Chemical analyses of coke oven emissions reveal the presence of a large number of scientifically recognized carcinogens as well as several agents known to enhance the effect of chemical carcinogens, especially on the respiratory tract.

Points of Attack: Respiratory system, lungs, bladder, kidneys, skin.

Medical Surveillance: Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products.

Preplacement Medical Examinations: These examinations shall include comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin, respiratory tract, liver, and kidneys. A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 × 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at 1 s

(FEV 1.0), and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive-pressure respirators.

Periodic Examinations: These examinations shall be made available at least annually and shall include interim medical and work histories. A physical examination as outlined above.

Initial Medical Examinations: These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations.

Pertinent Medical Records: These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer, or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Employers shall use engineering controls when needed to keep the concentration of airborne coal tar products at, or below, the specified limit. Employers shall provide protective clothing and equipment impervious to coal tar products to employees whenever liquid coal tar products may contact the skin or eyes. Emergency equipment shall be located at well-marked and clearly identified stations and shall be adequate to permit all personnel to escape from the area or to cope safely with the emergency on reentry. Protective equipment shall include eye and face protection; protective clothing; and respiratory protection as spelled out in detail by NIOSH.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where coal tar creosote is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of coal tar creosote should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Entry into areas containing coal tar creosote is to be controlled by permit only.

Shipping: The "Acridine" DOT number is used by NIOSH for coal tar pitch volatiles. The required label is "POISONOUS/TOXIC MATERIALS." It would fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep coal tar creosote out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

Fire Extinguishing: *For combustible solids.* Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

For combustible liquids. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. Coal tar creosote is a combustible liquid. Use dry chemical, CO_2, water spray, or foam extinguishers.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

National Institute for Occupational Safety and Health. (September 1977). *Criteria for a Recommended Standard: Occupational Exposure to Coal Tar Products*, NIOSH Document No. 78-107. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Creosote: Health and Environmental Effects Profile No. 53.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Creosote*. Trenton, NJ

Cobalt and oxides C:1300

Molecular Formula: Co

Synonyms: *cobalt metal:* Aquacat; C.I. 77320; Cobalt-59; Cobalto (Spanish); Kobalt (German); NCI-C60311; Super cobalt

CAS Registry Number: 7440-48-4 (cobalt metal); 1307-96-6 [cobalt(II)]; 1308-04-9 (cobalt oxide)

RTECS® Number: GF8750000 (cobalt metal); GG2800000 [cobalt(II)]; GG2900000 (cobalt oxide)

UN/NA & ERG Number: UN3189 (metal powder, self heating, n.o.s.)/135

EC Number: 231-158-0 (cobalt metal)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991.

Banned or Severely Restricted (In Pharmaceuticals) (United States).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cobalt compounds.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (70); 7200 (500); 7201 (10) (cobalt metal).

EPCRA (Section 313): Form R *de minimis* concentration reporting level: 1.0% (cobalt metal).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) Note: Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure (cobalt compounds).

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0% (cobalt compounds).

California Proposition 65 Chemical: Cancer (cobalt metal powder) 7/1/92; (cobalt oxide) 7/1/92.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (cobalt); National Pollutant Release Inventory (NPRI).

Mexico, Wastewater, Toxic Pollutant.

WGK (German Aquatic Hazard Class): No value assigned (oxides); Nonwater polluting agent (metal).

Description: Cobalt is a silver-gray to black, hard, brittle, magnetic metal. It is relatively rare; the important mineral sources are the arsenides, sulfides, and oxidized forms. It is generally obtained as a by-product of other metals, particularly copper. Molecular weight = 58.93 (cobalt); 74.93 [cobalt(II) oxide]; 165.86 [cobalt(III) oxide]; Specific gravity (H_2O:1) = 8.92; Boiling point = 2870°C; Freezing/Melting point = 1495°C. Hazard Identification (based on NFPA-704 M Rating System): (dust) Health 2, Flammability 3, Reactivity 2. Cobalt is insoluble in water. Cobalt fume and dust have the composition Co/CoO/Co_2O_2/Co_2O_4. Cobaltic oxide: Freezing/Melting point = (decomposes) 895°C. Insoluble in water.

Potential Exposure: Compound Description (cobalt): Tumorigen, Mutagen. Nickel–aluminum–cobalt alloys are used for permanent magnets. Alloys with nickel, aluminum, copper, beryllium, chromium, and molybdenum are used in the electrical, automobile, and aircraft industries. Cobalt is added to tool steels to improve their cutting qualities and is used as a binder in the manufacture of tungsten carbide tools. Various cobalt compounds are used as pigments in enamels, glazes, and paints; as catalysts in afterburners; and in the glass, pottery, photographic, electroplating industries. Radioactive cobalt (^{60}Co) is used in the treatment of cancer. Cobalt has been added to beer to promote formation of foam but cobalt acts with alcohol to produce severe cardiac effects at concentrations as low as 1.2−1.5 mg/L of beer. Cobalt is part of the vitamin B_{12} molecule and as such is an essential nutrient. The requirement of humans for cobalt in the form of vitamin B_{12} is about 0.13 μg/day.

Incompatibilities: Cobalt metal dust/powder may spontaneously ignite on contact with air, when finely divided. Reacts with acids, strong oxidizers, ammonium nitrate, causing fire and explosion hazard. Can promote decomposition of various organic substances. Cobaltic oxide reacts with reducing agents; and violently with hydrogen peroxide.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Co]/m^3 TWA as metal dust and fume.

NIOSH REL: 0.05 mg[Co]/m^3 TWA as metal dust and fume.

ACGIH TLV®[1]: 0.02 mg[Co]/m^3 TWA, animal carcinogen; BEI: 15 μg/L [Co] in urine at end-of-shift at end-of-work-week; 1 μg/L [Co] in blood at end-of-shift at end-of-work-week.

NIOSH IDLH: 20 mg[Co]/m^3.

Protective Action Criteria (PAC)

Metal

TEEL-0: 0.02 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 20 mg/m^3

Oxide

TEEL-0: 0.0272 mg/m^3
PAC-1: 0.0187 mg/m^3
PAC-2: 0.136 mg/m^3
PAC-3: 27.2 mg/m^3

[(II) oxide]

TEEL-0: 0.0254 mg/m^3
PAC-1: 0.0763 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 25.4 mg/m^3

DFG MAK: (*as inhalable fraction*) [skin] Danger of airway sensitization; Carcinogen Category 2 (includes cobalt-containing hard metals); Germ Cell Mutation Category 3A; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine.

Arab Republic of Egypt: TWA 0.1 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, 1999; Denmark: TWA 0.05 mg/m^3, 1999; Finland: TWA 0.05 mg/m^3 [skin] 1999; Hungary: TWA 0.1 mg/m^3; STEL 0.2 mg/m^3, 1993; the Netherlands: MAC-TGG 0.02 mg[Co]/m^3; MAC-TGG 0.02 mg/m^3, 2003; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, 1993; Poland: MAC (TWA) 0.05 mg/m^3, MAC (STEL) 0.2 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, 1993; Sweden: NGV 0.05 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, carcinogen, 1999; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia, for ambient air in residential areas: 0.001 mg/m^3 is the MAC on an average daily basis for cobalt metal. Several states have set guidelines or standards for cobalt in ambient air[60] ranging from 0.33 μg/m^3 (New York) to 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (Florida and North Dakota) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Cobalt metal, dust, and fume may be determined by filter collection, acid dissolution, digestion, and measurement by atomic absorption spectrophotometry. See NIOSH Analytical Method (IV)s #NIOSH 7027, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G, and ID-213.

Permissible Concentration in Water: The EPA[32] has suggested a permissible ambient goal of 0.7 μg/L based on health effects. Russia[43] set a MAC of 1 mg/L in water bodies used for domestic purposes. Limits in water bodies for fishery purposes have been set at 0.01 mg/L for freshwater and 0.05 mg/L for seawater.

Determination in Water: Atomic absorption spectroscopy gives a detection limit of 0.05 mg/L in water. Neutron activation can detect cobalt in urine below 0.5 μg/L.

Routes of Entry: Inhalation of dust or fume, ingestion, skin or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cobalt dust is mildly irritating to the eyes and to a lesser extent to the skin. It is an allergen and has caused allergic sensitivity type dermatitis in some industries where only minute quantities of cobalt are used. The eruptions appear in the flexure creases of the elbow, knee, ankle, and neck. Cross sensitization occurs between cobalt and nickel; and to chromium when cobalt and chromium are combined. Inhalation of dust and fume may cause irritation of the lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ingestion of cobalt or cobalt compounds is rare in industry. Vomiting, diarrhea, and a sensation of hotness may occur after ingestion; or after the inhalation of excessive amounts of cobalt dust.

Long Term Exposure: Repeated or prolonged inhalation exposure may affect lungs and cause an asthma-like disease with cough and dyspnea. This situation may progress to interstitial pneumonia with marked fibrosis. Pneumoconiosis may develop which is believed to be reversible. Since cobalt dust is usually combined with other dusts, the role cobalt plays in causing the pneumoconiosis is not entirely clear. Cobalt may decrease fertility in males.

Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the heart, resulting in cardiomyopathy. Cobalt may affect the thyroid and kidneys. Cobalt is possibly carcinogenic and mutagenic to humans. Some isotopes of cobalt emit ionizing radiation; such exposure is associated with an increased risk of developing cancer.

Points of Attack: Respiratory system, skin.

Medical Surveillance: In preemployment examinations, special attention should be given to a history of skin diseases; allergic dermatitis; baseline allergic respiratory diseases; and smoking history. A baseline chest X-ray should be taken and chest X-ray for scarring should be done every 2–3 years following 5 or more years of exposure. Periodic examinations should be directed toward skin and respiratory symptoms and lung function. Evaluation for heart failure. Kidney and thyroid function tests. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure. NIOSH lists (cobalt): end-of-shift/end-of-shift at end-of-work-week/end-of-work-week, Blood Serum, Chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1s), urine (chemical/metabolite) end-of-shift/end-of-shift at end-of-work-week/end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Where dust levels are excessive, dust respirators should be used by all workers. Protective clothing should be issued to all workers and changed on a daily basis. Showering after each shift is encouraged prior to change to street clothes. Gloves and barrier creams may be helpful in preventing dermatitis. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, for cobalt metal dust and fume: *0.25 mg/m^3: if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 mg/m^3*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *20 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Cobalt must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), acids, and ammonium nitrate since violent reactions occur. It should be stored in a cool place under an inert atmosphere. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: For metal powder, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall in Hazard Class 4.2 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. If spill involves radioactive cobalt, evacuate area and delay cleanup until properly instructed by qualified radiation authorities. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, however, powdered cobalt will ignite. Use dry chemical such as sand, dolomite, and graphite powder for extinguishing powdered metal fires. *Do not use water*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For cobalt chloride: chemical reaction with water, caustic soda, and slaked lime, resulting in precipitation of the metal sludge, which may be landfilled. Cobalt metal may be recovered from scrap and cobalt compounds from spent catalysts as alternatives to disposal.[22]

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Cobalt*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 188−205

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 47−48. New York: Van Nostrand Reinhold Co. (Cobalt)

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Cobalt*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Cobalt*. Trenton, NJ

Cobalt carbonyl C:1310

Molecular Formula: $C_8Co_2O_8$

Common Formula: $Co_2(CO)_8$

Synonyms: Cobalt octacarbonyl; Cobalto tetracarbonilo (Spanish); Cobalt tetracarbonyl; Cobalt tetracarbonyl dimer; Di-μ-carbonylhexacarbonyldicobalt; Dicobalt carbonyl; Dicobalt octacarbonyl; Octacarbonyldicobalt

CAS Registry Number: 10210-68-1; 37264-96-3; *(alt.)* 90043-99-5

RTECS® Number: GG0300000

UN/NA & ERG Number: UN1325 (flammable solid, organic)/133

EC Number: 233-514-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Carcinogenicity: IARC: Human Inadequate Evidence, group 2B, 1991.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cobalt compounds.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cobalt carbonyl is a pyrophoric (spontaneously flammable in air), red-orange (when pure) to dark-brown crystalline solid. Molecular weight = 341.94; Boiling point = (decomposes) 52°C; Freezing/Melting point = (decomposes) 50.5°C; Vapor pressure = 0.7 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen. This material is used as a catalyst for a number of reactions. It is also used in antiknock gasoline and for high-purity cobalt salts.

Incompatibilities: Reacts with strong acids and strong oxidizers. Decomposes on exposure to air or heat (at about 52°C) producing toxic fumes of carbon monoxide and cobalt. Stable in atmosphere of hydrogen and carbon monoxide.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA.

NIOSH IDLH: 20 mg[Co]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.27 mg/m^3

PAC-1: 0.27 mg/m^3

PAC-2: 27 mg/m^3

PAC-3: 60 mg/m^3

DFG MAK: Not established; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine; Carcinogen Category 2.

Australia: TWA 0.01 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg[Co]/m^3, 1999; France: VME 0.1 mg/m^3, 1999; Hungary: TWA 0.01 mg/m^3; STEL 0.02 mg/m^3, 1993; Japan: 0.05 mg[Co]/m^3, 2B carcinogen, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; United Kingdom: TWA 0.1 mg[Co]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Co]/m^3. Several states have set guidelines or standards for cobalt in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: OSHA ID-125G.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: May cause sensitization and allergic reaction by skin contact and inhalation. The carbonyls are direct irritants. Carbon monoxide causes breathlessness, headache, weakness, fatigue, nausea and vomiting, dimness of vision, collapse, and coma. Cobalt carbonyl is corrosive to the eyes, skin, and severely irritates the respiratory tract. Inhalation of the aerosols can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Cobalt carbonyls share the general high toxicity of carbonyls because of the direct irritant and systemic action of the compound coupled with the effects of carbon monoxide, which is released from their decomposition. The oral LD_{50} = (oral, rat) 754 mg/kg (slightly toxic).

Long Term Exposure: May cause lung irritation and decreased pulmonary function, wheezing, dyspnea (breathing difficulty). Animal tests produce liver and kidney injury.

Points of Attack: Eyes, skin, respiratory system, blood, central nervous system.

Medical Surveillance: Lung function tests. Liver and kidney function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Decomposes on exposure to air or heat; stable in atmosphere of hydrogen and carbon monoxide. Store in airtight, unbreakable containers in a cool, well-ventilated area away from strong oxidizers and acids.

Shipping: FLAMMABLE SOLID, N.O.S., Hazard Class 4.1, Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. If appropriate, moisten spilled material to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in airtight, sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including cobalt and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure,

explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cobalt Carbonyl*. Washington, DC: Chemical Emergency Preparedness Program

Cobalt hydrocarbonyl C:1320

Molecular Formula: C_5HO_5

Common Formula: $HCO(CO)_4$

Synonyms: Hydrocobalt tetracarbonyl; Tetracarbonylhydridocobalt; Tetracarbonylhydrocobalt

CAS Registry Number: 16842-03-8

RTECS® Number: GG0900000

UN/NA & ERG Number: UN1953 [Compressed gases, toxic, flammable, n.o.s.]/119

UN/NA & ERG Number: None assigned

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). *Note*: Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure.

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cobalt hydrocarbonyl is a highly flammable and toxic gas or liquid which decomposes rapidly at room temperature to toxic cobalt carbonyl. It has an offensive odor. Molecular weight = 171.98; Boiling point = 10°C; Freezing/Melting point = $-26°C$; Flash point = flammable gas. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 1. Very slightly soluble in water.

Potential Exposure: Those involved in manufacture and use of this material as a catalyst for organic reactions.

Incompatibilities: Unstable gas; decomposes rapidly in air at room temperature to toxic cobalt carbonyl and explosive hydrogen gas. A strong reducing agent; violent reaction with oxidizers and acids.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.292 ppm

PAC-1: 0.292 ppm

PAC-2: **0.9** ppm

PAC-3: **3** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.1 mg[Co]/m^3; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine; Carcinogen Category 2.

Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg[Co]/m^3, 1999; France: VME 0.1 mg/m^3, 1999; Japan: 0.05 mg[Co]/m^3, 2B carcinogen, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Norway: TWA 0.1 mg[Co]/m^3, 1999; Russia: STEL 0.01 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg [Co]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Co]/m^3. Some states have set guidelines or standards for cobalt in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use OSHA: Method #ID-125G.[rtecs]

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The 30-min LD_{50} = (inh, rats) 165 mg/m^3. The clinical effects are similar to nickel carbonyl and iron pentacarbonyl, but it has about one-half the toxicity of nickel carbonyl. In animals: irritation of respiratory system, dyspnea (breathing difficulty), cough.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preemployment physical examinations should give particular attention to the respiratory tract and skin. Periodic examinations should include the respiratory tract and nasal sinuses, smoking history as well as general health. A baseline chest X-ray should be available and pulmonary function followed.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Where the danger of splash or spill of liquids exists, impervious protective clothing should be used. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, well-ventilated area. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Cobalt hydrocarbonyl fits the description of compressed gases, toxic, flammable, n.o.s. It requires a label of "POISON GAS, FLAMMABLE GAS."[19]

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

American Council of Governmental Industrial Hygienists, Inc. (1986). *Documentation of the Threshold Limit Values: Supplemental Documentation* (5th ed.). Cincinnati, OH

Cobalt naphthenate C:1330

Molecular Formula: $C_{12}H_{18}CoO_4$

Common Formula: $(C_5H_9COO)_2Co$

Synonyms: Cobalt naphtha; Cobalt naphthenate powder; Cobaltous naphthenate; Naphtenate de cobalt (French); Naphthenate de cobalt (French); Naphthenic acid, cobalt salt

CAS Registry Number: 61789-51-3

RTECS® Number: QK8925000

UN/NA & ERG Number: UN2001/133

EC Number: 263-064-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1991.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). *Note:* Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure.

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cobalt naphthenate is a brown powder or bluish-red solid; Freezing/Melting point = 140°C; Flash point = 49°C; Autoignition temperature = 276°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Primary Irritant. Cobalt naphthenate is used as a drying agent in paints, varnishes, inks, and for curing plastics.

Incompatibilities: Contact with strong oxidizers causes a fire and explosion hazard. Highly flammable, powder or dust can form an explosive mixture with air.

Permissible Exposure Limits in Air

Cobalt and compounds

No TEEL available.

DFG MAK: Carcinogen Category 2, as inhalable fraction; [skin] danger of sensitization of the skin and airways; Germ Cell Mutation Category 3A.

Determination in Air: Cobalt metal, dust, and fume may be determined by filter collection, acid dissolution, digestion, and measurement by atomic absorption spectrophotometry. See NIOSH Analytical Method (IV) #7027. See also Method #7300, Elements, and OSHA Analytical Methods ID121 and ID125.

Permissible Concentration in Water: No criteria set. See Cobalt Metal.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Cobalt naphthenate can affect you when breathed in. Breathing the dust or fumes can cause lung allergy (asthma) to develop. Repeated exposures can cause lung scarring. High exposure can damage the heart and/or cause a large thyroid (goiter). Exposure can irritate the nose, throat, and lungs. Higher levels can cause a buildup of fluid (pulmonary edema). This can cause death. Repeated exposure can cause a loss of the sense of smell. Contact can cause a skin allergy to develop.

LD_{50} = (oral-rat) 3900 mg/kg (slightly toxic).

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated exposure to cobalt naphthenate can cause lung irritation, bronchitis, lung scarring with shortness of breath, coughing, and kidney damage.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. Chest X-ray (every 5 years) beginning 10 years after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. GTT and serum lipid studies (to check for blood sugar and fat changes). CBC exam of the cardiovascular system. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, for cobalt metal dust and fume: *0.25 mg/m³: if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 mg/m³*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *1.25 mg/m³:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m³:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *20 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where cobalt naphthenate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Cobalt naphthenate powder requires a "FLAMMABLE SOLID" label. They fall in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cobalt naphthenate is a combustible solid. Use dry chemical, sand, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Cobalt Naphthenate*. Trenton, NJ

Colchicine C:1340

Molecular Formula: $C_{22}H_{25}NO_6$

Synonyms: Acetamide, *N*-(5,6,7,9-Tetrahydro-1,2,3,10-tetramethoxy-9-oxobenzo[a]heptalen-7-yl); 7-Acetamido-6,7-dihydro-1,2,3,10-tetramethoxybenzo(a)heptalen-9(5H)-one; *N*-Acetyltrimethylcolchicinic acid methyl ether; Benzo[a]heptalen-9(5H)-one; 7-α-H-Colchicine; Colchineos; Colchisol; Colcin; Colquicina (Spanish); Colsaloid; Condylon; NSC 757; *N*-(5,6,7,9)-Tetrahydro-1,2,3,10-tetramethoxy-9-oxobenzo(a)heptalen-7-yl-acetamide

CAS Registry Number: 64-86-8

RTECS® Number: GH0700000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-598-5 [*Annex I Index No.:* 614-005-00-6]

Regulatory Authority and Advisory Bodies

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Developmental/Reproductive toxin (male) 10/1/92.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R46; R28; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Colchicine is a pale yellow powder. It has little or no odor. It darkens on contact with light. Molecular weight = 399.88; Freezing/Melting point = 142–157°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Colchicine is a drug used to treat gouty arthritis, pseudogout, sarcoidal arthritis, and calcific tendonitis.

Incompatibilities: Oxidizers, mineral acids. Keep away from light.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.04 mg/m^3

PAC-1: 0.125 mg/m^3

PAC-2: 0.9 mg/m^3

PAC-3: 0.9 mg/m^3

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Colchicine can irritate and burn the eyes, skin, nose, and throat. Exposure can cause nausea, vomiting, diarrhea, loss of appetite, and abdominal pain may occur several hours after exposure. Inhalation can cause lung irritation with coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Colchicine can affect the heart causing arrhythmia. Shock occurs because of extensive vascular damage. Kidney damage resulting in bloody urine and diminished urine output may occur. It is classified as super toxic. The LD_{low} oral (dog, cat) is 0.125 mg/kg. Probable oral lethal dose in humans is less than 5 mg/kg, i.e., less than 7 drops for a 70-kg (150-lb) person. Death results from respiratory arrest. The fatal dose varies considerably; as little as 7 mg of colchicine has proved fatal.

Long Term Exposure: May cause genetic changes; liver and kidney damage. High exposure can cause headache, confusion, muscle weakness, coma, and death.

Points of Attack: Heart, liver, kidneys, lungs.

Medical Surveillance: Complete blood count. Liver and kidney function tests. EKG. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: This material is an alkaloid. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place or a refrigerator. Protect from exposure to light, and keep away from mineral acids and oxidizers.

Shipping: Medicine, solid, toxic, n.o.s. requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using dry chemical, carbon dioxide, or water spray extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and carbon monoxide. Avoid breathing dusts and fumes from burning material. Keep upwind. Wear full protective clothing. Wear self-contained breathing apparatus. Avoid bodily contact with the material. Wash away any material which may have contacted the body with copious amounts of water or soap and water. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (March 1999). *Chemical Hazard Information Profile: Colchicine*. Washington, DC: Chemical Emergency Preparedness Program

Conjugated estrogens C:1350

Synonyms: Amnestrogen; Ces; Climestrone; Co-Estro; Conest; Conestron; Conjes; Conjugated estrogenic hormones; Equigyne (sodium estrone sulfate and sodium equilin sulfate, or synthetic estrogen piperazine estrone sulfate); Estratab; Estrifol; Estroate; Estrocon; Estromed; Estropan; Evex; Femacoid; Femest; Fem H; Femogen; Formatrix; Ganeake; Genisis; Glyestrin; Kestrin; Menest; Menogen; Menotab; Menotrol; Milprem; MsMed; Neo-Estrone; Novoconestron; Oestrilin; Oestro-Feminal; Oestropak; Morning; Ovest; Palopause; Par; Estro; Piperazine oestrone sulphate; PMB; Premarin; Presomen; Promarit; SK-Estrogens; Sodestrin-H; Sodium equilin sulphate; Tag-39; Transannon; Trocosone; Zeste

CAS Registry Number: 12126-59-9

RTECS® Number: GL1224000

EC Number: 235-199-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP: 7th Report on Carcinogens.[10]

California Proposition 65 Chemical: Cancer 1/27/87; Developmental/Reproductive toxin 4/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Conjugated estrogens generally occur as butter-colored powders that are soluble in water. The sodium equilin sulfate component is unstable to light and air. Piperazine estrone sulfate occurs as a white to yellowish white crystalline powder that is slightly soluble in water. Piperazine estrone sulfate melts at 245°C with decomposition. Conjugated estrogens are naturally occurring substances excreted in the urine of pregnant mares; piperazine estrone sulfate is not known to occur naturally.

Potential Exposure: Conjugated estrogens are used in the treatment of climacteric symptoms, vulvae dystrophies, female hypogonadism, and dysfunctional uterine bleeding. They are also used as a treatment following ovariectomy; for chemotherapy of mammary cancer and prostate carcinogema; and for the prevention of postpartum breast engorgement. Additionally, conjugated estrogens have been found in cosmetic preparations.

Incompatibilities: Estrogens are incompatible with strong oxidizers, strong bases, acid chlorides, and acid anhydrides.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set. Because conjugated estrogens are used as pharmaceuticals and in low quantities relative to other chemicals, they are not regulated by EPA. There may be a small pollution problem relative to hospital wastes.

Harmful Effects and Symptoms

Long Term Exposure: There is sufficient evidence that conjugated estrogens are carcinogenic in humans. Liver tumors, endometrial cancer, ovarian cancer, breast cancer, vascular system, and testicular cancer are associated with the use of conjugated estrogens in humans. A large number of studies of cancer of the endometrium suggest that use of conjugated estrogens causes the disease. Several studies reported on the relative risk of breast cancer from use of conjugated estrogens; the evidence is conflicting, both overall and within subgroups.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Copper & oxides C:1360

Molecular Formula: Cu

Synonyms: 1721 gold; Allbri natural copper; Anac 110; Arwood copper; Bronze powder; CDA 101; CDA 102; CDA 110; CDA 122; C.I. 77400; C.I. Pigment metal 2; Cobre (Spanish); Copper bronze; Elemental copper; Gold bronze; Kafar copper; M2 copper; MI (copper); OFHC Cu; Raney copper

CAS Registry Number: 7440-50-8; *(alt.)* 72514-83-1; 1317-38-0 (CuO, copper oxide fume); 1317-39-1 (copper oxide)

RTECS® Number: GL5325000; GL7900000 (CuO, copper oxide fume)

EC Number: 231-159-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—proprietary drug

US EPA, FIFRA, 1998 Status of Pesticides: Supported

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (60); 7210 (200).

Safe Drinking Water Act: MCL, 1.3 mg/L; MCLG, 1 mg/L; SMLC, 1.0 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 5000 lb (2270 kg) (no reporting of releases of this hazardous substance is required if the diameter of the pieces of solid metal released is equal to 0.004 in).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited; Drinking Water Quality $\leq$ 1.0 mg/L.

Mexico, Drinking Water = 1.0 mg/L.

WGK (German Aquatic Hazard Class): No value assigned (*metal*); 3—Highly water polluting (*copper oxide*).

Description: Copper is a reddish-brown metal which occurs free or in ores, such as malachite, cuprite, and chalcopyrite. Copper fume is a finely divided black particulate dispersed in air. Copper dusts and mists have been assigned the formula $CuSO_4 \cdot 5H_2O/CuCl$ by NIOSH. Copper fume has been designated as $Cu/CuO/Cu_2O$ by NIOSH. Molecular weight = 63.54; Boiling point = 2595°C; Freezing/Melting point = 1083°C. It may form both mono- and divalent compounds. Ignition temperature of dust cloud = 900°C; Minimum explosive concentration = unknown oz/ft^3.[USBM] Hazard Identification (based on NFPA-704 M Rating System). *copper powder*: Health 1, Flammability 3, Reactivity 0. Copper is insoluble in water but soluble in nitric acid and hot sulfuric acid. Relative explosion hazard of dust: Fire.

Potential Exposure: Compound Description: Tumorigen, Drug. Exposure to fume may occur in copper and brass plants; and during the welding of copper alloys; Reproductive Effector; Human Data. Metallic copper is an excellent conductor of electricity and is widely used in the electrical industry in all gauges of wire for circuitry, coil, and armature windings; high conductivity tubes; commutator bars, etc. It is made into castings, sheets, rods, tubing, and wire; and is used in water and gas piping; roofing materials; cooking utensils; chemical and pharmaceutical equipment; and coinage. Copper forms many important alloys: Be−Cu alloy, brass, bronze; gunmetal, bell metal; German silver; aluminum bronze, silicon bronze; phosphor bronze; and manganese bronze. Copper compounds are used as insecticides, algicides, molluscicides, plant fungicides, mordants, pigments, catalysts, as a copper supplement for pastures, and in the manufacture of powdered bronze paint and percussion caps. They are also utilized in analytical reagents, in paints for ships' bottoms; in electroplating; and in the solvent for cellulose in rayon manufacture.

Incompatibilities: Copper dust, fume, and mists form shock-sensitive compounds with acetylene gas, acetylenic compounds, azides, and ethylene oxides. Incompatible with acids, chemically active metals, such as potassium, sodium, magnesium, zinc, zirconium, strong bases. Violent reaction, possibly explosive, if finely-divided material come in contact with strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 mg/m^3 (fume) TWA.

NIOSH: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 mg/m^3 (fume) TWA.

ACGIH TLV®[1]: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.2 mg/m^3 (fume) TWA.

NIOSH IDLH: 100 mg[Cu]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 100 mg/m^3

Fume

TEEL-0: 0.125 mg/m^3
PAC-1: 0.751 mg/m^3
PAC-2: 1.25 mg/m^3
PAC-3: 125 mg/m^3

1317-39-1 (copper oxide)

TEEL-0: 0.1 mg/m^3
PAC-1: 0.25 mg/m^3
PAC-2: 1.5 mg/m^3
PAC-3: 100 mg/m^3

Copper and its inorganic compounds

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 mg/m^3 (fume), 1993; Australia: TWA 0.2 mg/m^3 (fume), TWA 1 mg/m^3 (*dust*), 1993; Austria: MAK 1 mg/m^3, MAK 0.1 mg/m^3 (fume), 1999; Belgium: TWA 0.2 mg/m^3 (fume), 1993; TWA 1 mg/m^3 (*dust*), 1993; Denmark: TWA 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg/m^3 (fume), MAC-TGG 1 mg/m^3 (*dust*), 2003; Finland: TWA 1 mg/m^3 (*dust*), 1999; France: VME (fume) 0.2 mg/m^3, VME (*dust*): 1 mg/m^3, 1999, VME 1 mg/m^3; STEL 2 mg/m^3 (*dust*), 1993; Hungary: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3 (*dust*), 1993; India: TWA 0.2 mg/m^3 (fume), 1993; Norway: TWA 0.05 mg[Co]/m^3, TWA 0.1 mg/m^3, fume, 1999; the Philippines: TWA 1.0 mg/m^3 (fume), 1993; Poland: MAC (TWA) fume 0.1 mg/m^3, MAC (STEL) fume 0.3 mg/m^3, MAC (TWA) dust 1 mg/m^3, MAC (STEL) dust 2 mg/m^3, 1999; Russia: STEL 0.5 ppm (1 mg/m^3) (*dust*), 1993; Sweden: NGV 0.2 mg/m^3 (respirable dust), NGV 1 mg/m^3 (total dust), 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.2 mg/m^3 (fume), MAK-W 1 mg/m^3, KZG-W 1 mg/m^3, 1999; Thailand: TWA 0.1 mg/m^3 (fume), TWA 1 mg/m^3, 1993; United Kingdom: TWA 0.2 mg/m^3, fume, TWA 1 mg/m^3; STEL 2 mg/m^3, dusts and mists as Cu, TWA 1 mg (week)/m^3; STEL 3 mg (week)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg[Cu]/m^3. Several states have set guidelines or standards for copper in ambient air[60] ranging from 0.26−1.57 μg/m^3 (Montana) to 2.0 μg/m^3 (North Dakota) to 2.0−20.0 μg/m^3 (Connecticut) to 4.0−20.0 μg/m^3 (Florida) to 5.0 μg/m^3 (Nevada) to 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (New York).

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G; NIOSH Analytical Methods (fume) #7029, #7300, #7301,

#7303 and OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5.6 μg/L as a 24-h average, never to exceed e[0.94 In (hardness) − 1.23] μg/L. *To protect human health:* 1000 μg/L.[6] Canada: Drinking Water Quality (AO) ≤ 1.0 mg/L. Mexico, Drinking Water = 1.0 mg/L. The Czech Republic[35] set a MAC of 0.1 mg/L in surface water and 0.05 mg/L in drinking water. Russia[35] and The former USSR-UNEP/IRPTC project have set a MAC of 1.0 mg/L in water used for domestic purposes and 0.001 mg/L in freshwater and 0.005 mg/L in seawater used for fishery purposes. States have set guidelines for copper in drinking water are Kansas at 1000 μg/L and Minnesota at 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by atomic absorption, or by colorimetry (using neocuproine), or by inductively coupled plasma (ICP) or optical emission spectrometry. Dissolved copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation of dust or fume, ingestion, or skin or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Copper salts act as irritants to the intact skin causing itching, erythema, and dermatitis. In the eyes, copper salts may cause conjunctivitis and even ulceration and turbidity of the cornea. Metallic copper may cause keratinization of the hands and soles of the feet, but it is not commonly associated with industrial dermatitis. The fumes and dust cause irritation of the upper respiratory tract; metallic taste in the mouth; nausea; metal fume fever. Inhalation of dusts, fumes, and mists of copper salts may cause congestion of the nasal mucous membranes. If the salts reach the gastrointestinal tract, they act as irritants producing salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis, and diarrhea. It is unlikely that poisoning by ingestion in industry would progress to a serious point as small amounts induce vomiting, emptying the stomach of copper salts. Chronic human intoxication occurs rarely and then only in individuals with Wilson's disease (hepatolenticular degeneration). This is a genetic condition caused by the pairing of abnormal autosomal recessive genes in which there is abnormally high absorption, retention, and storage of copper by the body. The disease is progressive and fatal if untreated.

Long Term Exposure: Copper may decrease fertility in both males and females. Repeated or prolonged contact may cause skin sensitization and allergy; thickening of the skin; and may give greenish color to the skin, teeth, and hair. Repeated exposure can cause chronic irritation of the nose and ulcers and hole in the septum dividing the inner nose. Repeated high exposure to copper can cause liver damage. There is evidence that workers in copper smelting plants have an increased risk of lung cancer, but this is thought to be due to arsenic trioxide and not copper.

Points of Attack: For copper dusts and mists: respiratory system, lungs, skin, liver, including risk with Wilson's disease, kidneys. For copper fume: respiratory system, skin, eyes, and risk with Wilson's disease.

Medical Surveillance: Serum and urine copper levels. Evaluation by a qualified allergist. Liver function tests. Copper often contains arsenic as an impurity. Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure. NIOSH lists the following tests: whole blood (chemical/metabolite), blood serum, biologic tissue/biopsy, urine (chemical/metabolite), urine (chemical/metabolite) 24-h collection.

First Aid: If copper dust or powder gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If copper dusts or powder contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Personal Protective Methods: *For copper dusts, powder, or mists:* Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m*^{3}: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m*^{3}*:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *25 mg/m*^{3}*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m³*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Copper fume: Up to 1 mg/m³: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m³:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece*). Up to 100 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe (*copper powder*) Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with copper you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas, oxidizers, and other incompatible materials listed above. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. *Copper powder:* sources of ignition, such as smoking and open flames, are prohibited where copper powder is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store to avoid conditions which create fumes or fine dusts.

Shipping: Copper, elemental is not specifically cited in DOT's Performance-Oriented Packaging Standards.[19]

Spill Handling: Warn other workers of spill. Put on proper protective equipment and clothing. Sweep or vacuum up solids being careful not to raise dust levels. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of copper dust and powder as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Copper powder can be a combustible solid. Copper metal does not burn. Use powdered dolomite, sodium chloride (common salt), or graphite. *Do not use water*. Copper may contain arsenic; poisonous gases may be produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill.[22]

References

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Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 48–49. New York: Van Nostrand Reinhold Co. (Copper)

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Copper*. Trenton, NJ

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Copper*. Version 3. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Copper acetoarsenite

see Paris green.

Copper chloride C:1370

Molecular Formula: Cl_2Cu

Synonyms: Copper bichloride; Copper(2+) chloride; Copper(II) chloride; Copper dichloride; Cupric chloride; Cupric chloride dihydrate; Cupric dichloride; Dicopper dichloride; Dikupferdichlorid (German); Kupferchlorid (CuCl) (German)

CAS Registry Number: 7447-39-4 (II); 7758-89-6 (I)

RTECS® Number: GL7237000

UN/NA & ERG Number: UN2802/154

EC Number: 231-210-2 (II); 231-842-9 (I)

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as copper and compounds.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, as copper compounds; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*dichloride*); 2—Water polluting (*monochloride*).

Description: Copper chloride is a brownish-yellow powder. Molecular weight = 134.44. Boiling point = 993°C (decomposes below this point); Freezing/Melting point = 498°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Copper chloride is used in petroleum, textiles, metallurgy, photography, agricultural products, feed additives, and wood preservation. It is also used in light-sensitive paper manufacturing, glass pigments, ceramics, and in making cyclonitrile.

Incompatibilities: Contact with strong acids forms monovalent copper salts and toxic hydrogen chloride gas. Forms shock-sensitive and explosive compounds with potassium, sodium, sodium hypobromite, nitromethane, acetylene. Keep away from moisture and alkali metals. Attacks metals in the presence of moisture. Reacts with moist air to form cupric chloride dihydrate. May be able to ignite combustible materials.

Permissible Exposure Limits in Air

NIOSH IDLH: 100 mg[Cu]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 2.12 mg/m^3

PAC-1: 6.35 mg/m^3

PAC-2: 10.6 mg/m^3

PAC-3: 212 mg/m^3

Copper and its inorganic compounds

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction of the aerosol; Peak Limitation Category I(1); Pregnancy Risk Group C.

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G, ID-206.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin or eye contact can cause corrosive burns and permanent damage. Irritates the stomach causing salivation, nausea, vomiting, stomach pain, and diarrhea.

Long Term Exposure: Repeated exposure may cause skin thickening and allergy. May cause a greenish color to the skin and hair. May damage the liver and kidneys. Repeated exposure can cause ulcers or a hole in the nasal septum with possible bleeding. May affect the blood.

Points of Attack: Kidneys, liver, skin, blood.

Medical Surveillance: Serum and urine copper levels. Liver and kidney function tests. Evaluation by a qualified allergist. Complete blood count (CBC). Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, moisture, and heat.

Shipping: This chemical requires a shipping label of "CORROSIVE." Copper chloride is in DOT/UN Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn but may ignite combustible materials. Use any extinguisher suitable for surrounding fires. Poisonous gases are produced in fire, including hydrogen chloride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Copper Chloride*. Trenton, NJ

Copper cyanide C:1380

Molecular Formula: $CCuN$, C_2CuN_2

Common Formula: $CuCN$, $Cu(CN)_2$

Synonyms: *cupric cyanide:* Copper(II) cyanide; Copper cynanamide; Cyanure de cuivre (French)

cuprous cyanide: Cianuro de cobre (Spanish); Copper(1+) cyanide; Copper(I) cyanide; Cupricin

CAS Registry Number: 14763-77-0 (cupric cyanide); 544-92-3 (cuprous cyanide)
RTECS® Number: GL7150000 (cuprous cyanide); GL7175000 (cupric cyanide)
UN/NA & ERG Number: UN1587/151
EC Number: 238-826-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As cuprous cyanide

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compounds.
Clean Water Act: Toxic Pollutant (Section 401.15).
US EPA Hazardous Waste Number (RCRA No.): P029.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. (copper).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. (cyanide).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (cupric cyanide); National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as copper compounds, n.o.s.; Drinking Water Quality = 0.2 mg (CN)/L MAC as cyanide compounds.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R26; R37; R40; R41; R43; R50/53; Safety phrases: S1/2; S28; ; S23; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Cuprous cyanide is a white crystalline substance. Cupric cyanide, $Cu(CN)_2$ is a yellowish-green powder which decomposes on heating. Molecular weight = 89.56 (cuprous); 115.55 (cupric); Freezing/Melting point = 473°C (in nitrogen) (cuprous cyanide). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Copper cyanide is used in electroplating copper on iron and as an insecticide and a catalyst.

Incompatibilities: Contact with heat, strong acids (HCl, H_2SO_4, HNO_3) forms deadly hydrogen cyanide gas. May form hydrogen cyanide with water. Keep away from acetylene gas and chemically active metals, such as potassium, sodium, magnesium, and zinc; strong oxidizers (chlorine, fluorine, peroxides, etc.).

Permissible Exposure Limits in Air

As cyanides, as CN

OSHA PEL: 5 mg/m^3 [skin].
Protective Action Criteria (PAC)
544-92-3
TEEL-0: 1.41 mg/m^3
PAC-1: 1.41 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 25 mg/m^3
NIOSH IDLH: 100 mg[Cu]/m^3.

Copper and its inorganic compounds

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction of the aerosol; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group C.
NIOSH IDLH: 100 mg[Cu]/m^3.
The limit set by Russia[43] is 0.3 mg/m^3 as a MAC in workplace air and 0.009 mg/m^3 as a momentary value in ambient air of residential areas; the daily average MAC allowable in residential areas is 0.004 mg/m^3.

Determination in Air: Use NIOSH Analytical Method #7904.[18] For copper: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: The permissible concentration for copper set by US EPA to protect human health is 1 mg/L and for cyanide is 0.2 mg (CN) per liter.[6] The Canadian MAC is the same. Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes and 0.05 mg/L in water bodies used for fishery purposes.

Determination in Water: Cyanide may be determined titrimetrically by EPA Methods 335.2 and 9010 which give total cyanide.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Copper cyanide can affect you when breathed in. Eye contact can cause severe burns with loss of vision. Skin contact can cause irritation or burns. Breathing copper cyanide causes irritation of respiratory tract and may cause nose bleeds or sores in the nose.

Long Term Exposure: Repeated exposure can cause copper to deposit in the liver and other body organs, causing damage, atrophy of the inner lining of the nose, with a watery discharge. Metallic taste may also occur. Repeated skin exposure can cause skin allergy and possibly a green discoloration of the skin and hair. May be able to affect the lungs.

Points of Attack: Skin, lungs, possibly other body organs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful. Urine copper test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with copper cyanide you should be trained on its proper handling and storage. Copper cyanide must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas.

Shipping: Copper cyanide must carry a "POISONOUS/TOXIC MATERIALS" label. It is classified by DOT[19] in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including cyanide gas and nitrous oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing wastes can be concentrated to the point where copper can be electrolytically removed and reclaimed. If recovery is not feasible, the copper can be precipitated by alkali; the cyanide destroyed by alkaline oxidation yielding a sludge which can be sent to a chemical waste landfill.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Copper Cyanide*. Trenton, NJ

Copper sulfate C:1390

Molecular Formula: CuO_4S

Common Formula: $CuSO_4$

Synonyms: Basicop; BCS copper fungicide; Blue copper; Blue stone; Blue vitriol; Copper monosulfate; Copper sulfate (1:1); Copper(2+) sulfate; Copper(2+) sulfate (1:1); Copper(II) sulfate; Copper sulfate pentahydrate; CP basic sulfate; Cupric sulfate anhydrous; Cupric sulphate; Griffin super Cu; Kupfersulfat (German); Phyto-Bordeaux; Roman vitriol; Sulfate of copper; Sulfate de cuivre (French); Sulfato de cobre (Spanish); Sulfuric acid, copper(2+) salt (1:1); TNCS 53; Triangle *pentahydrate:* Blue copper AS; Copper sulphate pentahydrate; Copper(2+) sulfate pentahydrate; Copper(II) sulfate pentahydrate; Cupric sulfate pentahydrate; Kupfersulfat−pentahydrat (German); Kupfervitriol (German); Salzburg vitriol; Sulfuric acid copper(2+) salt (1:1), pentahydrate; Sulfuric acid, copper(2+) salt, pentahydrate; Vencedor

CAS Registry Number: 7758-98-7; 7758-99-8 (pentahydrate)

RTECS® Number: GL8800000; GL8900000 (pentahydrate)

UN/NA & ERG Number: UN3077/171

EC Number: 231-847-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA: Cannot be Determined; Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

As copper compounds

Clean Water Act: Toxic Pollutant (Section 401.15).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical's infrastructure. This category does not include copper phthalocyanide compounds that are substituted with only hydrogen, and/or chlorine, and/or bromine. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Copper sulfate is a greenish-white crystalline solid; the pentahydrate is blue powder or granules, or ultramarine crystalline solid. Molecular weight = 159.60; 249.70 (pentahydrate). Boiling point = 150°C (pentahydrate) with $-5H_2O$; Melting point = (decomposes) >200°C; decomposes >110°C (pentahydrate) with $-4H_2O$; copper sulfate decomposes to CuO at 650°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Highly soluble in water; forms a bright blue solution.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; (pentahydrate) Agricultural Chemical; Tumorigen, Mutagen; Human Data. Copper sulfate is used as an intermediate and wood preservative; also used in the production of copper compounds; to detect and to remove trace amounts of water from alcohols and organic compounds; as a fungicide and algicide; in veterinary medicine and others.

Incompatibilities: Aqueous solution is an acid. May form explosive materials on contact with acetylene and nitromethane. Incompatible with strong bases; hydroxylamine, magnesium; zirconium, sodium hypobromite, hydrazine.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.51 mg/m^3

PAC-1: 2.51 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 251 mg/m^3

Pentahydrate

TEEL-0: 3.93 mg/m^3

PAC-1: 11.8 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 393 mg/m^3

NIOSH IDLH: 100 mg[Cu]/m^3.

Copper and its inorganic compounds

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 mg[Cu]/m^3 (fume), 1993; Australia: TWA 0.2 mg[Cu]/m^3 (fume), 1993; Australia: TWA 1 mg[Cu]/m^3 (*dust*), 1993; Belgium: TWA 0.2 mg[Cu]/m^3; TWA 1 mg[Cu]/m^3 (*dust*), 1993; Finland: TWA 0.2 mg[Cu]/m^3; TWA 1 mg[Cu]/m^3 (*dust*), 1999; France: VME 0.2 mg[Cu]/m^3 (fume); VME 1 mg[Cu]/m^3; STEL 2 mg[Cu]/m^3 (*dust*), 1993; Hungary: TWA 0.2 mg [Cu]/m^3; STEL 0.4 mg[Cu]/m^3 (*dust*), 1993; India: TWA 0.2 mg[Cu]/m^3 (fume), 1993; the Philippines: TWA 1.0 mg [Cu]/m^3 (fume), 1993; Russia: STEL 0.5 mg/m^3; STEL 0.5 ppm (1 mg[Cu]/m^3) (*dust*), 1993; Sweden: NGV 0.2 mg [Cu]/m^3 (respirable dust); NGV 1 mg[Cu]/m^3 (total dust), 1999; Switzerland: TWA 0.1 mg[Cu]/m^3; STEL 0.2 mg [Cu]/m^3 (fume); TWA 1 mg[Cu]/m^3; STEL 1 mg[Cu]/m^3, 1999; Thailand: TWA 0.1 mg[Cu]/m^3 (fume); TWA 1 mg [Cu]/m^3, 1993; United Kingdom: LTEL 0.2 mg[Cu]/m^3 (fume); LTEL 1 mg[Cu]/m^3, 1993. Russia[43] has set limits in the ambient air of residential areas of 0.009 mg/m^3 on a momentary basis and 0.004 mg/m^3 on a daily average basis. The Czech Republic[35]: MAC: 0.1 mg/m^3, daily average basis; MAC: 0.3 mg/m^3, 30-min basis.

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: Russia[43] set a MAC of 0.004 mg/L (0.001 as Cu) in water used for fishery purposes. The EPA[6] has set a maximum of 1.0 mg/L in water to protect human health.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to nose, throat, and lungs, causing coughing and wheezing. *Skin:* May cause irritation of skin, localized coloration, itching, and burns. *Eyes:* May cause severe irritation, inflammation, burns, excessive tissue fluid, and a cloudy cornea; possible permanent damage. *Ingestion:* Poisonous if swallowed. May cause burning and metallic taste in mouth; blue skin coloration; intense inflammation of the stomach and intestines, abdominal pain, vomiting, diarrhea, blood in feces, headache, cold sweat, weak pulse, salivation, nausea, dehydration, low blood pressure, jaundice, and kidney failure. Death may result from a dose of a little as a teaspoon for a 150-lb person.

Long Term Exposure: May cause mutations in humans. May damage the testes and decrease fertility in both males and females. May cause skin allergy and thickening of the skin; copper deposits can cause discoloration in the skin and hair, leaving a green color. Repeated exposure can cause shrinking of the lining of the inner nose with watery discharge; liver damage. Individuals with Wilson's disease absorb, retain, and store copper excessively.

Points of Attack: Skin, reproductive system, liver.

Medical Surveillance: Serum and urine copper level. Liver and kidney tests. Examination by a qualified allergist. More than light alcohol consumption may exacerbate the liver damage caused by copper sulfate.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Empty stomach by lavage with 0.1% solution of potassium ferrocyanide or milk. Liver or kidney function tests may be indicated. May result in methemoglobinemia.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials.

Shipping: Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including oxides of sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add soda ash to waste $CuSO_4$ solution; let stand 24 h. Decant and neutralize solution before flushing to sewer. Landfill sludge.[22]

References

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Copper Sulfate*. Version 3. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Cupric Sulfate*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Cotton dust (raw) C:1400

Molecular Formula: $C_{6n}H_{10n}O_{5n}$

Common Formula: $(C_6H_{10}O_5)_n$

Synonyms: Cotton fiber (raw)

CAS Registry Number: None

RTECS® Number: GN2275000

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1043).

Description: Cotton dust is defined as dust generated into the atmosphere as a result of the processing of cotton fibers combined with any naturally occurring materials, such as stems, leaves, bracts, and inorganic matter which may have accumulated on the cotton fibers during the growing or harvesting period. Any dust generated from processing of cotton through the weaving of fabric in textile mills and dust generated in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber by-products from textile mills are considered cotton dust. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0.

Potential Exposure: Compound Description: Human Data. The Occupational Safety and Health Administration has estimated that nearly a million workers are involved in work with cotton fibers and thus are potentially exposed to cotton dust in the workplace.

Incompatibilities: Strong oxidizers. Dust forms an explosive mixture with air.

Permissible Exposure Limits in Air

No TEEL available.

OSHA PEL: [Z-1-A & 1910.1043*] 1 mg/m^3 TWA [waste processing during waste recycling (sorting, blending, cleaning, and willowing (and garnetting))] 0.200 mg/m^3 TWA (textile yarn manufacturing and cotton washing operations) 0.750 mg/m^3 TWA (textile slashing and weaving operations) 0.500 mg/m^3 TWA [all other operations (for textile mill waste house operations or for dust from "lower grade washed cotton" used during yarn manufacturing)]. All PELs for cotton dust are mean concentrations of lint-free, respirable cotton dust collected by the vertical elutriator or an equivalent method and averaged over an 8-h period.

*The OSHA Standard in 29 CFR 1910.1043 does not apply to cotton harvesting, ginning, or the handling and processing of woven or knitted materials and washed cotton.

NIOSH REL: <0.200 mg/m^3 TWA (as lint-free cotton dust); Reduce exposures to cotton dust to the lowest feasible concentration to reduce the prevalence and severity of byssinosis.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA, 5 × PEL maximum for disposables, per OSHA cotton dust standard. If oil aerosol is present, use R or P95.

DFG MAK: 1.5 mg/m^3 (measured as the, inhalable fraction); Pregnancy Risk Group C.

NIOSH IDLH: 100 mg/m^3.

Finland: TWA 1 mg/m^3, 1999; France: VME 0.2 mg/m^3, fiber, 1999; India: TWA 0.2 mg/m^3, 1993; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; the Philippines: TWA 1 mg/m^3, 1993; Sweden: NGV 0.5 mg/m^3, 1999; Switzerland: MAK-W 0.32 mg/m^3, 1999; United Kingdom: LTEL 0.5 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg/m^3 (G).

Determination in Air: Vertical elutriator; none; Gravimetric; OSHA (1910.1043).

Routes of Entry: Inhalation of dust, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Human pulmonary effects. Breathing raw cotton fiber can cause coughing, fever (resembling metal fume fever), chills; and may cause nausea and vomiting, when first exposed. Allergens or fungi in the cotton or dust can cause illness.

Long Term Exposure: Repeated exposures can cause serious permanent lung damage ("brown lung" or byssinosis). The first symptoms are chest tightness and trouble breathing that occur a few hours after first starting work for the week. At first, the symptoms go away after a day or two but with continued exposure they can become constant.

Points of Attack: Cardiovascular system; respiratory system.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests; forced vital capacity; forced expiratory volume (1 s); forced expiratory volume (1 s)/forced vital capacity (ratio); percentage that the measured values of the forced expiratory volume (1 s) and forced vital capacity differ from the predicted values, using the standard tables in 29CFR1910.1043, Appendix C. Chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1 s); pulmonary function tests: pre- and postshift.

(*a*) *Preplacement*: A comprehensive physical examination shall be made available to include as a minimum: medical history, baseline forced vital capacity (FVC); and forced vital expiratory volume at 1 s (FEV_1). The history shall include administration of a questionnaire designed to elicit information regarding symptoms of chronic bronchitis, byssinosis, and dyspnea. If a positive personal history of respiratory allergy, chronic obstructive lung disease, or other diseases of the cardiopulmonary system are elicited, or where there is a positive history of smoking, the applicant shall be counseled on his increased risk from occupational exposure to cotton dust. At the time of this examination, the advisability of the workers using negative- or positive-pressure respirators shall be evaluated.

(*b*) *Each newly employed person:* Shall be retested for ventilatory capacity (FVC and FEV_1) within 6 weeks of employment. This retest shall be performed on the first day at work after at least 40 h of absence from exposure to cotton dust and shall be performed before and after at least 6 h of exposure on the same day.

(*c*) *Each current employee exposed to cotton dust*: Shall be offered a medical examination at least yearly that shall include administration of a questionnaire designed to elicit information regarding symptoms of chronic bronchitis, byssinosis, and dyspnea.

(*d*) Each current employee exposed to cotton dust shall have measurement of forced vital capacity (FVC) and of forced expiratory volume at 1 s (FEV_2). These tests of ventilatory function should be performed on the first day of work following at least 40 h of absence from exposure to cotton dust and shall be performed before and after at least 6 h of exposure on the same day.

(*e*) Ideally, the judgment of the employee's pulmonary function should be based on preplacement values (values taken before exposure to cotton dust). When preplacement values are not available, then reference to standard pulmonary function value tables may be necessary. Note that these tables may not reflect normal values for different ethnic groups. For example, the average healthy black male may have an approximately 15% lower FVC than a Caucasian male of the same body build. A physician shall consider, in cases of significantly decreased pulmonary function, the impact of further exposure to cotton dust and evaluate the relative merits of a transfer to areas of less exposure or protective measures. A suggested plan for the management of cotton workers was proposed as a result of a conference on cotton workers' health.

(*f*) Medical records, including information on all required medical examinations, shall be maintained for persons employed in work involving exposure to cotton dust. Medical records with pertinent supporting documents shall be maintained at least 20 years after the individual's termination of employment. These records shall be available to the medical representatives of the Secretary of Health, Education, and Welfare; of the Secretary of Labor; of the employee or former employee; and of the employer.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Engineering control shall be used wherever feasible to maintain cotton dust concentrations below the prescribed limit. Administrative controls can also be used to reduce exposure. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield unless full face-piece respiratory protection is worn. Respirators shall also be provided and used for nonroutine operations (occasional brief exposures above the environmental limit and for emergencies) and shall be considered for use by employees who have symptoms even when exposed to concentrations below the established environmental limit. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 1 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 2 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 10 mg/m^3:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Cotton fiber must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect cotton dust in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cotton fiber and dust is flammable. Use water only. Do not use chemical or carbon dioxide extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Cotton dust may be used as a cheap filling in quilt blankets. It contains a large organic fraction which can be digested anaerobically to produce manure plus biogas fuel.[22]

References

National Institute for Occupational Safety and Health. (1975). *Criteria for a Recommended Standard: Occupational Exposure to Cotton Dust*, NIOSH Document No. 75-118

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Cotton Dust (Raw)*. Trenton, NJ

Coumafuryl C:1410

Molecular Formula: $C_{17}H_{14}O_5$

Synonyms: 3-(α-Acetonylfurfuryl)-4-hydroxycoumarin; Cumafuryl (German); Foumarin®; Fumarin®; 3-(α-Furyl-β-acetylaethyl)-4-hydroxycumarin (German); 3-(1-Furyl-3-acetylethyl)-4-hydroxycoumarin; Krumkil; Ratafin®; Rat-A-Way®; Tomarin®

CAS Registry Number: 544-92-3

RTECS®Number: GN4850000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 204-195-5 [607-058-00-1]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: Dropped from listing in 1988.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Coumafuryl is a colorless, white, crystalline solid. Molecular weight = 298.31; Freezing/Melting point = 124°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: This material is an anticoagulant rodenticide. Therefore, those involved in its manufacture, formulation, and application are at risk.

Incompatibilities: Strong oxidizers may create a fire and explosive hazard. Incompatible with acids. At room temperature this material can decompose rapidly to cobalt carbonyl and hydrogen gas; at 52°C cobalt carbonyl decomposes, producing toxic fumes of carbon monoxide and cobalt.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Coumafuryl is very similar to warfarin, a hemorrhagic agent. Inhalation may cause symptoms described in long-term exposure. A single large ingested dose may cause hemorrhagic shock. The LD_{50} oral (mouse) is 14.7 mg/kg (highly toxic). This chemical can be absorbed through the skin, thereby increasing exposure or hemorrhagic effect. High exposure can cause death.

Long Term Exposure: Chronic exposure may cause death by hemorrhagic shock. Absorption by the lungs or after a few days or few weeks of repeated ingestion may cause inhibition of prothrombin synthesis, nosebleeds and bleeding gums, hematoma; small reddish spots like a rash; bruises of the elbows, knees, and buttocks; blood in urine and stools; anemia, occasional paralysis due to a stroke.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers.

Shipping: Coumarin derivative pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in the Hazard Class 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For *small spills*, absorb with sand or other noncombustible absorbent material and place into containers for later disposal. For *small dry spills*, with clean shovel place material into clean, dry container and cover; move containers from spill area. For *large spills*, dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Coumafuryl*. Washington, DC: Chemical Emergency Preparedness Program

Coumaphos C:1420

Molecular Formula: $C_{14}H_{16}ClO_5PS$

Synonyms: Asuntol®; Azunthol; Bay 21/199; Bayer 21/199; Baymix; Baymix 50; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*,*O*-diethyl phosphorothioate; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*,*O*-diethyl phosphorothionate; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*-ester with *O*,*O*-diethyl phosphorothioate; *O*-3-Chloro-4-methyl-7-coumarinyl *O*,*O*-diethyl phosphorothioate; 3-Chloro-4-methyl-7-coumarinyl-diethyl phosphorothioate; 3-Chloro-4-methyl-7-hydroxycoumarindiethyl thiophosphoric acid ester; 3-Chloro-4-methylumbelliferone *O*-ester with *O*,*O*-diethyl phosphorothioate; Co-Ral®; Coumafos; Cumafos (Spanish); *O*,*O*-Diaethyl-*O*-(3-chlor-4-methyl-cumarin-7-yl)-monothiophosphat (German); *O*,*O*-Diethyl 3-chloro-4-methyl-7-umbelliferone thiophosphate; Diethyl3-chloro-4-methylumbelliferyl thionophosphate; *O*,*O*-Diethyl *O*-(3-chloro-4-methyl-7-coumarinyl) phosphorothioate; *O*,*O*-Diethylo (3-chloro-4-methylcoumarinyl-7) thiophosphate; *O*,*O*-Diethyl *O*-(3-chloro-4-methyl-2-oxo-2H-benzopyran-7-yl) phosphorothioate; *O*,*O*-Diethyl *O*-(3-chloro-4-methylumbelliferyl) phosphorothioate; Diethylthiophosphoric acid ester of 3-chloro-4-methyl-7-hydroxycoumarin; Diolice; ENT 17,957; Meldane®; Meldone; Muscatox®; NCI-C08662; Negashunt®; Phosphorothioic acid, *O*-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) *O*,*O*-diethyl ester; Phosphorothioic acid, *O*,*O*-diethyl ester, *O*-ester with 3-chloro-7-hydroxy-4-methylcoumarin; Resitox®; Suntol®; Thiophosphate de *O*,*O*-diethyle et de *O*-(3-chloro-4-methyl-7-coumarinyle) (French); Umbethion

CAS Registry Number: 56-72-4

RTECS®Number: GN6300000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 200-285-3 [*Annex I Index No.*: 015-038-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (455/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R 21; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Coumaphos is a white to brownish crystalline solid with a slight sulfurous odor. Molecular weight = 362.78; Freezing/Melting point = 91°C. Odor threshold = 0.02 ppm. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this material which is used for control of a wide variety of livestock insects including cattle grubs, lice, scabies, flies, and ticks; the common ectoparasites of sheep, goats, horse, swine, and poultry; as well as for screw worms in all these animals.

Incompatibilities: Piperonyl butoxide, oxidizers, strong bases. Slowly reacts with caustics to be hydrolyzed. Keep away from water and heat.

Permissible Exposure Limits in Air

ACGIH TLV®: 0.05 mg/m^3 TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued (2005).

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 125 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Mexico has set a maximum permissible concentration in estuaries of 0.02 mg/L.

Determination in Water: No method available. Octanol−water coefficient: Log $K_{ow} = 4.13$. Fish Tox: 16.96524000 ppb MATC (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause burns to skin and eyes. Fatal skin absorption can occur even if there is no feeling of irritation after contact. Cholinesterase inhibitor. Exposure can cause rapid fatal organophosphate poisoning: with headache, sweating, nausea and vomiting, diarrhea, salivation, abdominal cramps; difficult breathing; stiffness of legs; blurring of vision; followed by loss of muscle coordination; muscle twitching; convulsions, coma, and death. LD_{50} = (oral-rat) 13 mg/kg (highly toxic). The probable oral lethal dose is 50−500 mg/kg; or between 1 teaspoonful and 1 oz for a 70-kg (150-lb) person. May be fatal if inhaled, swallowed, or absorbed through skin. The effects may be delayed.

Long Term Exposure: High or repeated exposure may cause nerve damage causing weakness, poor coordination in the arms and legs. May cause personality changes, depression, memory loss, or irritability. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox: 1.75000 ppb Health Advisory (HIGH).

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water, followed by alcohol. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. In case of poisoning with this substance specific treatment is required; the appropriate means, including instructions, should be available.

Respirator Selection: Where there is potential for exposure to coumaphos, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Coumarin derivative pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in the Hazard Class 6.1.[19,20] Regulated by US DOT as a severe marine pollutant.

Spill Handling: Do not touch spilled material; stop leak if you can do it without risk. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 18,000.

Fire Extinguishing: This material may burn but does not ignite easily. Extinguish with water, foam, carbon dioxide, or dry chemicals. This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chlorides, phosphorous oxides, sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Coumaphos can be decomposed by heating with concentrated alkali. Large amounts should be incinerated in a unit equipped with effluent gas scrubbing.[22]

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Coumaphos*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 53−56 (1984) and 9, No. 1, 19−29 (1989)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs.

(1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Coumaphos*. Trenton, NJ

Coumatetralyl C:1430

Molecular Formula: $C_{19}H_{16}O_3$

Synonyms: Bay 25634; Bay ENE 11183B; Bayer 25,634; 2H-1-Benzopyran-2-one, 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-naphthalenyl)-; Coumarin, 4-hydroxy-3-(1,2,3,4-tetrahydro-1-naphthyl)-; Cumatetralyl (German); Endox; Endrocid; Endrocide; ENE 11183; 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-napthalenyl)-2H-1-benzopyran-2-one; 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-napthyl)cumarin; Racumin; Raucumin 57; Rodentin; 3-(α-Tetral)-4-oxycoumarin; 3-(α-Tetrayl)-4-hydroxycoumarin; 3-(D-Tetrayl)-4-hydroxycoumarin

CAS Registry Number: 5836-29-3

RTECS®Number: GN7630000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 227-424-0 [*Annex I Index No.*: 607-059-00-7]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R48/24/25; R52/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Coumatetralyl is a yellowish-white, crystalline solid. Molecular weight = 292.35. Boiling point = 290°C; Freezing/Melting point = 69−70°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in hot water.

Potential Exposure: Coumatetralyl is used as a rodenticide, functioning as an anticoagulant that does not induce bait-shyness.

Incompatibilities: Contact with oxidizers may cause fire and explosion hazard. Keep away from metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 3 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 16.5 mg/m^3
PAC-3: 16.5 mg/m^3

Permissible Concentration in Water: No criteria set. Fish Tox = 16.96524000 ppb MATC (INTERMEDIATE); STV (Sediment Toxicity Value): VERY LOW.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause symptoms described in long-term exposure. A single large ingested dose may cause hemorrhagic shock. This chemical can be absorbed through the skin, thereby increasing exposure or hemorrhagic effect. High exposure can cause death. The LD_{50} oral (rat) is 16.5 mg/kg (highly toxic). Human Tox (ppb): 1.75000 (HIGH).

Long Term Exposure: Chronic exposure may cause death by hemorrhagic shock. Absorption by the lungs, or after a few days or few weeks of repeated ingestion, may cause inhibition of prothrombin synthesis; nosebleeds and bleeding gums; hematoma, small reddish spots like a rash; bruises of the elbows, knees, and buttocks; blood in urine and stools; anemia, occasional paralysis due to a stroke. Preexisting blood clotting disease or liver disease is aggravated by coumatetralyl exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−36 h following overexposure, as effects may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. The following might be considered in an emergency: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: Coumarin derivative pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in the Hazard Class 6.1.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. With clean shovel place material into clean, dry container and cover. Dike far ahead of *large spills* for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind, keep out of low areas. Wear positive-pressure breathing apparatus and special protective clothing. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire, including oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a solvent and burn in a furnace by spraying in the solution.[22]

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Coumatetralyl*. Washington, DC: Chemical Emergency Preparedness Program

p-Cresidine C:1440

Molecular Formula: $C_8H_{11}NO$

Common Formula: $C_6H_3(NH_2)(OCH_3)(CH_3)$

Synonyms: *m*-Amino-*p*-cresol, methyl ester; 3-Amino-*p*-cresol methyl ester; 1-Amino-2-methoxy-5-methylbenzene; 3-Amino-4-methoxytoluene; 2-Amino-4-methylanisole; *o*-Anisidine,5-methyl-; Azoic red 36; Benzeneamine, 2-methoxy-5-methyl-; C.I. azoic red 83; *p*-Cresidina (Spanish); Cresidine; Kresidine; Krezidin (German); Krezidine; 2-Methoxy-5-methylaniline; 2-Methoxy-5-methyl-benzenamine; 4-Methoxy-*m*-toluidine; 4-Methyl-2-aminoanisole; 5-Methyl-*o*-anisidine; NCI-C02982; Paracresol

CAS Registry Number: 120-71-8

RTECS®Number: BZ6720000

EC Number: 204-419-0 [*Annex I Index No.:* 612-209-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1982; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; Safety phrases: S53; R45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: *p*-Cresidine is a white crystalline solid. Molecular weight = 137.20. Boiling point = 235°C; Freezing/Melting point = 52°C; Flash point ≥ 112°C; Autoignition temperature = 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Primary Irritant. *p*-Cresidine is used as an intermediate in the production of various azo dyes, printing inks, and pigments; including 11 dyes that are produced commercially in the United States. Human exposure to *p*-Cresidine occurs primarily through inhalation of vapors or skin absorption of the liquid. Exposure to *p*-cresidine is believed to be limited to workers in dye-production facilities. The Consumer Product Safety Commission staff believes it is possible that residual levels or trace impurities of *p*-cresidine may be present in some dyes based on this chemical, and it may be present in the final consumer product. The presence of *p*-cresidine, even as a trace contaminant, may be a cause for concern. However, data describing the actual levels of impurities in the final product and the potential for consumer exposure and uptake are currently lacking.

Incompatibilities: Contact with oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: Carcinogen Category 2.

Austria: carcinogen, 1999; Finland: carcinogen, 1993; France: carcinogen, 1993; Switzerland: carcinogen, 1999. Zero in ambient air set by North Dakota.[60]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.67$.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include skin and eye irritation; nausea, vomiting, liver damage; cyanosis, methemoglobinemia, weakness, drowsiness, somnolence, and loss of consciousness. LD_{50} = (oral-rat) 1450 mg/kg (slightly toxic).

Long Term Exposure: May cause cancer in humans. When administered in the diet, *p*-cresidine was carcinogenic to rats, causing increased incidences of carcinomas and papillomas of the urinary bladder in both sexes; increased incidences of olfactory neuroblastomas in both sexes; and increased incidences of liver tumors in males. *p*-Cresidine was also carcinogenic in mice, causing carcinomas of the urinary bladders in both sexes and hepatocellular carcinomas in females. May cause anemia.

Points of Attack: Blood.

Medical Surveillance: Blood hemoglobin level. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. The following might be considered in an emergency: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue (*potential carcinogen*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Store in a refrigerator under an inert atmosphere for prolonged storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: *p*-Cresidine is not specifically cited in DOT's Performance-Oriented Packaging Standards.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. The substance decomposes on heating or on burning, producing toxic and irritating fumes including oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure,

explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Cancer Institute. (1979). *Bioassay of p-Cresidine for Possible Carcinogenicity*, DHHS Publication No. (NIH) 78-1394. Springfield, VA: National Technical Information Service

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: p-Cresidine*. Trenton, NJ

Cresols C:1450

Molecular Formula: C_7H_8O

Common Formula: $CH_3C_6H_4OH$

Synonyms: *m-isomer:* Benzene, 3-methyl-; *m*-Cresol; 3-Cresol; Cresol-*m*; *m*-Cresylic acid; 1-Hydroxy-3-methylbenzene; *m*-Hydroxytoluene; 3-Hydroxytoluene; *m*-Kresol (German); Metacresol; *m*-Methylphenol; 3-Methylphenol; Phenol, 3-methyl-; *m*-Toluol

mixed isomers: Acede cresylique (French); *ar*-Toluenol; Bacillol; Cresol isomers; Cresols (*o*-; *m*-; *p*-); Cresols (all isomers); Cresols and cresylic acids, mixed; Cresylic acid; Hydroxytoluole (German); Kresole (German); Methylphenol; Phenol, methyl-; Tekresol; Tricresol

o-isomer: Benzene, 2-methyl-; *o*-Cresol; 2-Cresol; Cresol-*o*; cresol-*o*-; *o*-Cresylic acid; 1-Hydroxy-2-methylbenzene; *o*-Hydroxytoluene; 2-Hydroxytoluene; *o*-Kresol (German); *o*-Methylphenol; 2-Methylphenol; Orthocresol; Phenol, 2-methyl; *o*-Toluol

p-isomer: Benzene, 4-methyl; *p*-Cresol; 4-Cresol; Cresol-*p*; *p*-Cresylic acid; 1-Hydroxy-4-methylbenzene; *p*-Hydroxytoluene; 4-Hydroxytoluene; *p*-Kresol (German); *p*-Methylphenol; 4-Methylphenol; Phenol, 4-methyl; *p*-Toluol

CAS Registry Number: 1319-77-3 (mixed isomers, cresylic acid); 95-48-7 (*o*-isomer); 108-39-4 (*m*-isomer); 106-44-5 (*p*-isomer)

RTECS®Number: GO5950000 (mixed isomers); GO6300000 (*o*-isomer); GO6125000 (*m*-isomer); GO6475000 (*p*-isomer)

UN/NA & ERG Number: UN2076 (cresols)

EC Number: 203-577-9 (*m*-isomer); 202-432-8 (*o*-isomer); 203-398-6 (*p*-isomer)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (*o-, m-, & p-isomers*): Possible Human Carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed, *m*-isomer.

Mixed isomers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 100 lb (4.54 kg); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U052.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 200 mg/L. *Note*: if *o*-, *m*-, and *p*-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cresols (*o-, m, and p-isomers*).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, all isomers; National Pollutant Release Inventory (NPRI).

WGK (German Aquatic Hazard Class): 2—Water polluting (*o-, m, and p-isomers*).

Description: Cresol is a mixture of the three isomeric cresols, *o-, m-*, and *p*-cresol. Cresols are slightly soluble in water.

m-isomer: Colorless or yellow liquid with characteristic odor. Molecular weight = 108.15; Specific gravity (H_2O:1) = 1.03; Boiling point = 202.7°C; Freezing/Melting point = 12.2°C; Vapor pressure = 0.14 mmHg at 25°C; Flash point = 86°C (cc); Autoignition point = 558°C. Explosive limits: LEL = 1.1% at 149°C. Hazard Identification (based on NFPA-704 M Rating System): (cresols) Health 3, Flammability 2, Reactivity 0. Solubility in water = 2%.

o-isomer: Colorless or yellow liquid or crystals that turn dark on exposure to air and light, with characteristic phenolic odor. Molecular weight = 108.15; Specific gravity (H_2O:1) = 1.05; Boiling point = 191.1°C; Freezing/Melting point = 31.1°C; Vapor pressure = 0.29 mmHg at 25°C; Flash point = 81°C (cc); Autoignition point = 599°C. Explosive limits: LEL = 1.4% at 149°C. Hazard Identification (based on NFPA-704 M Rating System): (cresols) Health 3, Flammability 2, Reactivity 0. Solubility in water = 2%.

p-isomer: Colorless to yellow crystals that turn dark on exposure to air and light, with characteristic odor. Molecular weight = 108.15; Specific gravity (H_2O:1) = 1.04; Boiling point = 201.8°C; Freezing/Melting point = 36°C; Flash point = 86°C (cc); Autoignition point = 558-560°C. Explosive limits: LEL = 1.1%; UEL = -%. Hazard Identification (based on NFPA-704 M Rating System): (cresols) Health 3, Flammability 2, Reactivity 0. Solubility in water = 2%.

mixed isomers: Molecular weight = 108.15; Boiling point = 202°C; Freezing/Melting point = 35°C; Vapor pressure = 0.11 mmHg at 25°C; Flash point = 43−82°C; Autoignition point = about 560°C. Explosive limits: LEL = 1.1%. Hazard Identification (based on NFPA-704 M Rating System): (cresols) Health 3, Flammability 2, Reactivity 0. Solubility in water = 2%.

Potential Exposure: Compound Description (*m*-, *o*-): Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. (*p*-isomer): Tumorigen, Drug, Mutagen, Natural Product; Primary Irritant. Cresol is used as a disinfectant and fumigant, as an ore flotation agent, and as an intermediate in the manufacture of chemicals, dyes, plastics, and antioxidants. A mixture of isomers is generally used; the concentrations of the components are determined by the source of the cresol.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, oxidizers, alkalies, aliphatic amines, amides, chlorosulfonic acid, oleum. Decomposes on heating, producing strong acids and bases, causing fire and explosion hazard. Liquid attacks some plastics and rubber. Attacks many metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.43 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/22 mg/m^3 TWA [skin].

NIOSH REL: 2.3 ppm/10 mg/m^3 TWA.

ACGIH TLV®[1]: 20 ppm TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

All isomers

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 24.9 ppm

PAC-3: 250 ppm

DFG MAK *(all isomers)*: [skin]; Germ Cell Mutation Category 3A.

NIOSH IDLH: 250 ppm.

Austria: MAK 5 ppm (22 mg/m^3), [skin], 1999; Denmark: TWA 5 ppm (22 mg/m^3), [skin], 1999; France: VME 5 ppm (22 mg/m^3), 1999; Japan: 5 ppm (22 mg/m^3), 1999; Norway: TWA 5 ppm (22 mg/m^3), 1999; United Kingdom: TWA 5 ppm (22 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm [skin]. Russia set a MAC of 0.5 mg/m^3 in work-place air.[35] They have also set a MAC of 0.005 mg/m^3 in ambient air in residential areas both on a momentary and on a daily average basis. Several states have set guidelines or standards for cresols in ambient air[60] ranging from 12.0 μg/m^3 (Massachusetts) to 73.0 μg/m^3 (New York) to 110 μg/m^3 (Indiana) to 200 μg/m^3 (Connecticut) to 220 μg/m^3 (Florida, North Dakota, South Carolina) to 370 μg/m^3 (Virginia) to 524 μg/m^3 (Nevada) to 2200 μg/m^3 (North Carolina).

Determination in Air: XAD-7® (tube); Methanol; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #2546, Cresols and Phenol, or OSHA Analytical Method 32.

Permissible Concentration in Water: No criteria set, but EPA has suggested a permissible ambient concentration, based on health effects, of 304 μg/L. Russia[43] set a MAC of 0.004 μg/L in water used for domestic purposes of *m*- and *p*-isomers. A limit of 0.003 mg/L of *o*-isomer is set for water bodies used for fishery purposes. Mexico[35] set a MAC of 1.5 mg/L of cresols in the waters in estuaries.

Routes of Entry: Inhalation of percutaneous absorption of liquid or vapor, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Corrosive on ingestion. May affect the central nervous system. Exposure may result in death. The effects may be delayed. *Inhalation:* A level of 4 ppm was reported not to cause symptoms. Exposure to 48 ppm for 5−10 min may cause irritation to the nose, throat, and lungs; nausea; vomiting; and general muscle weakness. High blood pressure, tremors, and convulsions have been reported in people exposed to Cresol at unspecified levels. Due to irritating effects, the inhalation of appreciable amounts of cresol vapor in the workplace under normal conditions is unlikely. *Skin:* This is a major route of exposure and the one which causes most work-related cresol injuries. Contact with 20 mL of 90% cresol resulted in burns, swelling, internal bleeding, and kidney damage, and has caused death in children; 10% cresol left on the skin for 2 h has caused inflammation, blistering, and scarring; 6% for 5−6 h has caused drying and peeling, inflammation, facial tremors, and tearing. A 4% solution tested on human skin produced no sensitization reaction. *Ingestion:* 250 mL of 50% Cresol has caused pneumonia, irritation of the pancreas, kidney failure, and unconsciousness. Symptoms reported from swallowing an unspecified amount of cresol include an immediate burning of the tissues, sweating, headache, dizziness; muscle weakness; ringing in the ears and pale skin appearance. Death has occurred from as little as 1 g (about ¼ teaspoon). Exposure may result in a burning pain in the mouth and throat; white necrotic lesions in the mouth, esophagus, and stomach; abdominal pain; vomiting, diarrhea, paleness, sweating; weakness, headache, dizziness; ringing in ears; shallow respiration with "phenol" odor on the breath; scanty, dark-colored or "smoky" urine; and possible delirium followed by unconsciousness. Convulsions are rarely seen, except in children. Hypersensitivity develops in certain individuals. The chemical is rated as a very toxic compound with a probable oral lethal dose in humans of 50−500 mg/kg, or between 1 teaspoon and 1 oz for a 70-kg (150-lb) person.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung damage. Repeated or prolonged exposure may affect the central nervous system, kidneys, and liver. *p-isomer:* Repeated or prolonged skin contact with the *p*-isomer may cause dermatitis.

Points of Attack: Central nervous system, respiratory system, liver, kidneys, skin, eyes.

Medical Surveillance: Consider the skin, eyes, respiratory system, liver, and kidney functions in placement or periodic examinations. Liver and kidney function tests. Evaluation by a qualified allergist. Consumption of alcohol may increase liver damage. NIOSH lists the following tests: Liver function tests; pulmonary function tests; urine (chemical/metabolite); urine (chemical/metabolite) Pre- and Postshift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. *m-Cresol 108-39-4* **4 h**: (at least 4 but <8 h of resistance to breakthrough >0.1 $\mu g/cm^2/min$): Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots. *p-Cresol 106-44-5* **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 $\mu g/cm^2/min$): 4H™ and Silver Shield™ gloves. Also, Saranex™ has been recommended as a protective material for cresols. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH as cresol: *23 ppm:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; Sa (APF = 10) (any supplied-air respirator). *57.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *115 ppm:* GmFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cresols you should be trained on its proper handling and storage. Before entering confined space where cresols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Away from strong acids or oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: For cresols, this chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and the Packing Group is II.[19,20]

Spill Handling: Avoid inhalation. Wear proper respiratory protection and eye protection. Wear protective clothing. Do not touch spilled material. Stop leak if you can do so without risk. Use water spray to reduce vapors. For *small spills:* absorb the material with sand or other noncombustible absorbent material and place into containers for later disposal. For *small dry spills*, shovel up and place into clean, dry containers and cover. For *large spills*, dike far ahead of spill for later disposal. If clothing becomes contaminated remove immediately and isolate at the site. If a leak or spill has not ignited, use water spray to disperse the vapors and to provide protection for personnel attempting to stop a leak. Water spray may be used to flush spills away from exposures. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cresols are combustible. Stay upwind, keep out of low areas. Ventilate closed spaces before entering them. Use water to blanket the fire and dry chemical, foam, or carbon dioxide to extinguish the flames. Extinguish small fires with dry chemical, carbon dioxide, water spray, or foam. For large fires use water spray, fog, or foam. Move container from fire area if you can do so without risk. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Dike fire control water for later disposal; do not scatter the material. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Wastewaters may be subjected to biological treatment. Concentrations may be further reduced by ozone treatment. High concentration wastes may be destroyed in special waste incinerators.[22]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Cresol*, NIOSH Document No. 78-133. Washington, DC

US Environmental Protection Agency. (June 1978). *A Study of Industrial Data on Candidate Chemicals for Testing (Alkyl Phthalates and Cresols)*, Report EPA-560/5-78-002. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Cresols and Cresylic Acid: Health and Environmental Effects Profile No. 54*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Cresylic Acid.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1985). *Hazardous Substances Fact Sheet: Cresylic Acid.* Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Cresol (Mixture)*. Albany, NY: Bureau of Toxic Substance Assessment. Also separate fact sheets on "*ortho*-Cresol," "*meta*-Cresol," and "*para*-Cresol"

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, for *o*-cresol: 5, No. 3, 30−34 (1985), for *m*-cresol: 1, No. 6, 44−46 (1981), and 6, No. 1, 41−46 (1986)

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Cresols (Mixed Isomers)*. Trenton, NJ

Crimidine C:1460

Molecular Formula: $C_7H_{10}ClN_3$

Common Formula: $C_7H_{10}N_3Cl$

Synonyms: Castrix®; 2-Chloro-4-methyl-6-dimethylaminopyrimidine; Crimidin (German); Pyrimidine, 2-chloro-4-(dimethylamino)-6-methyl-; W 491

CAS Registry Number: 535-89-7

RTECS®Number: UV8050000

UN/NA & ERG Number: UN2588/151

EC Number: 208-622-6 [*Annex I Index No.:* 613-004-00-8]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (Germany) (UN).[13]

Substances and Quantity Potential Likely to Cause Major Accidents (ILO): 100 kg.

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: r28; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Crimidine is a brown, waxy solid. Molecular weight = 171.65; Boiling point = about 145°C; Freezing/Melting point = 87°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Crimidine is used as a rodenticide but is not registered in the United States as a pesticide.

Incompatibilities: Acids and acid fumes, strong bases.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.25 mg/m^3
PAC-1: 0.75 mg/m^3
PAC-2: 1.2 mg/m^3
PAC-3: 1.2 mg/m^3

Routes of Entry: Ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation and burns. Inhalation can irritate the nose and throat. Exposure may result in serious central nervous system damage with anxiety, restlessness, muscle stiffness, light sensitivity; noise sensitivity; touch sensitive; cold sweat; and leading to convulsions that may be fatal. If patient survives 5−6 h there may not be serious problems. Extremely toxic; the LD_{50} oral (rat) is 1.25 mg/kg; probable oral lethal dose in humans is less than 5 mg/kg or less than 7 drops for a 70-kg (150-lb) person.

Long Term Exposure: Chronic health effects are unknown at this time.

Points of Attack: Central nervous system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. *Skin Contact:* Quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately. *Inhalation:* Remove the person from exposure, trying to avoid rapid, jerky motions or noise. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. If seizures occur, begin seizure first aid measures. Call for immediate medical attention to visit the patient prior to transfer if possible. Any facility using this chemical should have 24-h rapid access to medical personnel with training and equipment for emergency treatment. All area employees should be trained in first aid measures for Castrix, including seizure management and CPR.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Castrix, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air-purifying respirators. If while wearing a filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect castrix, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Castrix you should be trained on its proper handling and storage. Castrix must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and acid fumes, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. Crimidine falls in Hazard Class 6.1.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use organic vapor respiratory protection. Stay upwind; keep out of low areas. Wear self-contained (positive-pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do so without risk. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. If water pollution occurs, notify appropriate authorities. Ventilate area of spill or leak. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chloride fumes and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Crimidine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Castrix*. Trenton, NJ

Crotonaldehyde C:1470

Molecular Formula: C_4H_6O

Common Formula: $CH_3CH{=}CHCHO$

Synonyms: *cis*-isomer*:* Aldehido crotonico (Spanish); Aldehyde crotonique (French); 2-Butenal; Crotonic aldehyde; β-methylacrolein; Propylene aldehyde; Topenel

trans-isomer: Aldehido crotonico, (*E*)- (Spanish); Aldehyde crotonique (*E*)- (French); (*E*)-2-Butenal; *trans*-2-Butenal; 2-Butenal, (*E*)-; Crotonal; Crotonaldehyde; Crotonaldehyde, (*E*)-; Crotonaldehyde

trans-isomer; Crotonic aldehyde; Ethylene dipropionate (8CI); 3-Methylacroleine; NCI-C56279; Propylene aldehyde, (*E*)-; Propylene aldehyde, *trans*-; Propylene aldehyde-*trans*

CAS Registry Number: 4170-30-3 (*cis*-); 123-73-9 (*trans*-)

RTECS® Number: GP 9499000 (*cis*-); GP9625000 (*trans*-)

UN/NA & ERG Number: UN1143/131

EC Number: 224-030-0 [*Annex I Index No.:* 605-009-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1995; EPA: Possible Human Carcinogen.

European/International Regulations: Hazard Symbol: F, T, N; Risk phrases: R11; R24/25; R26; R37/38; R41; R48/22; R50; R68; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting.

trans-isomer*:*

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

cis-isomer*:*

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U053.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*cis*- and *trans*-).

European/International Regulations: Hazard Symbol: F, T, N; Risk phrases: R11; R24/25; R26; R37/38; R41; R48/22; R50; R68; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*cis*- and *trans-isomers*).

Description: Crotonaldehyde is water-white (turns pale yellow on contact with air) with an irritating, pungent, suffocating odor. Odor threshold = 0.11 ppm. Molecular weight = 70.10; Specific gravity (H_2O:1): 0.85; Boiling point = 103.8°C; Freezing/Melting point = (*trans-*) −73.8; (*cis-*) − 69°C; Vapor pressure = 19 mmHg at 25°C; Flash point = 13°C (oc); Autoignition temperature = 232°C. Explosive limits (*trans-*): LEL = 2.1%; UEL = 15.5%. NFPA 704 M Hazard Identification (*trans-*): Health 3-4, Flammability 3, Reactivity 2. Soluble in water; solubility = 18%.

Potential Exposure: Compound Description (*cis-*): Tumorigen, Mutagen; Human Data. Crotonaldehyde is used as a warning agent in fuel gases and gas line leaks; as solvent; in chemical warfare; as an intermediate in the manufacture of *n*-butanol and crotonic and sorbic acids; in resin and rubber antioxidant manufacture; also used as a solvent in mineral oil purification; as an alcohol denaturant.

Incompatibilities: A strong reducing agent. Forms explosive mixture with air. Readily converted by oxygen to peroxides and acids; heat or contact with alkalis and many other substances may cause polymerization. Incompatible with strong oxidizers; strong acids including nonoxidizing mineral acids; ammonia, organic amines; aliphatic amines; aromatic amines; 1,3-butadiene, strong bases. Liquid attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.87 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 2 ppm/6 mg/m^3 TWA.

NIOSH REL: 2 ppm/6 mg/m^3 TWA; See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.3 ppm/0.86 mg/m^3, Ceiling Concentration [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 50 ppm.

Protective Action Criteria (PAC) Crotonaldehyde, *trans-**

TEEL-0: 0.06 ppm

PAC-1: **0.19** ppm

PAC-2: **4.4** ppm

PAC-3: **14** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 3B; Germ Cell Mutation Category 3B.

Australia: TWA 2 ppm (6 mg/m^3), 1993; Belgium: TWA 2 ppm (5.7 mg/m^3), 1993; Denmark: TWA 2 ppm (6 mg/m^3), [skin], 1999; Finland: TWA 2 ppm (6 mg/m^3); STEL 6 ppm (17 mg/m^3), [skin], 1999; France: VME 2 ppm (6 mg/m^3), 1993; the Philippines: TWA 2 ppm (6 mg/m^3), 1993; Poland: TWA 6 mg/m^3; STEL 12 mg/m^3, 1999; Switzerland: MAK-W 2 ppm (6 mg/m^3), [skin], 1999; United Kingdom: LTEL 2 ppm (6 mg/m^3); STEL 6 ppm (18 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: ceiling 0.3 ppm [skin]. Several states have set guidelines or standards for Crotonaldehyde in ambient air[60] ranging from 60-180 μg/m^3 (North Dakota) to 100 μg/m^3 (Virginia) to 120 μg/m^3 (Connecticut) to 143 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3516 or OSHA Analytical Method 81.

Permissible Concentration in Water: No criteria set. Regulated by Clean Water Act.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.63.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator (causing tearing). Contact or vapor can cause severe and painful irritation and burn eyes (can cause corneal damage) and skin. The vapor can irritate the respiratory tract causing cough and shortness of breath. The substance may affect the lungs, resulting in impaired function, coughing, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Medical observation is indicated. Although slightly less toxic, crotonaldehyde is similar chemically and toxicologically to acrolein which is rated as extremely toxic. LD_{50} = (oral-rat) 206 mg/kg (moderately toxic). A 15-min exposure at 4.1 ppm is highly irritating to the nose and upper respiratory tract and causes tearing. Brief exposure at 45 ppm proved very disagreeable, with prominent eye irritation. Toxic concentrations for human inhalation have been reported at 12 mg/m^3/10 min. As with acrolein, vapor exposures cause gastrointestinal distress when ingested.

Long Term Exposure: Crotonaldehyde causes mutations; such chemicals may have a cancer risk. There is limited evidence that this chemical causes cancer in animals, and may cause liver cancer. May cause skin allergy. Testing has not been completed to determine the carcinogenicity of low-molecular-weight aldehydes. However, the limited studies to date indicate that some aldehydes may have chemical reactivity and mutagenicity similar to potential occupational carcinogens, such as acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Consider the skin, eyes, and respiratory system in placement or periodic examinations. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Responder™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *20 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with crotonaldehyde you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat, caustics, ammonia, amines, oxidizing material, mineral acids, and 1,3-butadiene, since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Stabilized crotonaldehyde should be labeled: "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive pressure breathing apparatus and special protective clothing. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at

(800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be absorbed on vermiculite and burned in open incinerator or dissolved in solvent and sprayed into incinerator.

References

US Environmental Protection Agency. (April 30, 1980). *Crotonaldehyde: Health and Environmental Effects Profile No. 55*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (January/February 1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 56−59. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Crotonaldehyde*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Crotonaldehyde, (E)*. Trenton, NJ

Crotonic acid C:1480

Molecular Formula: $C_4H_6O_2$

Synonyms: α-Butenoic acid; 2-Butenoic acid; α-Crotonic acid; β-Methylacrylic acid; 3-Methylacrylic acid

CAS Registry Number: 3724-65-0

UN/NA & ERG Number: UN2823

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Crotonic acid is a white or colorless, crystalline solid with a pungent odor. May be transported as a molten liquid. Molecular weight = 86.10; Boiling point = 187−189°C; Freezing/Melting point = 72°C; Flash point = 88°C (oc); Autoignition temperature = 396°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water; solubility = 9% at 25°C. This chemical is the commercially used *trans*-isomer. The *cis*-isomer is less stable and melts at 15°C.

Potential Exposure: Compound Description: Primary Irritant. Used to make plastics, resins, plasticizers, lacquers, and medicines.

Incompatibilities: Forms explosive mixture with air. A strong reducing agent. The aqueous solution is a weak acid. Violent reaction with oxidizers, combustibles, strong bases, peroxides. Moisture or strong sunlight (UV) may cause explosive polymerization. May accumulate static electrical charges, and may cause ignition of its vapors. Combustible when exposed to heat or flame.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 12 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 400 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Corrosive: contact with the skin or eyes can cause burns and permanent damage. Inhalation can cause coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Moderately toxic by ingestion, skin contact, and subcutaneous routes.

Long Term Exposure: Irritates the lungs; may cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (3) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with crotonic acid, you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases, and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This chemical requires a shipping label of "CORROSIVE." Crotonic acid is in DOT/UN Hazard Class 8 and Packing Group III.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, alcohol, or polymer foam extinguishers. Poisonous gases are produced in fire, including acrid fumes and organic acids. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Crotonic Acid.* Trenton, NJ

Crufomate C:1490

Molecular Formula: $C_{12}H_{19}ClNO_3P$

Synonyms: 4-T-Butyl-2-chlorophenyl methyl methylphosphoramidate; 4-*tert*. Butyl 2-chlorophenyl methylphosphoramidate de methyle (French); *O*-(4-*tert*-Butyl-2-chlor-phenyl)-*O*-methyl-phosphorsaeure-*N*-methylamid (German); Dowco 132; ENT 25,602-X; *O*-Methyl *O*-2-chloro-4-*tert*-butylphenyl *n*-methylamidophosphate; Methylphosphoramidic acid, 4-*t*-butyl-2-chlorophenyl methyl ester; Montrel®; Phenol,4-*t*-

butyl-2-chloro-, ester with methyl methylphosphoramidate; Phosphoramidic acid, 4-*tert*-butyl-2-chlorophenylphosphor amidate; Phosphoramidic acid, methyl-,4-*tert*-butyl-2-chlorophenyl; Phosphoramidic acid, methyl-,2-chloro-4-(1,1-dimethylethyl)phenyl methyl ester; Ruelene®; Ruelene® Drench; Rulene®

CAS Registry Number: 299-86-5

RTECS®Number: TB3850000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152; UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 015-074-00-X

Regulatory Authority and Advisory Bodies

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Crufomate is a white crystalline solid; the commercial product is a yellow oil. Molecular weight = 291.71; Boiling point = (decomposes); Freezing/Melting point = (decomposes) 63°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. Those involved in the manufacture, formulation, and application of this insecticide and anthelmintic for cattle.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Decomposes on heating, forming corrosive and toxic fumes of hydrogen chloride and nitrogen and phosphorous oxides. Incompatible with strongly alkaline and strongly acidic media. Unstable over long periods in aqueous preparations or above 60°C.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA; 20 mg/m^3 STEL.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen; BEI_A issued: Acetylcholinesterase inhibiting pesticides.

No TEEL available.

Australia: TWA 5 mg/m^3; STEL 20 mg/m^3, 1993; Belgium: TWA 5 mg/m^3; STEL 20 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Russia: STEL 0.5 mg/m^3, [skin], 1993; Switzerland: MAK-W 5 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for crufomate in ambient air[60] ranging from 50−200 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust. OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Skin absorption, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: A cholinesterase inhibitor. Crufomate irritates the eyes, skin, and respiratory tract. Crufomate can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic organophosphate chemical. Exposure can cause effects on the nervous system; rapid severe poisoning with headache, sweating, nausea, and vomiting; diarrhea, loss of coordination; convulsions, respiratory failure; and death. The LD_{50} = (oral-rat) 460 mg/kg (slightly toxic). The health effects may be delayed.

Long Term Exposure: Exposure may affect the developing fetus. Crufomate may damage the testes. High or repeated exposure may cause nerve damage and poor coordination in arms and legs. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−36 h.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles when working with liquid or wear dust-proof goggles when working with powders or dusts unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for exposures over 5 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved full face-piece respirator with a pesticide cartridge. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from heat. Also, avoid contact with oxidizers (such as peroxides, permanganates, chlorates, perchlorates, and nitrates).

Shipping: A "POISONOUS/TOXIC MATERIALS" label is required for organophosphorus pesticides, solid, toxic. This chemical falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: If crufomate is in dry form, extinguish fire using an agent suitable for the type of surrounding fire; crufomate itself does not burn. If an oily or liquid form is used, consider the flammability of the solvent in determining appropriate procedures. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Corrosive and toxic fumes of hydrogen chloride, nitrogen oxides, and phosphorous oxides are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Crufomate decomposes above pH 7.0 in alkaline media. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Crufomate*. Trenton, NJ

Cumene C:1500

Molecular Formula: C_9H_{12}

Common Formula: $C_6H_5CH(CH_3)_2$

Synonyms: Benzene isopropyl; Benzene, (1-methylethyl-)-; Cum; Cumeno (Spanish); Cumol; Isopropylbenzene; Isopropylbenzol; Isopropyl-benzol (German); 1-Methylethyl benzene; 2-Phenylpropane

CAS Registry Number: 98-82-8

RTECS®Number: GR8575000

UN/NA & ERG Number: UN1918 (Isopropylbenzene)/130

EC Number: 202-704-5 [*Annex I Index No.:* 601-024-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Cannot be Determined; Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U055.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer: 4/6/10.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cumene is a colorless liquid with a sharp, penetrating, aromatic odor. The odor threshold is 0.008−0.132 ppm. Molecular weight = 120.21; Specific gravity (H_2O:1) = 0.90; Boiling point = 152°C; Melting point = −96°C; Vapor pressure = 8 mmHg at 25°C; Flash point = 36°C; Autoignition temperature = 420°C. Explosive limits are: LEL = 0.9%; UEL = 6.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Cumene is used as a high octane gasoline component; it is used in production of phenol and acetone and as a thinner for paints and lacquers; it is an important intermediate in phenol manufacture.

Incompatibilities: Vapor forms explosive mixture with air. Incompatible with strong acids (nitric, sulfuric acids), strong oxidizers. Air contact forms cumene hydroperoxide. Attacks rubber. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.92 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/245 mg/m^3 TWA [skin].

NIOSH REL: 50 ppm/245 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 50 ppm/246 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 50 ppm

PAC-1: **50** ppm

PAC-2: **300** ppm

PAC-3: **730** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 50 ppm/250 mg/m^3 [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C.

NIOSH IDLH: 900 ppm [LEL].

Australia: TWA 50 ppm (245 mg/m^3), [skin], 1993; Austria: MAK 50 ppm (245 mg/m^3), [skin], 1999; Belgium: TWA 50 ppm (246 mg/m^3), [skin], 1993; Denmark: TWA 25 ppm (120 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (245 mg/m^3); STEL 75 ppm (370 mg/m^3), [skin], 1999; France: VME 50 ppm (245 mg/m^3), [skin], 1999; Hungary: TWA 80 mg/m^3; STEL 100 mg/m^3, 1993; the Netherlands: MAC-TGG 100 mg/m^3, [skin], 2003; Norway: TWA 25 ppm (125 mg/m^3), 1999; the Philippines: TWA 50 ppm (245 mg/m^3), [skin], 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 350 mg/m^3, 1999; Russia: STEL 50 mg/m^3, 1993; Sweden: NGV 25 ppm (120 mg/m^3), KTV 35 ppm (170 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (245 mg/m^3), [skin], 1999; United Kingdom: TWA 25 ppm (125 mg/m^3); STEL 75 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for Cumene in ambient air[60] ranging from 2.45−3.65 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 4.9 mg/m^3 (Connecticut) to 5.83 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography. Use NIOSH Analytical Method #1501 for hydrocarbons, aromatic.

Determination in Water: No method listed. Octanol−water coefficient: Log K_{ow} = 3.7.

Routes of Entry: Inhalation, ingestion, skin and eye contact. Passes through the unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact may cause a burning sensation and/or rash. Higher levels can cause dizziness, lightheadedness, headaches, unconsciousness, narcosis, coma. Levels of 4000 ppm may cause unconsciousness. LD_{50} = (oral-rat) 1400 mg/kg (slightly toxic).

Long Term Exposure: Drying and cracking of the skin. May cause lung, liver, and kidney damage. Although cumene has not been adequately tested to determine whether brain or nerve damage could occur with repeated exposure, many solvents and other petroleum-based chemicals have been shown to cause such damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Interview for brain effects, including recent memory, mood, concentration, altered sleep patterns; and nervous system evaluation. NIOSH lists the following tests: whole blood (chemical/metabolite); expired air; urine (chemical/metabolite): last 2 h of 8-h exposure; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not* induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Tychem 1000™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Also, chlorinated polyethylene (CPE) may offer protection and is among the recommended protective materials. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if contaminated or wet.

Respirator Selection: *500 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cumene must be stored to avoid contact with oxidizers, such as permanganates, nitrites, peroxides, chlorates, and perchlorates, since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where Cumene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Cumene requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (January/February 1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 59−62. New York: Van Nostrand Reinhold Co.

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Cumene*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Cumene*. Trenton, NJ

Cumene hydroperoxide C:1510

Molecular Formula: $C_9H_{12}O_2$

Common Formula: $C_6H_5C(CH_3)_2OOH$

Synonyms: Cument hydroperoxide; Cumenyl hydroperoxide; Cumolhydroperoxid (German); α-Cumylhydroperoxide;

Cumyl hydroperoxide; α,α-Dimethylbenzyl hydroperoxide; Hidroperoxido de cumeno (Spanish); Hydroperoxide, 1-methyl-1-phenylethyl-; Hydroperoxyde de cumene (French); Hydroperoxyde de cumyle (French); Hyperiz; Isopropylbenzene hydroperoxide; Trigorox K 80

CAS Registry Number: 80-15-9

RTECS®Number: MX2450000

UN/NA & ERG Number: UN3109 (Organic peroxide type F, liquid)/145

EC Number: 201-254-7 [*Annex I Index No.*: 617-002-00-8]

Regulatory Authority and Advisory Bodies

Listed in the TSCA inventory.

OSHA: Considered Highly Hazardous.

US EPA Hazardous Waste Number (RCRA No.): U096.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; on DSL List; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: O, T, N; Risk phrases: R7; R20/22; R23; R34; R48/20/22; R51/53; Safety phrases: S1/2; S3/7; S14; S36/37/39; S45; S50; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Cumene hydroperoxide, an organic peroxide, is a colorless to pale yellow to green liquid. Mild odor. Molecular weight = 152.21; Boiling point = 153°C; Freezing/Melting point = − 10°C. It explodes on heating; Flash point = 79°C. Its explosive limits are: LEL = 0.9%; UEL = 6.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 4 (Oxidizer). Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Cumene hydroperoxide is used as a polymerization initiator, curing agent for unsaturated polyester resins and cross-linking agent; as an intermediate in the process for making phenol plus acetone from cumene.

Incompatibilities: The pure material is reported to explode on heating at elevated temperatures (various values given are 50°C, 109°C,[75] 150°C[11]) or in strong sunlight. The substance is a strong oxidizer; reacts violently with combustible and reducing agents, causing fire and explosion hazard. Contact with metallic salts of cobalt, copper, or lead alloys; mineral acids; bases; and amines may lead to violent decomposition. Vapor forms an explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

AIHA WEEL: 1 ppm TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 5 ppm

PAC-2: 20 ppm

PAC-3: 20 ppm

DFG MAK: Organic peroxide (section Xa).

Routes of Entry: Inhalation, eyes, passing through the unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: Cumene hydroperoxide is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Corrosive on ingestion. Inhalation may include nosebleeds, sore throat, hoarseness, cough with phlegm, increased saliva, and shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema), a medical emergency, which can cause death. Other exposure symptoms may include headache, dizziness, poor coordination, and even unconsciousness. LD_{50} = (oral-rat) 382 mg/kg (moderately toxic).

Long Term Exposure: Cumene hydroperoxide may cause mutations. Handle with extreme caution. May cause skin allergy. High or repeated overexposure may damage lungs, kidneys, and liver.

Points of Attack: Lungs, skin, kidneys, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Tests for kidney and liver function. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof

chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to cumene hydroperoxide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with cumene hydroperoxide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cumene hydroperoxide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric) and organic materials; reducing agents; copper, copper or lead alloys, cobalt and mineral acids, since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Cumene hydroperoxide, technically pure, requires an “ORGANIC PEROXIDE” label. It falls in Hazard Class 5.2 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cumene hydroperoxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an unstable, flammable liquid. Poisonous gases, including phenol, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1996). *Hazardous Substances Fact Sheet: Cumene Hydroperoxide*. Trenton, NJ

Cupferron C:1520

Molecular Formula: $C_6H_9N_3O_2$

Common Formula: $C_6H_5N(NO)ONH_4$

Synonyms: Ammonium-*N*-nitrosophenylhydroxylamine; Benzeneamine, *n*-Hydroxy-*N*-nitroso, ammonium salt; Hydroxylamine, *n*-nitroso-*N*-phenyl-, ammonium salt; Kupferron; NCI-C03258; *n*-Nitrosophenylhydroxylamin ammonium salz (German); *n*-Nitroso-*N*-phenylhydroxylamine ammonium salt; *n*-Nitrosophenylhydroxylamine ammonium salt

CAS Registry Number: 135-20-6

RTECS® Number: NC4725000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-183-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; mouse; California Proposition 65 Chemical: Cancer; NTP: Reasonably anticipated to be a human carcinogen.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cupferron is a creamy-white crystalline compound. Molecular weight = 156.21; Freezing/Melting point = 163°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Cupferron is used to separate tin from zinc, and copper and iron from other metals in the laboratory. Cupferron also finds application as a quantitative reagent for vanadates and titanium; and for the colorimetric determination of aluminum. The potential for exposure appears to be greatest for those engaged in analytical or research studies involving use of the chemical. Workers may also be exposed to the compound during manufacturing processes.

Incompatibilities: Forms unstable and possibly explosive compounds with thorium salts, titanium, zirconium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 7.5 mg/m^3
PAC-1: 25 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 75 mg/m^3
Russia: STEL 1 mg/m^3, 1993.

Routes of Entry: Human exposure to cupferron occurs mainly through ingestion or inhalation of the dust from the dry salt. Skin absorption is a secondary route of exposure.

Harmful Effects and Symptoms

Long Term Exposure: Cupferron, given in the diet, was carcinogenic to Fisher 344 rats, causing hemangiosarcomas, hepatocellular carcinomas, and squamous cell carcinomas of the forestomach in males and females, as well as carcinomas of the auditory sebaceous gland in females. The chemical was also carcinogenic to B6C3F1 mice, causing hemangiosarcomas in males; and hepatocellular carcinomas, carcinomas of the auditory sebaceous gland, a combination of hemangiosarcomas and hemangiomas; and adenomas of the Harderian gland in females. LD_{50} = (oral-rat) 257 mg/kg (moderately toxic).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. In an emergency, consider the following: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cupferron you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Cupferron should be stored in a refrigerator or in a cool dry place and protected from exposure to moisture.

Shipping: Cupferron can be classified as Toxic solids, organic, n.o.s. which requires a shipping label of "POISONOUS/TOXIC MATERIALS." Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

National Cancer Institute. (1978). *Bioassay of Cupferron for Possible Carcinogenicity*, Technical Report Series No. 100, DHEW Publication No. (NIH) 78-1350. Bethesda, MD

Cupric acetate C:1530

Molecular Formula: $C_4H_6CuO_4$

Common Formula: $Cu(OOCCH_3)_2$

Synonyms: Acetate de cuivre (French); Acetato de cobre (Spanish); Acetic acid, copper(2+) salt; Acetic acid, copper (II) salt; Acetic acid, cupric salt; Copper acetate; Copper (2+) acetate; Copper(II) acetate; Copper diacetate; Copper (2+) diacetate; Copper(II) diacetate; Crystallized verdigris; Crystals of venus; Cupric diacetate; Neutral verdigris

CAS Registry Number: 142-71-2; 6046-93-1 (monohydrate)

RTECS®Number: AG3480000

UN/NA & ERG Number: UN3077/171

EC Number: 205-553-3

Regulatory Authority and Advisory Bodies

Water Pollution Standard Proposed (EPA)[6] (Russia).[35]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15); as copper and compounds.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as copper compounds, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cupric acetate is a greenish blue powder or small crystals. Molecular weight = 181.64; Boiling point = 240°C (decomposes); Freezing/Melting point = 115°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Cupric acetate is used as a fungicide, as a catalyst for organic reactions; in textile dyeing and as a pigment for ceramics.

Incompatibilities: Forms explosive materials with acetylene gas, ammonia, caustic solutions, sodium hypobromite, nitromethane. Keep away from chemically active metals, strong acids, nitrates. Decomposes above 240°C forming acetic acid fumes.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

142-71-2, anhydrous

TEEL-0: 2.86 mg/m^3

PAC-1: 2.86 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 286 mg/m^3

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: Russia[43] set a MAC of 0.004 mg/L (0.001 as Cu) in water used for fishery purposes. The EPA[6] has set a maximum of 1.0 mg/L in water to protect human health.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Inhaling cupric acetate dust and vapors can irritate the respiratory tract causing coughing and wheezing. High levels may cause fluid to build up in the lungs (pulmonary edema). This can cause death. Corrosive: contact can irritate and may burn the skin and eyes. LD_{50} = (oral-rat) 595 mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure can cause skin allergy, thickening of the skin, and/or a green discoloration of the skin and hair. Repeated exposure can cause shrinking (atrophy) of the inner lining of the nose; and may cause sores in the nose. Can cause liver and kidney damage.

Points of Attack: Skin, lung, liver, and kidney damage.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Serum and urine tests for copper can measure recent exposure. Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Cupric acetate must be stored to avoid contact with acetylene gas, chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including acetic acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Cupric Acetate.* Trenton, NJ

Cupric nitrate C:1540

Molecular Formula: CuN_2O_6
Common Formula: $Cu(NO_3)_2$
Synonyms: Copper dinitrate; Copper(2+) nitrate; Copper (II) nitrate; Cupric dinitrate; Nitrato de cobre (Spanish); Nitric acid, copper(2+) salt; Nitric acid, copper(II) salt
CAS Registry Number: 3251-23-8

RTECS®Number: WU7400000

UN/NA & ERG Number: UN1479/140

EC Number: 221-838-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15); as copper and compounds.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL µg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cupric nitrate is a blue crystalline solid. Molecular weight = 187.55; Boiling point = 170°C (decomposes below this point); Freezing/Melting point = 115°C. Soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 3₩ (Oxidizer). Soluble in water; solubility = 135 g/100 mL (trihydrate).

Potential Exposure: Cupric nitrate is used as an insecticide, in paint, varnish, enamel, and wood preservatives. Metal compounds are often used in "hot" operations in the workplace. These may include, but are not limited to, welding, brazing, soldering, plating, cutting, and metallizing. At the high temperatures reached in these operations, metals often form metal fumes which have different health effects and exposure standards than the original metal compound and require specialized controls.

Incompatibilities: A strong oxidizer. Aqueous solution is acidic; incompatible with bases. Violent reaction with potassium hexacyanoferrate; ammonia and potassium amide mixtures; acetic anhydrides, cyanides, ethers. Forms explosive materials with nitromethanes, sodium hypobromite, acetylene; chemically active metals, such as potassium, sodium, etc. May ignite on contact with aluminum foil or tin. Risk of spontaneous combustion with combustibles (wood, cloth, etc.), organics, or reducing agents and readily oxidizable materials. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH: 100 mg[Cu]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 2.95 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 295 mg/m^3

Copper and its inorganic compounds

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C.

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: Russia[43] set a MAC of 0.004 mg/L (0.001 as Cu) in water used for fishery purposes. The EPA[6] has set a maximum of 1.0 mg/L in water to protect human health.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact can cause irritation and burns. Inhalation can irritate the nose and throat, causing coughing and wheezing. Cupric nitrate may produce fumes that can cause "metal fume fever." Ingestion causes salivation, nausea, vomiting, stomach pain. May cause blood effects if swallowed. High exposure can cause unconsciousness. LD_{50} = (oral-rat) 940 mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure can cause copper to deposit in various parts of the body. Large deposits can make the skin and hair a green color. Repeated exposure can cause shrinking of the inner lining of the nose, and may cause runny nose and sores. Excess deposits in the liver can cause liver damage. Metallic taste may also occur. Skin allergy with rash sometimes occurs. If allergy develops, even small future exposures can trigger rash. Repeated exposures can also cause thickening of the skin not caused by allergy.

Points of Attack: Skin, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for copper can measure recent exposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m*^{3}: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m*^{3}*:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m*^{3}*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m*^{3}: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m*^{3}*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Cupric nitrate must be stored to avoid contact with combustible, organic, or other readily oxidizable materials; and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from acetylene gas. Protect storage containers from physical damage. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Oxidizing solid, n.o.s. require an "OXIDIZER" label. They fall in DOT Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep cupric nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Copper nitrate itself is noncombustible, but it will increase the intensity of fire and may ignite combustible materials. Flooding amounts of water may be used to minimize its oxidizing effect on other materials. Caution: when large quantities are involved, application of water may cause scattering of molten material. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Decomposes below 170°C forming nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to water; stir in excess soda ash. Let stand, then neutralize. Decant solution and flush to sewer; landfill sludge.

References

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Cupric Nitrate*. Trenton, NJ

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 35–38 (1982) and 5, No. 6, 45–49 (1985)

Cupric oxalate C:1550

Molecular Formula: $C_2H_2O_4 \cdot Cu$

Synonyms: Copper oxalate; Copper(II) oxalate; Ethanedioic acid, copper(2+) salt; Oxalic acid, copper(2+) salt

CAS Registry Number: 814-91-5

RTECS®Number: RO2670000

EC Number: 212-411-4

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as copper and compounds.

Reportable Quantity (RQ): 100 lb (45.4 kg).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as copper compounds, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

Cited in US State Regulations: California (A,G), New Jersey (G).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cupric oxalate is a bluish-white, odorless powder. Molecular weight = 153.58. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Insoluble in water.

Potential Exposure: Used as a catalyst for organic reactions and in seed treatment as a repellent for birds and rodents.

Incompatibilities: Explosive materials are formed on contact with acetylene gas, ammonia, caustic solutions, sodium hypobromite, nitromethane. Slight heating can cause a weak explosion.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.42 mg/m^3

PAC-1: 7.25 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 242 mg/m^3

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5.6 μg/L as a 24-h average, never to exceed e [0.94 In (hardness) − 1.23] μg/L. *To protect human health:* 1000 μg/L.[6] Canada: Drinking Water Quality AO ≤ 1.0 mg/L. Mexico, Drinking Water = 1.0 mg/L.

Determination in Water: Total copper may be determined by digestion followed by atomic absorption or colorimetry (using neocuproine) or inductively coupled plasma (ICP) optical emission spectrometry. Dissolved copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Powerful irritant. Contact with skin and/or eyes causes severe irritation, burns, and can cause permanent damage. Inhalation irritates the respiratory tract causing coughing and wheezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. If swallowed, cupric oxalate has a caustic effect on the mouth, esophagus, and stomach; causing salivation, nausea, vomiting, diarrhea, and may cause damage to the kidneys.

Long Term Exposure: Repeated exposure can cause thickening of the skin; greenish color to the skin and hair; shrinking and perforation of the nasal septum with possible bleeding. May cause skin allergy and liver damage.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist. Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with cupric oxalate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas, ammonia, caustic solutions, and nitromethane.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Cupric Oxalate.* Trenton, NJ

Cupriethylene diamine C:1560

Molecular Formula: $C_2H_{10}CuN_2$

Common Formula: $Cu(C_2N_2H_{10})$

Synonyms: Complex; Copper-ethylenediamine complex; Cupriethylene diamine; Ethane, 1,2-diamino-, copper; Komeen®; Koplex® aquatic herbicide

CAS Registry Number: 13426-91-0

RTECS®Number: KH8660000

UN/NA & ERG Number: UN1761/154

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included.

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cupriethylenediamine is a purple liquid (may contain red or blue sediment), with an ammoniacal odor. Also described as a fishy odor. Molecular weight = 506.91; Boiling point = 100°C. Reacts with water.

Potential Exposure: Cupriethylene diamine is used to dissolve cellulose products to give a cuprammonium-type solution.

Incompatibilities: Violent reaction with water. A powerful reducing agent. Violent reaction with oxidizers, organic materials, and many other substances. Forms unstable peroxides under normal conditions of temperature and storage. Dissolves wood, cotton, and other cellulosic material.

Permissible Exposure Limits in Air

No TEEL available.

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5.6 μg/L as a 24-h average, never to exceed e [0.94 In (hardness) − 1.23] μg/L. *To protect human health:* 1000 μg/L.[6] Canada: Drinking Water Quality AO ≤ 1.0 mg/L. Mexico, Drinking Water = 1.0 mg/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Cupriethylene diamine is a corrosive chemical that can cause severe irritation and burns of the skin and eyes on contact. Exposure to Cupriethylene diamine can irritate the throat and air passages. May cause asthma-like symptoms with wheezing, cough, and tightness in the chest.

Long Term Exposure: Repeated exposure can cause thickening of the skin or a green color to form on the skin and hair. Repeated exposure can cause shrinking (atrophy) of the inner lining of the nose and may cause sores in the nose and watery discharge. Excessive buildup of copper can cause liver damage.

Points of Attack: Skin, lungs, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Urine copper test. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 mg/m*^{3}: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m*^{3}*:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m*^{3}*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m*^{3}: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m*^{3}*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Cupriethylene diamine solution requires a "CORROSIVE, POISONOUS/TOXIC MATERIALS" label.[19] It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cupriethylene diamine may burn but does not readily ignite. Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire, including nitrous oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Cupriethylenediamine*. Trenton, NJ

Cyanamide C:1570

Molecular Formula: CH_2N_2
Common Formula: H_2NCN
Synonyms: Amidocyanogen; Carbamonitrile; Carbimide; Carbodiimide; Cyanogenamide; Cyanogen nitride
CAS Registry Number: 420-04-2; *(alt.)* 65931-45-5
RTECS®Number: GS5950000
UN/NA & ERG Number: UN3276 (nitriles, toxic, n.o.s.)/151
EC Number: 206-992-3 [*Annex I Index No.:* 615-013-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: Active registration.

European/International Regulations: Hazard Symbol: T; Risk phrases: R21; R25; R36/38; R43; Safety phrases: S1/2; S3; S22; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Description: Cyanamide is a combustible crystalline solid, but it is usually found as a 25% liquid solution. Molecular weight = 42.05; Specific gravity (H_2O:1) = 1.28; Boiling point = decomposes at 260°C; Freezing/Melting point = 45°C; Flash point = 141°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 3. Highly soluble in water; solubility = 78% at 15°C.

Potential Exposure: Compound Description: Agricultural Chemical; Drug; Reproductive Effector. Cyanamide may be melted to give a dimer, dicyandiamide or cyanoguanidine. At higher temperatures it gives the trimer, melamine; a raw material for melamine−formaldehyde resins.

Incompatibilities: Cyanamide may polymerize at temperatures above 122°C, or on evaporation of aqueous solutions. Reacts with acids, strong oxidants, strong reducing agents, and water, causing explosion and toxic hazard. Attacks various metals. Decomposes when heated above 49°C, on contact with acids, bases, 1,2-phenylene diamine salts, and moisture, producing toxic fumes including nitrogen oxides and cyanides.

Permissible Exposure Limits in Air

OSHA PEL: None.
NIOSH REL: 2 mg/m^3 TWA.
ACGIH TLV®[1]: 2 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 7.5 mg/m^3
DFG MAK: 1 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2) [skin] Danger of skin sensitization; Pregnancy Risk Group C.

Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, [skin], 1999; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3; STEL 4 mg/m^3, [skin], 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 2 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, [skin], 1993; Switzerland: MAK-W 2 mg/m^3, 1999; United Kingdom: TWA 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3. Russia[43] has limits for ambient air in residential areas of 0.01 mg/m^3 on an average daily basis. Several states have set guidelines or standards for Cyanamide in ambient air[60] ranging from 6.7 μg/m^3 (New York) to 20.0 μg/m^3 (Florida and North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 50 μg/m^3 (South Carolina).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cyanamide is caustic and severely irritates the eyes, skin, and respiratory tract; and may affect the liver. Ingestion or inhalation may cause transitory intense redness of the face, headache, vertigo, increased respiration, tachycardia, and hypotensions. The adverse effects of cyanamide are potentiated by the ingestion of alcohol (beer, wine, or liquor) within 1−2 days before or after exposure. Cyanamide is a highly reactive chemical and is a dangerous explosion hazard.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Exposure may cause liver and nervous system damage.

Points of Attack: Liver, skin.

Medical Surveillance: If overexposure occurs or if illness is suspected, the following are recommended: liver function tests. Examination of the nervous system. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential for exposures over 2 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from acids or acid fumes. Cyanamide can be stored in glass containers if it is stabilized with phosphoric, acetic, sulfuric, or boric acid; it attacks iron and steel, copper, and brass.

Sources of ignition, such as smoking and open flames, are prohibited where cyanamide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever cyanamide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nitriles, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep cyanamide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be

properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.1
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9

Fire Extinguishing: Cyanamide may burn but does not readily ignite. Poisonous gas is produced in fire, including nitrogen oxides and cyanides. Use dry chemical or CO_2 extinguishers. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add excess alkaline calcium hypochlorite with agitation. Flush to sewer after 24 h. Cyanamide can also be destroyed in an incinerator equipped with afterburner and scrubber.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 5, 65−68

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Cyanamide*. Trenton, NJ

Cyanazine C:1580

Molecular Formula: $C_9H_{13}ClN_6$

Synonyms: Bladex®; Bladex® 80WP; 2-Chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-1,3,5-triazine; 2-Chloro-4-ethylamino-6-(1-cyano-1-methyl)ethylamino-*s*-triazine; 2-[[4-Chloro-6-(ethylamino)-*s*-triazin-2-yl]amino]-2-methyl-propanenitrile; 2-([4-Chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino)-2-methylpropanenitrile; 2-([4-Chloro-6-(ethylamino)-*s*-triazin-2-yl]amino)-2-methylpropionitrile; 2-(4-Chloro-6-ethylamino-1,3,5-triazin-2-ylamino)-2-methylpropionitrile; Cyanazine triazine pesticide; [(1-Cyano-1-methylethyl)amino]-6-(ethylamino)-*s*-triazine; DW 3418®; EPA pesticide chemical code 100101; Fortrol®; Payze®; Propanenitrile, 2-([4-chloro-6-(ethylamino)-*s*-triazin-2-yl] amino)-2-methyl-; Propanenitrile, 2-([4-Chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino)-2-methyl-; SD 15418®; *s*-Triazine, 2-chloro-4-ethylamino-6-(1-cyano-1-methyl) ethylamino-; WL 19805®

CAS Registry Number: 21725-46-2

RTECS®Number: UG1490000

UN/NA & ERG Number: UN2763 (Triazine pesticides, solid, toxic)/151

EC Number: 244-544-9 [*Annex I Index No.:* 613-013-00-7]

Regulatory Authority and Advisory Bodies

Safe Drinking Water Act: Priority List (55 FR 1470).

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents; as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 4/1/90.

Canada, Drinking Water Quality, IMAC = 0.01 mg/L.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyanazine is an off-white to tan crystalline solid. Molecular weight = 240.73; Freezing/Melting point = 167−169°C. Hazard Identification (based on

NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water. Physical properties may be altered by carrier solvents used in commercial formulations.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Natural Product. Those involved in the manufacture, formulation, and application of this herbicide used for preemergence or postemergence weed control in field corn.

Incompatibilities: Cyanazine decomposes in heat producing very toxic fumes and gases of hydrogen cyanide, hydrogen chloride, ethyl chloride, ammonia, acetone, and ethylene. Attacks metals in the presence of heat and moisture.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

No TEEL available.

Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.

Permissible Concentration in Water: A no-observed-adverse-effect-level of 1 mg/kg/day has been determined by EPA. This has resulted in a drinking water equivalent level of 0.13 mg/L for a 10-kg child and a level of 0.046 mg/L on a long-term basis. This also results in a lifetime health advisory of 0.009 mg/L for an adult. Kansas[61] has set a guideline for cyanazine in drinking water of 42 μg/L. Canada's IMAC is 0.01 mg/L for drinking water.

Determination in Water: High-performance liquid chromatography is applicable to the determination of cyanazine in water according to EPA.

Routes of Entry: Inhalation, passing through the unbroken skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Exposure can irritate the nose, throat, and bronchial tubes. Contact can irritate the skin or eyes. Overexposure can cause weakness, nausea, and difficulty breathing. LD_{50} = (oral-rat) 149 mg/kg (moderately toxic). Toxicological properties may be altered by carrier solvents used in commercial formulations.

Long Term Exposure: Long-term effects are unknown. Related chemicals in the triazin chemical groups can cause liver damage, reduce thyroid function, and/or cause skin allergy. May cause reproductive toxicity in humans.

Medical Surveillance: Liver function tests. Thyroid function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Engineering control must be effective to ensure that exposure to cyanazine does not occur. Where there is potential for exposures to cyanazine, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air-purifying respirators.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air-respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanazine you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Triazine pesticides, solid, toxic, require a label of "POISONOUS/TOXIC MATERIALS." Cyanazine falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. If appropriate, moisten to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyanazine may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen cyanide, hydrogen chloride, ethyl chloride, ammonia, acetone, and ethylene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 47−50. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (August 1987). *Chemical Hazard Information Profile: Cyanazine*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Bladex*. Trenton, NJ

Cyanides C:1590

Molecular Formula: CKN, CNNa, KCN, NaCN

Synonyms: Carbon nitride ion (CN); Cianuro (Spanish); Cyanide anion; Cyanure (French); Isocyanide

CAS Registry Number: 57-12-5 (cyanide ion); 151-50-8 (potassium cyanide); 592-01-8 (calcium cyanide); 506-78-5 (iodine cyanide)

RTECS®Number: GS7175000 (cyanide ion); TS8750000 (potassium cyanide); VZ7520000 (sodium cyanide); NN1750000 (iodine cyanide); EW0700000 (calcium cyanide)

UN/NA & ERG Number: UN1588 (Cyanides, inorganic, solid, n.o.s.)/157; UN1680 (potassium cyanide)/157; UN1689 (sodium cyanide)/157; UN1575 (calcium cyanide)/157

Other cyanide compounds:

1051/117 Hydrogen cyanide, anhydrous, stabilized
1565/157 Barium cyanide
1694/159 Bromobenzyl cyanides
1575/157 Calcium cyanide
1587/151 Copper cyanide
1613/154 Hydrocyanic acid, aqueous solution, with < 5% Hydrogen cyanide
1613/154 Hydrogen cyanide, aqueous solution, with not > 20% Hydrogen cyanide
1614/152 Hydrogen cyanide, stabilized (absorbed)
1620/151 Lead cyanide
1626/157 Mercuric potassium cyanide
1636/154 Mercuric cyanide
1642/151 Mercuric oxycyanide
1648/127 Methyl cyanide
1653/151 Nickel cyanide
1679/157 Potassium cuprocyanide
1684/151 Silver cyanide
2316/157 Sodium cuprocyanide, solid
2317/157 Sodium cuprocyanide, solution
1713/151 Zinc cyanide

EC Number: 006-007-00-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (cyanide, free): Not Classifiable as to human carcinogenicity.

Banned or Severely Restricted (in agriculture) (Germany) (In Consumer Products) (US).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Cyanide:

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.2; Nonwastewater (mg/kg), 590; RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards as cyanides, total dust: Wastewater (mg/L), 0.86; Nonwastewater (mg/kg), 30 as cyanides (amenable). *Note*: Both cyanides, total dust and cyanides (Amenable) for nonwastewaters are to be analyzed using Method 9010 or 9012, found in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in 40 CFR 260.11, with a sample size of 10 g and a distillation time of 1 h and 15 min.

Safe Drinking Water Act: MCL, 0.2 mg/L; MCLG, 0.2 mg/L as free cyanide; Regulated chemical (47 FR 9352).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, as cyanide compounds, inorganic, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

Potassium cyanide:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P098.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.
Cyanide compounds:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.
US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents; as cyanides, soluble salts and complexes, n.o.s.
EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.
Cyanides, soluble salts and compounds:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total; Toxic Pollutant (Section 401.15).
US EPA Hazardous Waste Number (RCRA No.): P030.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.2, total dust; 0.86 (amenable); Nonwastewater (mg/kg), 590, total dust; 30 (amenable).
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 9010 (40).
Safe Drinking Water Act: MCL, 0.2 mg/L; MCLG, 0.2 mg/L; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanides, inorganic, n.o.s.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.
WGK (German Aquatic Hazard Class): 3—Highly water *polluting (potassium cyanide and calcium cyanide)*.

Description: KCN and NaCN are white crystalline solids with a faint almond odor. Sodium cyanide also has a slight odor of hydrocyanic acid when damp. *KCN:* Boiling point = 1625°C; Freezing/Melting point = 634°C. *NaCN:* Boiling point = 1496°C; Freezing/Melting point = 564°C. NFPA 704 M Hazard Identification (KCN and NaCN): Health 3, Flammability 0 [(4) gas], Reactivity 1 [(2) gas]. Soluble in water.

Potential Exposure: *Sodium and potassium cyanides* are used primarily in the extraction of ores, electroplating, metal treatment, and various manufacturing processes. *Iodine cyanide:* Used generally for destroying all lower forms of life; in taxidermy to preserve insects, etc.

Incompatibilities: The aqueous solution of potassium and sodium cyanide are highly corrosive, and strong bases. KCN and NaCN react violently with acids, releasing highly flammable hydrogen cyanide. Potassium and sodium cyanide are incompatible with strong oxidizers (such as acids, acid salts, chlorates, nitrates), organic anhydrides, isocyanates, alkylene oxides, epichlorohydrin, aldehydes, alcohols, glycols, phenols, cresols, caprolactum. Reacts with water, forming hydrogen cyanide. Attacks aluminum, copper, zinc in the presence of moisture. KCN and NaCN absorb moisture from the air forming a corrosive syrup.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
151-50-8 (potassium cyanide)
TEEL-0: 5 mg/m^3
PAC-1: **5.3** mg/m^3
PAC-2: **19** mg/m^3
PAC-3: **40** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
As cyanides
OSHA PEL: 5 mg[CN]/m^3 TWA.
NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 min] Ceiling Concentration.
ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration (1993−1994).
NIOSH IDLH: 25 mg[CN]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 25 mg/m^3
Calcium cyanide
TEEL-0: 3.8 mg/m^3
PAC-1: 3.8 mg/m^3
PAC-2: 13 mg/m^3
PAC-3: 28 mg/m^3
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.
Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin],

2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 mg/m^3 [skin]. Russia[43] has set MAC values of 0.009 mg/m^3 for ambient air in residential areas on a momentary basis and 0.004 mg/m^3 on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μ/m^3 (New York) to 50.0 μg/m^3 (Florida and North Dakota) to 80.0 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut and South Dakota) to 119.0 μg/m^3 (Nevada) to 125 μg/m^3 (South Carolina) .

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen Cyanide.[18]

Permissible Concentration in Water: In 1976 the EPA criterion was 5.0 μg/L for freshwater and marine aquatic life and wildlife. As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for humans is 8.4 mg/day.[6]

On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L and Germany 50 μg/L as drinking water standards.

Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes.

The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Potassium cyanide can be absorbed through the skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Potassium and sodium cyanide are corrosive to the eyes, skin, and the respiratory tract. Contact can cause eye and skin burns; may cause permanent damage to the eyes. Corrosive if swallowed. These substances may affect the central nervous system. Symptoms include headaches, confusion, nausea, pounding heart, weakness, unconsciousness, and death.

Long Term Exposure: Repeated or prolonged contact with potassium or sodium cyanide may cause thyroid gland enlargement. May cause nosebleed and sores in the nose; changes in blood cell count. May cause central nervous system damage with headache, dizziness, confusion, nausea, vomiting, pounding heart, weakness in the arms and legs, unconsciousness, and death. May affect liver and kidney function.

Points of Attack: Liver, kidneys, skin, cardiovascular system, central nervous system, thyroid.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep under observation for 24−48 h as symptoms may return.

Note: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and MUST be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Note to physician: Consider the administration of Ketocyanor (cobalt edetate) in dose of 300−600 mg i.v. initially. If recovery does not occur quickly (in 1–2 min) give a second dose of 300 mg, followed by i.v. glucose 5%. Alternatively, administer sodium nitrite (3%) in an i.v. dose of 10 mL over 3 min.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanides you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Protect against physical damage. Store in cool dry place. Separate from other storage and protect from acids and oxidizing materials.

Shipping: Inorganic cyanides require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and in Packing Group I.

Spill Handling: Avoid contact with solids, dusts, or solutions. Wear chemical protective suit with self-contained breathing apparatus. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Do not allow this chemical to enter the environment. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN1680 (potassium cyanide) and UN1989 (sodium cyanide) are in the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: Cyanides, such as KCN and NaCN, are not combustible themselves but contact with acid releases highly flammable hydrogen cyanide and oxides of nitrogen. Reacts with water-releasing hydrogen cyanide. NO hydrous agents. NO water. NO carbon dioxide. Use dry chemical and foam on surrounding fires. Vapors are heavier than air and may collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 h. Then flush to sewer with large volumes of water.[22]

References

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Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 56−60 (Potassium cyanide)

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US Public Health Service. (January, 1988). *Toxicological Profile for Cyanide*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

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US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Cyanide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Potassium Cyanide*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Sodium Cyanide*. Trenton, NJ

Cyanogen C:1600

Molecular Formula: C_2N_2

Common Formula: $(CN)_2$

Synonyms: Carbon nitride; Cyanogene (French); Cyanogen gas; Dicyan; Dicyanogen; Ethanedinitrile; Monocyanogen; Nitriloacetonitrile; Oxalic acid dinitrile; Oxalic nitrile; Oxalonitrile; Oxalyl cyanide; Prussite

CAS Registry Number: 460-19-5

RTECS®Number: GT1925000

UN/NA & ERG Number: UN1026/119

EC Number: 207-306-5 [*Annex I Index No.*: 608-011-00-8]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). *Theft hazard* 45 (≥11.67% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): P031.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanides, inorganic, n.o.s.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: Hazard Symbol: F+ , T, N; Risk phrases: R121; R23; R50/53; Safety phrases: S1/2; S9; S16; S23; S33; S45; 63; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyanogen is a colorless, flammable, compressed liquefied gas at room temperature. At deadly levels only, it has a pungent, almond-like odor. Molecular weight = 52.04; Boiling point = −21°C; Relative density (gas) = 1.82; Freezing/Melting point = − 28°C; Vapor pressure = 5.1 atm at 25°C; Relative vapor density (air = 1) = 1.82. Explosive limits: LEL = 6.6%; UEL = 32.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Soluble in water; solubility = 1%.

Note: The irritant properties of cyanogen have been tested using both human male and female subjects, 21−65 years of age. The distinctive bitter almond smell of cyanogen could not be detected at concentrations of 50, 100, and 250 ppm. When exposed to 8 ppm for 6 min or 16 ppm for 6−8 min, immediate eye and nose irritation occurred.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Cyanogen is currently used as an intermediate in organic syntheses; at one time, it was used in poison gas warfare.

Incompatibilities: Explosive reaction with acids, strong oxidizers (e.g., dichlorine oxide, fluorine). Slowly hydrolyzed in water to form hydrogen cyanide, oxalic acid, ammonia.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.13 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 10 ppm/ 20 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/ 21 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **2.0** ppm

PAC-2: **8.3** ppm

PAC-3: **25** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/11 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Group D.

Arab Republic of Egypt: TWA 10 ppm (20 mg/m^3), 1993; Australia: TWA 10 ppm (20 mg/m^3), 1993; Austria: MAK 10 ppm (22 mg/m^3), [skin], 1999; Belgium: TWA 10 ppm (21 mg/m^3), 1993; Denmark: TWA 10 ppm (20 mg/m^3), 1999; Finland: STEL 10 ppm (22 mg/m^3), [skin], 1999; France: VME 2 ppm (4 mg/m^3), VLE 10 ppm (20 mg/m^3), 1999; the Netherlands: MAC-TGG 20 mg/m^3, 2003; Norway: TWA 10 ppm (22 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (22 mg/m^3), KZG-W 50 ppm (110 mg/m^3), [skin], 1999; United Kingdom: TWA 10 ppm (22 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm. Several states have set guidelines or standards for Cyanogen in ambient air[60] ranging from 66.7 μg/m^3 (New York) to 200 μg/m^3 (Florida and North Dakota) to 350 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 476 μ/m^3 (Nevada) to 500 μg/m^3 (South Carolina).

Determination in Air: Use OSHA Analytical Method PV-2104.

Routes of Entry: Inhalation, passing through the skin, and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator (causing tearing). This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, nose, upper respiratory system. Skin contact with the liquid caused frostbite. Vision loss can occur following a high exposure. Cyanogen hydrolyzes to yield one molecule of hydrogen cyanide and one of cyanate; based on this, the toxic effects of $(CN)_2$ are thought to be comparable to HCN. The cyanide ion when released in the body causes a form of asphyxia by inhibiting many enzymes−especially those concerned with cellular respiration. Although the blood is saturated with oxygen, the tissues are not able to use it. Symptoms appear within a few seconds or minutes of ingesting or breathing vapors. Symptoms include cherry-red lips, tachypnea, hypernea, bradycardia, headache, vertigo (an illusion of movement), convulsions, dizziness. The victims experience constriction of the chest, giddiness, confusion, headache, hyperpnea, palpitation, unconsciousness, convulsions, feeble and rapid respiration, and an extremely weak pulse. Death occurs within a few minutes after a large dose.

Long Term Exposure: Enlargement of the thyroid gland. There is some evidence that long-term exposure can cause damage to the nervous system. Victims experience loss of appetite and weight loss.

Points of Attack: Eyes, respiratory system, central nervous system, cardiovascular system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: serum and urine thiocyanate levels. If symptoms develop or overexposure is suspected, the following may be useful: examination of the thyroid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is advised for 24−48 h. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

If cyanide poisoning is suspected: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Lower exposure can cause irritation of the eyes, nose, and throat. If these symptoms are noticed, immediately leave the work area. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. *Clothing:* Avoid skin contact with cyanogen. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye protection:* Wear air-tight gas-proof goggles, unless full face-piece respiratory protection is worn. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanogen you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from heat and light. Cyanogen must be stored to avoid contact with fluorine and oxygen, water or steam, acid or acid fumes, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where cyanogen is handled, used, or stored. Outside storage or storage in an area of noncombustible construction is preferable. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Where cyanogen is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Cyanogen must be labeled: "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3 and there is no Packing Group.[19] It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Keep cyanogen out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of cyanogen as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 2.2/3.5

Restrict persons not wearing protective equipment from areas of leaks until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Fire Extinguishing: This chemical is a highly flammable gas; it burns with a purple-tinged flame. Poisonous gases, including hydrogen cyanide, are produced in fire. Stop the flow of gas if it can be done safely. *Do not use water.* Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; oxides or nitrogen are removed from the effluent gas by scrubbers and/or thermal devices.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—-Single Chemicals: Cyanogen*, Report TR 79-607. Rockville, MD, pp. 39−44

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 103−105. New York: Van Nostrand Reinhold Co.

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Cyanogen*. Trenton, NJ

Cyanogen bromide C:1610

Molecular Formula: BrCN

Synonyms: Bromine cyanide; Bromocyan; Bromocyanogen; Bromure de cyanogen (French); Bromuro de cianogeno (Spanish); Campilit; Cyanobromide; Cyanogen monobromide

CAS Registry Number: 506-68-3

RTECS®Number: GT2100000

UN/NA & ERG Number: UN1889/157

EC Number: 208-051-2

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): U246.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
MARINE POLLUTANT (49CFR, Subchapter 172.10).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Canada, Ocean dumping prohibited.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cyanogen Bromide is a colorless or white, volatile, crystalline solid with a penetrating odor. Molecular weight = 105.93; Boiling point = 61−62°C; Freezing/

Melting point = 52°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3₩. Soluble in water; dangerous reaction.

Potential Exposure: Compound Description: Human Data. Used as an activating reagent for insoluble supports for affinity absorption. In danger are those manufacturing this compound or using it in organic synthesis or as a fumigant; in textile treatment; in gold cyaniding; or as a military poison gas.

Incompatibilities: May be unstable unless dry and pure. Violent reaction with acids, ammonia, amines. The substance decomposes on heating or on contact with water, acids, or acid vapors, producing highly toxic and flammable hydrogen cyanide and corrosive hydrogen bromide.

Permissible Exposure Limits in Air

NIOSH IDLH: 25 mg[CN]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 20.4 mg/m^3

PAC-1: 20.4 mg/m^3

PAC-2: 44 mg/m^3

PAC-3: 102 mg/m^3

As cyanides

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Cyanogen bromide's toxic action resembles that of hydrocyanic acid. Cyanogen bromide is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may result in death. Super toxic; probable oral lethal dose in humans in less than 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150-lb) person. Vapors are highly irritant and very poisonous. High concentrations produce excessive respiration, causing increased uptake of cyanide; then labored breathing, paralysis, unconsciousness, convulsions, and respiratory arrest. Headache, dizziness, nausea, and vomiting may occur with lesser concentrations.

Patients may experience confusion, anxiety, and an initial rise in blood pressure with a decreased heartbeat followed by an increased heartbeat; cyanosis is not a consistent finding, in fact, the patient may be reddish. An odor of bitter almonds on the patient's breath may be present. Individuals with chronic diseases of the kidneys, respiratory tract, skin, or thyroid are at greater risk of developing toxic cyanide effects.

Long Term Exposure: Repeated or prolonged exposure to cyanogen bromide may cause thyroid gland enlargement. Chronic exposure may cause fatigue and weakness.

Points of Attack: Eyes, respiratory system, thyroid gland.

Medical Surveillance: Thyroid gland examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. Do not perform direct mouth-to-mouth resuscitation; use bag/mask apparatus. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. If dried over sodium, pure material may be stored in a desiccator for several months. Impure material decomposes and may explode. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, acids, ammonia, amines, and incompatible materials listed above.

Shipping: DOT label required is "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I. A DOT regulated marine pollutant.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Protective clothing including impervious hand protection should be worn. Wear positive-pressure breathing apparatus. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. If conditions permit, do not extinguish. Cool exposures using unattended monitors (FEMA). If fire must be extinguished, use agent suitable for type of surrounding fire. Material itself does not burn or burns with difficulty. *Do not use water* on material itself. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog. Use water spray to absorb vapors. Keep material out of water sources and sewers. Use water spray to knock down vapors. Vapors are heavier than air and will collect in low areas. Wear full protective clothing. Avoid direct water contact as it will cause cyanogen bromide to decompose, releasing toxic gases. Avoid breathing vapors; keep upwind; wear self-contained breathing apparatus. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be added to strong alkaline solution of calcium hypochlorite, let stand for 24 h and flush to sewer. May also be dissolved in flammable solvent and sprayed into an incinerator equipped with afterburner and scrubber.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 60–62. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cyanogen Bromide.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Cyanogen Bromide*. Trenton, NJ

Cyanogen chloride (Agent CK, WMD) C:1620

Molecular Formula: CClN

Common Formula: CNCl

Synonyms: Chlorcyan; Chlorine cyanide; Chlorocyan; Chlorocyanide; Chlorocyanogen; Chlorure de cyanogene (French); CK (military designation); Cloruro de cianogeno (Spanish); Cyanogen chloride, containing less than 0.9% water

CAS Registry Number: 506-77-4

RTECS®Number: GT2275000

UN/NA & ERG Number: UN1589/125

EC Number: 208-052-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). *Theft hazard* 15 (≥2.67% concentration).

Carcinogenicity: NTP: Carcinogenesis studies; selected, October 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA Process Safety Management of Highly Hazardous Chemicals (29CFR, Part 1910.119, Appendix A): Threshold Quantity: 500 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P033.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Safe Drinking Water Act: Priority List (55 FR 1470).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cyanogen chloride is a colorless gas or liquid (below 55°F/13°C) with a pungent, irritating odor. Shipped as a liquefied gas. A solid below −6°C. Molecular weight = 61.47; Boiling point = 13.7°C; Freezing/Melting point = −6°C; Vapor pressure = 1010 mmHg at 20°C; Relative vapor density (air = 1) = 2.16; Flash point = 51°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2. Soluble in water (slowly decomposes); solubility = 7%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen; Human Data. Cyanogen chloride is used as a fumigant, metal cleaner; in ore refining; production of synthetic rubber and in chemical synthesis. CK is used as a military poison gas (blood agent). It forms cyanide in the body.

Incompatibilities: CK is incompatible with, or, may react with, most basic and acidic solvents. CK reacts slowly with water or water vapor to form toxic hydrogen cyanide and hydrogen chloride. Cyanogen chloride may polymerize violently if contaminated with chlorine. CK is unstable; it may be stabilized (i.e., inhibited) to prevent polymerization. In crude form CK trimerizes violently if catalyzed by traces of hydrogen chloride or ammonium chloride. Contact with alcohols, acids, acid salts, amines, strong alkalis, olefins, and strong oxidizers may cause fire and explosion. Heat causes decomposition producing toxic and corrosive fumes of hydrogen cyanide, hydrochloric acid, nitrogen oxides. Reacts slowly with water or water vapor, forming hydrogen chloride. Attacks copper, brass, and bronze in the presence of moisture.

Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 0.3 ppm/0.6 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 0.3 ppm Ceiling Concentration.
Protective Action Criteria (PAC) CK*
TEEL-0: 0.02 ppm
PAC-1: 0.06 ppm
PAC-2: **0.4** ppm
PAC-3: **4** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**. Emergency Response Planning Guidelines (AIHA).
ERPG-1: Not appropriate
ERPG-2: 0.4 ppm
ERPG-3: 4 ppm
DFG MAK: No numerical value established. Data may be available.
Australia: TWA 0.3 ppm (0.6 mg/m^3), 1993; Belgium: STEL 0.3 ppm (0.75 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.3 mg/m^3), 1999; Finland: STEL 0.1 ppm (0.3 mg/m^3) [skin] 1999; France: VLE 0.3 ppm (0.6 mg/m^3), 1999; the Netherlands: MAC 0.6 mg/m^3, 2003; Norway: TWA 0.25 ppm (0.6 mg/m^3), 1999; Switzerland: MAK-W 0.3 ppm (0.8 mg/m^3), 1999; United Kingdom: STEL 0.3 ppm (0.77 mg/m^3), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.3 ppm. Israel: STEL 0.3 ppm (0.6 mg/m^3). Some states have set guidelines and standards for cyanogen chloride in ambient air[60] ranging from 5.0 μ/m^3 (Virginia) to 6.0 μg/m^3 (North Dakota) to 14.0 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption (liquid), ingestion (liquid), skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Cyanogen chloride is converted to cyanide in the body. A lacrimator. Cyanogen chloride severely irritates the eyes, skin, and respiratory tract. Inhalation can cause weakness, headache, giddiness, dizziness, confusion, nausea, vomiting, irregular heartbeat, and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Skin contact with the liquid may cause frostbite and irritation. The toxicity of cyanogen chloride resides very largely on its pharmacokinetic property of yielding readily to hydrocyanic acid *in vivo*. Inhaling small amounts of cyanogen chloride causes dizziness, weakness, congestion of the lungs, hoarseness, conjunctivitis, loss of appetite, weight loss, and mental deterioration. These effects are similar to those found from inhalation of cyanide. Ingestion or inhalation of a lethal dose of cyanogen chloride (LD_{50} = 13 mg/kg). Cyanide or other cyanogenic compounds causes dizziness, rapid respiration, vomiting, flushing, headache, drowsiness, drop in blood pressure, rapid pulse, unconsciousness, convulsions, with death occurring within 4 h.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system.

Medical Surveillance: Lung function tests. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Decontamination: CK is a gas at normal temperature; the liquid will quickly evaporate. When it mixes with water it forms hydrochloric acid. Since the more concentrated the acid, the more dangerous it is; consequently, the acid must be diluted as much as possible. Decontamination must be started quickly before it has time to do much damage. Extra minutes before decontamination can make a big difference. Although CK is a gas, the victim cannot spread the agent to others. But, if the victim is wet, or the victim's clothes are wet, hydrochloric acid may be spread to others outside the hot and warm zones. So, wash a victim thoroughly so that he cannot spread the acid to others. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash–strip–wash–evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available). Subsequently move away from the hot zone in an upwind and uphill direction. *Do not use household or other bleach products* to decontaminate the victim. Wash the victim with warm water and soap. After decontamination, treat the acid burns as you would with burns from a fire. Decontaminate with water or with soap and water. Be sure you have decontaminated the victim as much as you can before they leave the area. If you get any of the acid on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can following the incident.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas- and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Where there is a potential for overexposure*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: *Corrosive, Toxic gas.* Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Provide ventilation along the floor as the vapors are heavier than air. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Cyanogen chloride must be labeled: "CORROSIVE, INHALATION HAZARD; TOXIC GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

CK, when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

CK, when used as a weapon

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.5
Night	1.0/1.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2000/600

Then: Protect persons downwind (miles/kilometers)

Day	2.5/4.0
Night	5.0/8.0

Cyanogen chloride, stabilized

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.5
Night	0.9/1.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400

Then: Protect persons downwind (miles/kilometers)

Day	2.0/3.2
Night	4.3/6.8

Fire Extinguishing: Containers may explode when heated or if they are contaminated with water. Containers may rocket. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Let it burn! Cyanogen chloride will not burn, but getting close to put out a fire surrounding a broken CK container is very dangerous. Use an unattended fire monitor to “knock down” the cyanogen chloride gas, and remain aware that the water that falls to the ground becomes acidic, and may be concentrated and dangerous. Stay away from it! *Containers:* Cyanogen chloride cannot burn, but the container can explode if heated by the surrounding fire, so you should evacuate immediately. If a container of cyanogen chloride is near a fire, use water hoses (use an unmanned fire monitor if possible to reduce the danger to you) to cool the container so it will not explode. Since the container can explode even if you are trying to keep it cool, evacuate the area. Firefighting risks: The cyanogen chloride gas and the hydrochloric acid (HCl) formed when the gas mixes with firefighting water are both dangerous, so one could easily get injured or killed fighting a fire. That is why it is best to let the surrounding fire burn out. However, if there is some reason that you have to put out the fire, do it from a secure, explosion-proof location; use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Use the firefighting method that is best for what is burning. But first think it through—do you really have to fight this fire? Heat causes decomposition, producing toxic and corrosive fumes of hydrogen cyanide, hydrogen chloride, nitrogen oxides. Cyanogen chloride is a gas that moves downwind and downhill; it is diluted by the wind. It is heavier than air which means that it sticks together longer than if it were lighter than air. Stay upwind from a spill. It will dissolve in water, so spraying water into the cloud from an unmanned fire monitor will help react it with water as well as mix it with the air and get rid of it. But remember the water will be full of HCl. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with strong calcium hypochlorite solution for 24 h, then flush to sewer with large volumes of water.

References

US Environmental Protection Agency. (April 30, 1980). *Cyanogen Chloride: Health and Environmental Effects Profile No. 57*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 62−63 (1981) and 6, No. 1, 46−49 (1986)

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Cyanogen Chloride*. Trenton, NJ

Schneider, A. L., (Ed.) (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

Cyanogen iodide C:1630

Molecular Formula: CIN

Common Formula: CNI

Synonyms: Cyanogen moniodide; Iodine cyanide; Jodcyan; NCI; Yoduro de cianogeno (Spanish)

CAS Registry Number: 506-78-5

RTECS® Number: NN1750000

UN/NA & ERG Number: UN1588/157

EC Number: 208-053-3

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyanogen iodide is a combustible, white crystalline solid with a very pungent odor. Molecular weight = 152.92; Freezing/Melting point = 146.5°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity ₩. Soluble in water; slow reaction.

Potential Exposure: Used by taxidermists as a preservative. Generally used for destroying all lower forms of life.

Incompatibilities: Incompatible with phosphorus.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

As cyanides

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

NIOSH IDLH: 25 mg[CN]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 29.4 mg/m^3

PAC-1: 29.4 mg/m^3

PAC-2: 147 mg/m^3

PAC-3: 147 mg/m^3

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C. Skin contact may contribute significantly in overall exposure.

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides.

Routes of Entry: Ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Highly irritating to eyes and skin. Converted to cyanide in the body. Causes convulsions, paralysis, and death from respiratory failure. Poisonous, may be fatal if swallowed or absorbed through skin. Health effects are similar to cyanides and iodides. Upon ingestion, a bitter, acrid, burning taste is sometimes noted. Other symptoms are anxiety, confusion, dizziness, giddiness, rapid and difficult breathing, palpitations, tightness in chest, unconsciousness, violent convulsions, and death.

Long Term Exposure: Long-term contact with iodides can cause weakness, anemia, loss of appetite, loss of weight, and general depression.

Points of Attack: Blood.

Medical Surveillance: EKG, blood cyanide level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanogen iodide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Refrigerate at (approx.) 4°C. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This chemical requires a "POISONOUS/TOXIC MATERIALS" label. This material falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: If outside, cover material to protect from wind, rain, or spray. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a combustible solid. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Poisonous gases are produced in fire, including cyanide gas, iodide gas, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cyanogen Iodine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2003). *Hazardous Substances Fact Sheet: Cyanogen Iodide*. Trenton, NJ

Cyanophos C:1640

Molecular Formula: $C_8H_{16}N_5O_6P_2S_2$

Synonyms: Bay 34727; Bayer 34727; Ciafos; Cianofos (Spanish); *O*-(4-Cyanophenyl) *O*,*O*-dimethyl phosphorothioate; *O*,*p*-Cyanophenyl *O*,*O*-dimethyl phosphorothioate; Cyanophos organophosphate compound; Cyanox; Cyap; *O*, *O*-Dimethyl-*O*-(4-cyano-phenyl)-monothiophosphat (German); *O*,*O*-Dimethyl *O*,*p*-cyanophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-cyanophenyl phosphorothioate; ENT 25,675; May & Baker S-4084; Phosphorothioic acid, *O*-(4-cyanophenyl)-*O*,*O*-dimethyl ester; Phosphorothioic acid, *O*-(4-cyanophenyl)-9,9-dimethyl ester; Phosphorothioic acid, *O*,*O*-dimethyl ester, *O*-ester with *p*-hydroxybenzonitrile; S 4084; Sumitomo S 4084; Sunitomo S 4084

CAS Registry Number: 2636-26-2

RTECS$^®$Number: TF7600000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 220-130-3 [*Annex I Index No.:* 015-087-00-0]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R21/22; R50/53; Safety phrases: S2; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyanophos is a yellow to reddish-yellow or amber liquid. Molecular weight = 243.23; Boiling point = 119°C (decomposes); Freezing/Melting point = 14.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide which is used against rice stem borers and houseflies. It is not registered as a pesticide in the United States.

Incompatibilities: Alkaline materials and exposure to light can cause rapid decomposition. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

Protective Action Criteria (PAC)
TEEL-0: 1.25 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Determination in Air: Filter/Bubbler; Potassium hydroxide; Ion-specific electrode; NIOSH Analytical Method (IV) #7904, Cyanides. OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Cyanophos is an organophosphorus insecticide. It is a cholinesterase inhibitor. Death may occur after a large oral dose; with smaller accidental doses, onset of illness may be delayed. The LD_{50} oral (rat) is 25 mg/kg (highly toxic).

Symptoms of organophosphorus pesticide poisoning include headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, pinpoint pupils, tearing, salivation and other excessive respiratory tract secretion, vomiting, cyanosis, papilledema, uncontrollable muscle twitches followed by muscular weakness, convulsions, coma, loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; possible cumulative effect. Cyanophos may damage the nervous system; resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH also Criteria Document 212 *Nitriles*.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Cyanophos is stable to storage for 2 years or more under normal conditions. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Organophosphorus pesticides, liquid, toxic, require a "POISONOUS/TOXIC MATERIALS" label. Cyanophos falls in Hazard Class 6.1.[19,20]

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Dike far ahead of *large spills* for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including nitrogen oxides, phosphorous oxides, cyanide and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cyanophos*. Washington, DC: Chemical Emergency Preparedness Program

Cyanopyridines C:1650

Molecular Formula: $C_6H_4N_2$

Common Formula: C_5H_4N-CN

Synonyms: *2-cyano-isomer:* Picolinic acid nitrile; 2-Pyridinecarbonitrile
3-cyano-isomer: 3-Azabenzonitrile; 3-Cyanopyridine; Nicotinic acid nitrile; Nicotinonitrile; 3-Pyridinecarbonitrile; 3-Pyridinenitrile; 3-Pyridylcarbonitrile
4-cyano-isomer: 4-Azabenzonitrile; Isonicotinonitrile; 4-Pyridine carbonitrile

CAS Registry Number: 100-70-9 (2-cyano-); 100-54-9 (3-cyano-); 100-48-1 (4-cyano-)

RTECS®Number: QT3030000 (3-cyano-)

UN/NA & ERG Number: UN3276 (nitriles, toxic, n.o.s.)/151

EC Number: 202-880-3 (2-cyano-); 202-863-0 (3-cyano-); 202-865-2 (4-cyano-)

Regulatory Authority and Advisory Bodies

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents; as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: The cyanopyridines are as follows:

2-cyano-: A white to tan liquid or solid with an almond odor. Boiling point = about 213°C; Freezing/Melting point = 27°C; Flash point = 89°C.

3-cyano-: A colorless liquid or gray crystalline solid. Molecular weight = 104.12; Boiling point = 83–84°C; Freezing/Melting point = 47–49°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

4-cyano-: A beige solid. Freezing/Melting point = 75.8°C.

Potential Exposure: The cyanopyridines are used in the synthesis of organic compounds and as corrosion inhibitors for aluminum.

Incompatibilities: Oxidizing agents, such as perchlorates, peroxides, and permanganates.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

No TEEL available.

Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to the nose and throat. *Skin:* May cause irritation. *Eyes:* May cause irritation. Animal data suggest eye damage can result from contact. *Ingestion:* Possible central nervous system damage due to cyanide content.

Long Term Exposure: No information found. The LD_{50} oral-rat for 3-cyanopiridines is 1105 mg/kg (slightly toxic).
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles.*
Respirator Selection: Wear a chemical cartridge respirator with organic vapor or organic vapor/acid gas cartridges, if necessary.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame and separate from oxidizing materials.
Shipping: Nitriles, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS". They fall in Hazard Class 6.1.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Wash area of spill with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).
Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.1
Night 0.1/0.2
Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9
Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New York State Department of Health. (June 1986). *Chemical Fact Sheet: Cyanopyridine(s).* Albany, NY: Bureau of Toxic Substance Assessment

Cycasin C:1660

Molecular Formula: $C_8H_{16}N_2O_8$
Synonyms: β-D-Glucopyranoside, (methyl-ONN-azoxy) methyl-; Side methylazoxymethanol β-D-glucoside
CAS Registry Number: 14901-08-7
RTECS®Number: LZ5982000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1976.[9]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Hazardous Waste (EPA-RCRA) Hazardous Constituent Waste (EPA).

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cycasin is a crystalline solid. Molecular weight = 252.08; Freezing/Melting point = (decomposes) 154°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0.

Potential Exposure: Cycasin occurs naturally, in the seeds, roots, and leaves of cycad plants which are found in the tropical and subtropical regions of the world. Nuts from the cycads are used to make chips, flour, and starch. Cycasin is not produced or used commercially. The major potential exposure is the ingestion of the foods containing cycasin. It is estimated that about 50−55% of the inhabitants of Guam are potentially exposed (50,000−60,000 persons) to cycasin. Wastewater from the preparation of the cycad nuts contains large amounts of cycasin and represents a potential secondary exposure source.

Permissible Exposure Limits in Air

No TEEL available.

North Dakota[60] has set a guideline for cycasin in ambient air of zero.

Harmful Effects and Symptoms

Cycasin is carcinogenic in 5 animal species, inducing tumors in various organs. Following oral exposure, it is carcinogenic in the rat, hamster, guinea pig, and fish. By this route, the data in the mouse is of borderline significance and the negative experiment in chickens only lasted 68 weeks. It is active in single-dose experiments and following prenatal exposure. The carcinogenicity of its metabolite, methylazoxymethanol, has been demonstrated in the rat and the hamster, and that of a closely related synthetic substance, methylazoxymethanol acetate. In the rat LD_{50} = (oral-rat) 270 mg/kg (moderately toxic).

Short Term Exposure: Poisonous; a neurotoxin. May cause eye damage.

Long Term Exposure: A possible human carcinogen. Laboratory tests on animals suggest this chemical is a teratogen; mutation data have been reported. May cause liver and brain damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cycasin you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." Cycasin is in Hazard Group 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal

environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 48−49

New Jersey Department of Health and Senior Services. (December 2002). *Hazardous Substances Fact Sheet: Cycasin*. Trenton, NJ

Cycloheptene C:1670

Molecular Formula: C_7H_{12}

Synonyms: Suberane; Suberylene

CAS Registry Number: 628-92-2

RTECS®Number: GU4615000

UN/NA & ERG Number: UN2242/128

EC Number: 211-060-4

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cycloheptene is a flammable, colorless, oily liquid. Molecular weight = 96.2; Boiling point = 115°C; Flash point = −7°C (also listed at 23°C). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Cycloheptene may be used in organic synthesis.

Incompatibilities: Contact with strong oxidizers may cause a fire or explosion hazard.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Cycloheptene can affect you when breathed in and by passing through your skin. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Contact can irritate the skin.

Long Term Exposure: May cause drying and cracking of the skin.

Points of Attack: Skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with cycloheptene. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures to cycloheptene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Cycloheptene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where cycloheptene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of cycloheptene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of cycloheptene. Wherever cycloheptene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Cycloheptene must be labeled "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cycloheptene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Cycloheptene*. Trenton, NJ

Cyclohexane C:1680

Molecular Formula: C_6H_{12}

Synonyms: Benzene hexahydride; Benzene, hexahydro; Ciclohexano (Spanish); Cyclohexan (German); Hexahydrobenzene; Hexamethylene; Hexanaphthene

CAS Registry Number: 110-82-7

RTECS®Number: GU6300000

UN/NA & ERG Number: UN1145/128

EC Number: 203-806-2 [*Annex I Index No.:* 601-017-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U056.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; R38; R65; R67; R50/53; Safety phrases: S2; S9; S16; S25; S33; S60; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Cyclohexane is a colorless liquid with a mild, sweet odor. Odor threshold = 0.16 ppm. Molecular weight = 83.8; Specific gravity (H_2O:1) = 0.78; Boiling point = 81°C; Freezing/Melting point = 7°C; Vapor pressure = 78 mmHg at 20°C; Flash point = −20°C (cc); Autoignition temperature = 260°C. The explosive limits are: LEL = 1.3%; UEL = 8.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Cyclohexane is used as a chemical intermediate; as a solvent for fats, oils, waxes, resins, certain synthetic rubbers; and as an extractant of essential oils in the perfume industry.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers, nitrogen dioxide, and oxygen can cause fire and explosion hazard. Can explode in heat when mixed with dinitrogen tetroxide liquid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.44 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 300 ppm/1050 mg/m^3 TWA.

NIOSH REL: 300 ppm/1050 mg/m^3 TWA.

ACGIH TLV®[1]: 300 ppm/344 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 300 ppm

PAC-1: 300 ppm

PAC-2: 300 ppm

PAC-3: 1300 ppm

DFG MAK: 200 ppm/700 mg/m^3 TWA; Peak Limitation Category II(4); Pregnancy Risk Group D.

NIOSH IDLH: 1300 ppm [LEL].

Australia: TWA 300 ppm (1050 mg/m^3), 1993; Austria: MAK 300 ppm (1050 mg/m^3), 1999; Belgium: TWA 300 ppm (1030 mg/m^3), 1993; Denmark: TWA 200 ppm (690 mg/m^3), 1999; Finland: TWA 300 ppm (1050 mg/m^3); STEL 375 ppm (1315 mg/m^3), 1999; France: VME 300 ppm (1050 mg/m^3), VLE 375 ppm (1300 mg/m^3), 1999; Hungary: TWA 500 mg/m^3; STEL 1000 mg/m^3, 1993; the Netherlands: MAC-TGG 875 mg/m^3, 2003; Norway: TWA 150 ppm (525 mg/m^3), 1999; Poland: MAC (TWA) 300 mg/m^3, MAC (STEL) 1000 mg/m^3, 1999; Russia: TWA 150 ppm; STEL 80 mg/m^3, 1993; Sweden: NGV 300 ppm (1000 mg/m^3), KTV 370 ppm (1300 mg/m^3), 1999; Switzerland: MAK-W 300 ppm (1050 mg/m^3), KZG-W 600 ppm (2100 mg/m^3), 1999; Turkey: TWA 300 ppm (1050 mg/m^3), 1993; United Kingdom: TWA 100 ppm (350 mg/m^3); STEL 300 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm. Several states have set guidelines or standards for cyclohexane in ambient air[60] ranging from 1.4 mg/m^3 (Massachusetts) to 10.5−13.0 mg/m^3 (North Dakota) to 17.0 mg/m^3 (Virginia) to 21.0 mg/m^3 (Connecticut, Florida and New York) to 25.0 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36−126°C; OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes and 0.01 mg/L in water bodies used for fishery purposes.

Determination in Water: No method listed. Octanol−water coefficient: Log $K_{ow} = 3.4$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: High concentrations (300 ppm): irritates eyes, nose, and respiratory tract. Inhalation of high concentration (300 ppm) may cause irritation of the eyes, nose, and throat. Higher concentrations may act as a narcotic resulting in dizziness, nausea, vomiting, or loss of consciousness. Levels of 1800 ppm can cause death. Vapor or liquid may cause skin irritation. This chemical destroys the skin's natural oils. If allowed to remain in contact with skin, may cause cracking, drying, chapping, smarting, and reddening. Ingestion of the liquid may cause aspiration into the lungs and chemical pneumonia. Animal studies suggest a lethal dose between 1 oz and one pint for an adult. Exposure to high levels can cause nausea, dizziness, lightheadedness, and drowsiness. Unconsciousness and death may occur at levels far above the occupational exposure limit. Alcohol synergistically increases the toxic effects of cyclohexane.

Long Term Exposure: Prolonged or repeated exposure may cause skin drying, rash, and dermatitis. May cause damage to the liver, kidneys, brain, heart, and circulatory system.

Points of Attack: Eyes, respiratory system, central nervous system, skin.

Medical Surveillance: Consider possible irritant effects to the skin and respiratory tract in any preplacement or periodic examination, as well as any renal or liver complications. NIOSH lists the following tests: whole blood (chemical/metabolite); expired air: during exposure; urine (chemical/metabolite): last 4 h of 8-h exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): nitrile rubber gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Responder™ suits; **4 h** (at least 4 but $<$ 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Teflon™ gloves, suits, boots. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed; shield, hydrocarbon-insoluble rubber or plastic apron.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexane you should be trained on its proper handling and storage. Before entering confined space where cyclohexane may be present, check to make sure that an explosive concentration does not exist. Cyclohexane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever cyclohexane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The label required for cyclohexane is “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Cyclohexane*. Albany, NY: Bureau of Toxic Substance Assessment of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Cyclohexane*. Trenton, NJ

Cyclohexanol C:1690

Molecular Formula: $C_6H_{12}O$

Common Formula: $C_6H_{11}OH$

Synonyms: Adronal; Anol; Ciclohexanol (Spanish); 1-Cyclohexanol; Cyclohexyl alcohol; Hexahydrophenol; Hexalin; Hydralin; Hydrophenol; Hydroxycyclohexane; Naxol; Phenol, hexahydro-

CAS Registry Number: 108-93-0

RTECS$^{®}$Number: GB7875000

UN/NA & ERG Number: UN1986 (Alcohols, flammable, toxic, n.o.s.)/131

EC Number: 203-630-6 [*Annex I Index No.:* 603-009-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Delisted 1/25/02.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases R20/22-R37/38; Safety phrases: S2; S24/25. WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cyclohexanol is a sticky solid (above 25°C/ 77°F) or colorless, viscous liquid with a faint camphor odor. Odor threshold = 0.07 ppm. Molecular weight = 100.16; Specific gravity (H_2O:1) = 0.96; Boiling point = 161°C; Freezing/Melting point = 24°C; Vapor pressure = mmHg at 25°C; Flash point = 68°C; Autoignition temperature = 300°C. The explosive limits are: LEL = 2.4%; UEL = 12%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slight solubility in water; solubility = 4% at 20°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Hormone, Primary Irritant. Cyclohexanol is used in making plasticizers, dry cleaning, dyebath; and textile finishing formulations; as a solvent for ethyl cellulose and other resins; it is used in soap manufacture; it is used as a raw material for adipic acid manufacture; as a nylon intermediate.

Incompatibilities: Forms explosive mixture in air. Contact with strong oxidizers cause a fire and explosion hazard. Attacks some plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.10 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/200 mg/m^3 TWA.

NIOSH REL: 50 ppm/200 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 50 ppm/206 mg/m^3 TWA [skin].

NIOSH IDLH: 400 ppm.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 50 ppm

PAC-2: 50 ppm

PAC-3: 400 ppm

DFG MAK: 50 ppm/210 mg/m^3 [skin]; Peak Limitation Category I(1) Pregnancy Risk Group: D.

Australia: TWA 50 ppm (200 mg/m^3), [skin], 1993; Austria: MAK 50 ppm (200 mg/m^3), 1999; Belgium: TWA 50 ppm (206 mg/m^3), [skin], 1993; Denmark: TWA 50 ppm (200 mg/m^3), 1999; Finland: TWA 50 ppm (200 mg/m^3); STEL 75 ppm (300 mg/m^3), 1999; France: VME 50 ppm (200 mg/m^3), VLE 75 ppm (300 mg/m^3), 1999; Hungary: TWA 20 mg/m^3; STEL 40 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Norway: TWA 25 ppm (100 mg/m^3), 1999; the Philippines: TWA 50 ppm (200 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; STEL 60 mg/m^3, 1999; Russia: TWA 25 ppm, 1993; Sweden: NGV 50 ppm (200 mg/m^3), KTV 75 ppm (300 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (200 mg/m^3), KZG-W 100 ppm (400 mg/m^3), 1999; United Kingdom: TWA 50 ppm (208 mg/m^3), 2000; LTEL 50 ppm (200 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm [skin]. Several states have set guidelines or standards for cyclohexanol in ambient air[60] ranging from 0.476 mg/m^3 (Kansas) to 2.0 mg/m^3 (North Dakota) to 3.3 mg/m^3 (Virginia) to 4.0 mg/m^3 (Connecticut) to 4.76 mg/m^3 (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #1402, Method #1405, and OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/L in water bodies used for domestic purposes.

Determination in Water: No method listed. Octanol–water coefficient: Log K_{ow} = 1.2.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cyclohexanol irritates the eyes, skin, and respiratory tract. May affect the central nervous system. In high concentrations it can cause headache, nausea, vomiting, dizziness, and unconsciousness.

Long Term Exposure: Removes the natural oils from the skin causing drying, cracking, and dermatitis. Prolonged or high exposures can cause liver, kidney, and lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests, liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough > 0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Teflon™ gloves, suits, boots; Viton™ gloves, suits; **4 h** (at least 4 but < 8 h of resistance to breakthrough > 0.1 μg/cm^2/min): Neoprene™ rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 400 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; eye protection required.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexanol you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cyclohexanol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Cyclohexanol is not specifically cited by DOT[19] but the "Alcohols, flammable, toxic, n.o.s." category may be applied. This category requires the label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 1997). *Hazardous Substances Fact Sheet: Cyclohexanol*. Trenton, NJ

Cyclohexanone C:1700

Molecular Formula: $C_6H_{10}O$

Synonyms: Anon; Anone; Ciclohexanona (Spanish); Cyclohexyl ketone; Hexalin; Hexanon; Hydralin; Hytrol O; Ketohexamethylene; Nadone; NCI-C55005; Oxocyclohexane; Pimelic ketone; Pimelin ketone; Pomelic acetone; Sextone

CAS Registry Number: 108-94-1

RTECS® Number: GW1050000

UN/NA & ERG Number: UN1915/127

EC Number: 203-631-1 [*Annex I Index No.:* 606-010-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Hazardous Waste Number (RCRA No.): U057.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.36; Nonwastewater (mg/L), 0.75 TCLP.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20; Safety phrases: S2; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cyclohexanone is a water-white to slight yellow liquid with a peppermint-like or acetone-like odor. The odor threshold is 0.12−0.24 ppm in air. Molecular weight = 98.16; Specific gravity = 0.95; Boiling point = 157°C; Freezing/Melting point = − 32.1°C; Flash point = 44°C; Autoignition temperature = 420°C. The explosive limits are: LEL = 1.1% at 100°C; UEL = 9.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. It is used in metal degreasing and as a solvent for lacquers, resins, and insecticides. It is an intermediate in adipic acid manufacture. Also used as an emulsifier.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizing agents or nitric acid may cause a violent reaction. Do not use brass, copper, bronze, or lead fittings. Attacks many coatings and plastic materials.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.02 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/200 mg/m^3 TWA.

NIOSH REL: 25 ppm/100 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 20 ppm TWA; 50 ppm STEL [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 700 ppm.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 50 ppm

PAC-2: 50 ppm

PAC-3: 700 ppm

DFG MAK: [skin] Carcinogen Category 3B.

European OEL: 10 ppm TWA; 20 ppm STEL [skin] (2000).

Australia: TWA 25 ppm (100 mg/m^3), 1993; Austria: MAK 25 ppm (100 mg/m^3), 1999; Belgium: TWA 25 ppm (100 mg/m^3), 1993; Denmark: TWA 25 ppm (100 mg/m^3) [skin] 1999; Finland: TWA 50 ppm (200 mg/m^3); STEL 75 ppm (250 mg/m^3), 1999; France: VME 25 ppm (100 mg/m^3), 1999; Japan: 25 ppm (100 mg/m^3), 1999; Norway: TWA 20 ppm (80 mg/m^3), 1999; the Philippines: TWA 50 ppm (200 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; STEL 160 mg/m^3, 1999; Russia: TWA 25 ppm; STEL 10 mg/m^3, 1993; Sweden: NGV 25 ppm (100 mg/m^3), KTV 50 ppm (200 mg/m^3) [skin] 1999; Switzerland: MAK-W 25 ppm (100 mg/m^3), KZG-W 50 ppm (200 mg/m^3), 1999; Turkey: TWA 50 ppm (200 mg/m^3), 1993; United Kingdom: TWA 25 ppm (102 mg/m^3); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: ACGIH TLV®: [skin]; confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for cyclohexanone in ambient air[60] ranging from 1.0−4.0 mg/m^3 (North Dakota) to 1.6 mg/m^3 (Virginia) to 2.0 mg/m^3 (Connecticut) to 2.38 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300 (Ketones), Method #2555, and OSHA Analytical Method 1. Also, NIOSH Analytical Method #2549, Volatile organic compounds.

Permissible Concentration in Water: Russia[43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cyclohexanone irritates the eyes, skin, and respiratory tract. Contact can burn the eyes. LD_{50} = (oral-rat) 1535 mg/kg (slightly toxic). Cyclohexanone may affect the central nervous system. Exposure of high concentrations can cause dizziness, lightheadedness, and unconsciousness.

Long Term Exposure: Repeated or prolonged contact with skin may cause drying, cracking, and dermatitis. The following chronic (long-term) health effects can occur at some time after exposure to cyclohexanone and can last for months or years: cyclohexanone may damage the developing fetus. Long-term exposure may cause liver and kidney damage. Long-term exposure may cause clouding of the eye lenses (cataracts).

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater or significant skin contact), the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Examination of the eyes. Interview for brain effects including recent memory, mood, concentration, headaches, malaise, and altered sleep patterns. Consider cerebellar, autonomic, and peripheral nervous system evaluation. Positive and borderline victims should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves; **4 h** (at least 4 but < 8 h of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Remove clothing immediately if set or contaminated to avoid flammability hazard.

Respirator Selection: *625 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *700 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Cyclohexanone you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cyclohexanone must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat, sparks, and flames. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Cyclohexanone requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators

recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Cyclohexanone*. Trenton, NJ

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 50−52

Cyclohexene C:1710

Molecular Formula: C_6H_{10}

Synonyms: Benzene tetrahydride; Benzene, tetrahydro-; Cyclohexene; Cyclohex-1-ene; Hexanaphthylene; Tetrahydrobenzene; 1,2,3,4-Tetrahydrobenzene

CAS Registry Number: 110-83-8

RTECS®Number: GW2500000

UN/NA & ERG Number: UN2256/130

EC Number: 203-807-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cyclohexene is a colorless liquid (cyclic alkene) with a sweetish odor. Molecular weight = 82.16; Specific gravity = 0.81; Boiling point = 82.7°C; Freezing/Melting point = −104°C; Vapor pressure = 67 mmHg at 20°C; Flash point = −6°C; Autoignition temperature = 310°C. Explosive limits in air: LEL = 1.2%; UEL = −4.8% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 2. Insoluble in water.

Potential Exposure: May be used as an intermediate in making other chemicals (e.g., adipic acid, maleic acid, hexahydrobenzoic acid), oil extraction and as a catalyst solvent.

Incompatibilities: Forms explosive mixture with air. The substance can form explosive peroxides. The substance may polymerize under certain conditions. Reacts with strong oxidants, causing a fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 300 ppm/1015 mg/m^3 TWA.

NIOSH REL: 300 ppm/1015 mg/m^3 TWA.

ACGIH TLV®[1]: 300 ppm/1010 mg/m^3 TWA.

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 300 ppm

PAC-1: 300 ppm

PAC-2: 500 ppm

PAC-3: 2000 ppm

Australia: TWA 300 ppm (1015 mg/m^3), 1993; Austria: MAK 300 ppm (1015 mg/m^3), 1999; Belgium: TWA 300 ppm (1010 mg/m^3), 1993; Denmark: TWA 300 ppm (1015 mg/m^3), 1999; Finland: TWA 300 ppm (1015 mg/m^3), [skin] 375 ppm (1270 mg/m^3), 1999; France: VME 300 ppm (1015 mg/m^3), 1999; the Netherlands: MAC-TGG 1015 mg/m^3, 2003; the Philippines: TWA 300 ppm (1015 mg/m^3), 1993; Poland: MAC (TWA) 300 mg/m^3, MAC [skin] 900 mg/m^3, 1999; Russia [skin] 50 mg/m^3, 1993; Switzerland: MAK-W 300 ppm (1015 mg/m^3), KZG-W 600 ppm (2030 mg/m^3), 1999; Turkey: TWA 300 ppm (1050 mg/m^3), 1993; United Kingdom: TWA 300 ppm (1020 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 300 ppm TWA. Several states have set guidelines or standards for Cyclohexene in ambient air[60] ranging from 10.15 mg/m^3 (North Dakota) to 17.0 mg/m^3 (Virginia) to 20.3 mg/m^3 (Connecticut) to 24.2 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption followed by workup with CS_2, and analysis by gas chromatography. Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36−126°C; OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cyclohexene irritates the eyes, skin, and respiratory tract. This chemical can be absorbed through the skin, thereby increasing exposure. Swallowing the liquid may cause droplets to enter the lung and cause chemical pneumonia. Overexposure can cause dizziness, lightheadedness, loss of muscle coordination. Higher exposures can cause tremors, collapse, and death. A closely related chemical, cyclopropane, can cause irregular heartbeat, although it is not known if this chemical causes the same effect. High exposure can cause liver and brain damage.

Long Term Exposure: Repeated or high concentrations can cause dry skin and rash, liver and brain damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do NOT induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *Up to 2000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where cyclohexene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of cyclohexene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of cyclohexene. Wherever cyclohexene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." Cyclohexene falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cyclohexene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Cyclohexene*. Trenton, NJ

Cyclohexenyl trichlorosilane C:1720

Molecular Formula: $C_9H_9Cl_3Si$
Common Formula: $C_6H_9SiCl_3$
Synonyms: Cyclohexene, 4-(trichlorosilyl)-; Trichloro-3-cyclohexenylsilane; 4-(Trichlorosilyl) cyclohexene
CAS Registry Number: 10137-69-6
RTECS®Number: VV2800000
UN/NA & ERG Number: UN1762/156
EC Number: 233-377-7

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyclohexenyl trichlorosilane is a colorless fuming liquid that smells like hydrogen chloride. Molecular weight = 215.59; Boiling point = 94°C; Flash point = 99°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Reacts with water.

Potential Exposure: This material is used to make silicone polymers.

Incompatibilities: Steam and moisture form toxic and corrosive chloride gases, including hydrogen chloride. Attacks metals in the presence of moisture. Some chlorosilanes self-ignite in air. Contact with ammonia can cause a self-igniting compound.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Based on 15 other trichlorosilanes with the same TEELs

TEEL-0: 0.2 ppm
PAC-1: 0.6 ppm
PAC-2: 7.3 ppm
PAC-3: 33 ppm

Determination in Air: No OEL established.

Permissible Concentration in Water: No criteria set ₩ (water reactive).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Cyclohexenyl trichlorosilane can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid (pulmonary edema), a medical emergency. This can cause death. Cyclohexenyl trichlorosilane is a corrosive chemical and contact can cause severe skin and eye burns. Exposure can irritate the eyes, nose, and throat. LD_{50} = (oral-rat) 2830 mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure may cause bronchitis with phlegm and shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Cyclohexenyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with Cyclohexenyl trichlorosilane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames, are prohibited where cyclohexenyl trichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Cyclohexenyl trichlorosilane requires a "CORROSIVE" label. This material falls in DOT Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep Cyclohexenyl trichlorosilane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.9/1.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Cyclohexenyl Trichlorosilane*. Trenton, NJ

Cycloheximide C:1730

Molecular Formula: $C_{15}H_{23}NO_4$

Synonyms: Acti-Aid®; Actidione; Actidione TGF; Actidone; Actispray; 3[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]glutarimide; Glutarimide,3-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]-; Hizarocin®; Kaken®; Naramycin®; Naramycin A®; Neocycloheximide®; NSC-185; 2,6-Piperidinedione, 4-(2-3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl-, (IS)-[1a (S*),3a,5b]-

CAS Registry Number: 66-81-9; 21059-09-6

RTECS®Number: MA4375000

EC Number: 200-636-0 [*Annex I Index No.:* 613-140-00-8]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program: Positive: *E. coli* polA with S9; Sperm morphology—mouse; Negative: *N. crassa—aneuploidy*; Inconclusive: Carcinogenicity—mouse/rat; Inconclusive: *D. melanogaster*—whole sex chromosome loss; Inconclusive: Mammalian micronucleus; *E. coli* polA without S9.

Banned or Severely Restricted (in agriculture) (Malaysia) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Very Toxic Substance (World Bank).[15]

Reportable Quantity (RQ): 100 lb (45.4 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 1/1/89.

European/International Regulations *(66-81-9)*: Hazard Symbol: T+, N; Risk phrases: R61;R28; R51/53; R68; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (CAS 66-81-9).

Description: Cycloheximide is a colorless crystalline substance. Molecular weight = 281.39; Freezing/Melting point = 119.5−121°C. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Primary Irritant. Those involved in the manufacture, formulation, or application of this fungicide and pesticide. Used as an antibiotic, plant growth regulator, and protein synthesis inhibitor. Used on oranges for processing and to inhibit growth of many pathogenic plant fungi. Also used as a repellent for rodents and other animal pests; and in cancer therapy.

Incompatibilities: Incompatible with oxidizers, acid anhydrides, strong bases.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 2 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation. Exposure can cause excessive salivation, nausea, vomiting, diarrhea, and elevated blood urea nitrogen (BUN). High exposures can also cause imbalance, tremors, seizures, and coma. Extremely toxic (LD_{50} value for rats is only 3.7 mg/kg). The probable oral lethal dose in humans is 5−50 mg/kg, or 7 drops to 1 teaspoonful for a 150-lb person. Signs of skin irritation may appear as much as 6−24 h after exposure.

Long Term Exposure: May cause mutations and damage the developing fetus. May cause liver and kidney damage.

Points of Attack: Reproductive system. Liver and kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h following skin contact.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents, acid hydrides, and strong bases.

Spill Handling: Avoid breathing dusts. Keep upwind. Wear self-contained breathing apparatus. Material is rapidly inactivated at room temperature by dilute alkali. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Wear SCBA and full protective clothing. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incinerator with flue gas scrubbing equipment.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 41−43 (1982) and 9, No. 1, 55−64 (1989)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cycloheximide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Cycloheximide*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Cyclohexylamine C:1740

Molecular Formula: $C_6H_{13}N$

Common Formula: $C_6H_{11}NH_2$

Synonyms: Aminocyclohexane; Aminohexahydrobenzene; Aniline, hexahydro-; CHA; Ciclohexilamina (Spanish); Cyclohexanamine; Cyclohexaneamine; Hexahydroaniline; Hexahydrobenzenamine

CAS Registry Number: 108-91-8

RTECS®Number: GX0700000

UN/NA & ERG Number: UN2357/132

EC Number: 203-629-0 [*Annex I Index No.:* 612-050-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence 1980; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: Cell transformation—SA7/SHE; Cytogenetics—male germ cell; Positive/dose response: *In vitro* cytogenetics—nonhuman; Negative: *In vivo* cytogenetics—nonhuman bone marrow; Negative: *In vitro* cytogenetics—human lymphocyte; Negative: *D. melanogaster*—reciprocal translocation; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: Carcinogenicity—mouse/rat; Inconclusive: *D. melanogaster*—whole sex chrom. loss; Inconclusive: Rodent dominant lethal; Host-mediated assay; Inconclusive: *E. coli* polA without S9.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R10; R21/22; R34; R62; Safety phrases: S1/2; S26; S36/37/39; SS45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cyclohexylamine is a colorless to yellow liquid (amines, primary aromatic). It has an unpleasant fishy odor. Molecular weight = 99.20; Specific gravity = 0.87; Boiling point = 134.4°C; Freezing/Melting point = − 17.7°C; Vapor pressure = 11 mmHg at 20°C; Flash point = 31°C; Autoignition temperature = 293°C. Explosive limits: LEL = 1.5%; UEL = 9.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. CHA is used in making dyes, chemicals, dry cleaning chemicals, insecticides, plasticizers, rubber chemicals, and as a chemical intermediate in the production of cyclamate sweeteners. Used in water treatment and as a boiler feedwater additive. It is also used in rubber production to retard degradation.

Incompatibilities: Forms explosive mixture with air. Cyclohexylamine is a strong base: it reacts violently with acid. Contact with strong oxidizers may cause fire and explosion hazard. Incompatible with organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution, lead. Corrosive to copper alloys, zinc, or galvanized steel.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 10 ppm/40 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/41 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 1.8 ppm

PAC-1: **1.8** ppm

PAC-2: **8.6** ppm

PAC-3: **30** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/8.2 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Group C.

Australia: TWA 10 ppm (40 mg/m^3), 1993; Austria: MAK 10 ppm (40 mg/m^3), 1999; Belgium: TWA 10 ppm (41 mg/m^3), 1993; Denmark: TWA 10 ppm (40 mg/m^3), [skin], 1999; Finland: STEL 10 ppm (40 mg/m^3), [skin], 1999; France: VME 10 ppm (40 mg/m^3), [skin], 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, [skin], 2003; Poland: TWA 40 mg/m^3; STEL 80 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: TWA 5 ppm (20 mg/m^3); STEL 10 ppm (40 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (40 mg/m^3), KZG-W 20 ppm (80 mg/m^3), [skin], 1999; United Kingdom: TWA 10 ppm (41 mg/m^3), [skin] 2000; Argentina, Bulgaria, Columbia, Israel; Jordan, South Korea, Mexico; New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyclohexylamine in ambient air[60] ranging from 95.238 μg/m^3 (Kansas) to 400 μg/m^3 (North Dakota) to 650 μg/m^3 (Virginia) to 800 μg/m^3 (Connecticut) to 952 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2010, amines, aliphatic, and OSHA Analytical Method PV-2016.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible concentration based on health effects of 550 μg/L.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Cyclohexylamine is caustic to the skin, eyes, and respiratory tract. Its systemic effects in humans include nausea, vomiting, anxiety, restlessness, drowsiness, lightheadedness, anxiety, apprehension, slurred speech, papillary dilation, severe skin irritation. Cyclohexylamine may also be a skin sensitizer. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

This material is classified as moderately toxic, LD_{50} = (oral-rat) 156 mg/kg—probable oral lethal dose is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150-lb) person. It is considered a nerve poison; and is a weak methemoglobin-forming substance.

Long Term Exposure: Cyclohexylamine causes mutations (genetic changes). Such chemicals may have a cancer risk. Many scientists believe there is no safe level of exposure to a cancer-causing agent. It may damage the developing fetus. It may also damage the testes (male reproductive gland) and reduce the fertility of females. *Other long-term effects:* Exposure may increase blood pressure. Repeated or severe exposures may damage vision and possibly kidneys and liver. Cyclohexylamine may cause a skin allergy. Very low future exposures can cause itching and a skin rash. The Food and Drug Administration banned the use of cyclamates as artificial sweeteners in 1969 because of their metabolic conversion to cyclohexylamine, which was thought to be carcinogenic in rats. There is now no evidence that CHA is a carcinogen, however.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: blood pressure check. If symptoms develop or overexposure is suspected, the following may be useful: eye and vision examination. Kidney and liver function tests. Skin testing with dilute cyclohexylamine may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved full face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with cyclohexylamine you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect containers from physical damage. Outdoor or detached storage is recommended. Cyclohexylamine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Sources of ignition, such as smoking and open flames, are prohibited where cyclohexylamine is handled, used, or stored. The vapor can form explosive mixtures in the air. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." The Hazard Class is 8 and the Packing Group is II.

Spill Handling: Stay upwind; keep out of low areas. Wear self-contained (positive-pressure if available) breathing apparatus and full protective clothing. Establish forced ventilation to keep levels below explosive limit. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with vermiculite, dry sand, or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

US Environmental Protection Agency. (October 21, 1977). *Chemical Hazard Information Profile: Cyclohexylamine*. Washington, DC

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Cyclohexylamine*, Report TR 79-607. Rockville, MD, pp. 45−55

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Cyclohexylamine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Cyclohexylamine*. Trenton, NJ

Cyclohexyl isocyanate C:1750

Molecular Formula: $C_7H_{11}NO$

Common Formula: $C_6H_{11}NCO$

Synonyms: CHI; Cyclohexane, isocyanato-; Isocyanatocyclohexane; Isocyanic acid, cyclohexyl ester

CAS Registry Number: 3173-53-3

RTECS®Number: NQ8650000

UN/NA & ERG Number: UN2488/155

EC Number: 221-639-3

Regulatory Authority and Advisory Bodies

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Cyclohexyl isocyanate is a clear, flammable liquid. It has a sharp, pungent odor. Molecular weight = 125.19; Specific gravity (H_2O:1): 0.98; Boiling point = 168°C; Flash point = 48°C (cc). Hazard Identification (based on NFPA-704 M Rating System):

Health 2, Flammability 2, Reactivity 0. Soluble in water (reaction).

Potential Exposure: Compound Description: Mutagen. The material is used in the synthesis of agricultural chemicals.

Incompatibilities: Cyclohexyl isocyanate polymerize due to heating above 93°C/200°F and under the influence of various chemicals including organometallic compounds. Cyclohexyl isocyanate decomposes in fire, forming toxic hydrogen cyanide and nitrogen oxides fumes. Reacts with oxidizers, strong bases, water, alcohol, acids, amines, metal compounds, surface-active materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

Isocyanate-bearing waste (as CNs, n.o.s.)

TEEL-0: 0.004 ppm

PAC-1: 0.0125 ppm

PAC-2: 0.02 ppm

PAC-3: **0.10** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator (causes tearing). Exposure can severely irritate and may burn the skin, eyes, nose, throat, and lungs. Very high levels may lead to a buildup of fluid in the lungs (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause lung damage and/or asthma. A suspected carcinogen.

Points of Attack: Lungs, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber gloves have been recommended by the manufacturer as protection against this substance. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to cyclohexyl isocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyclohexyl isocyanate you should be trained on its proper handling and storage. Cyclohexyl isocyanate must be stored to avoid contact with moisture and temperatures above 93°C, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, strong bases, alcohol, metal compounds, or surface-active materials. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Cyclohexyl isocyanate requires a label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they

must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 0.9/1.5

Fire Extinguishing: Cyclohexyl isocyanate may burn but does not readily ignite. Containers may explode in fire. Poisonous gases are produced in fire, including hydrogen cyanide and nitrogen oxides. Use dry chemical, CO_2, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Cyclohexyl Isocyanate*. Trenton, NJ

Cyclohexyl trichlorosilane C:1760

Molecular Formula: $C_6H_{11}Cl_3Si$
Common Formula: $C_6H_{11}SiCl_3$
Synonyms: Silane, trichlorohexyl-; Trichlorocyclohexylsilane; 1-(Trichlorosilyl)cyclohexane
CAS Registry Number: 98-12-4
RTECS$^{®}$Number: VV2890000
UN/NA & ERG Number: UN1763/156
EC Number: 202-639-2

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyclohexyl trichlorosilane is a colorless to pale yellow liquid. Molecular weight = 217.6; Boiling point = 208°C; Flash point = 91°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1₩. Insoluble in water; reactive.

Potential Exposure: The material is used to make silicone polymers.

Incompatibilities: Contact with water or moisture forms hydrochloric acid. Incompatible with heat, strong oxidizers, strong bases, alcohols, metal compounds. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

No standards or TEEL available for this specific material. See below:

Protective Action Criteria (PAC)

Based on 15 other trichlorosilanes with the same TEELs

TEEL-0: 0.2 ppm
PAC-1: 0.6 ppm
PAC-2: 7.3 ppm
PAC-3: 33 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Cyclohexyl trichlorosilane can affect you when breathed in. Exposure can irritate the eyes, nose, throat, and lungs, causing coughing, wheezing, and/or shortness of breath. Cyclohexyl trichlorosilane is a corrosive chemical and can cause severe skin and eye burns leading to permanent eye damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 2830 mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure may cause bronchitis to develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Cyclohexyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture; and away from combustible materials, such as wood, oil, and paper; and incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Cyclohexyl trichlorosilane requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.9/1.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chloride and hydrogen chloride, are produced in fire. *Do not use water* or hydrous agents. Use dry chemical or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Cyclohexyl Trichlorosilane*. Trenton, NJ

Cyclonite C:1770

Molecular Formula: $C_3H_6N_6O_6$

Synonyms: Cyclotrimethylenetrinitramine; Hexahydro-1,3,5-trinitro-*s*-triazine; Hexogen; Hexolite; Hexotol; HMX; RDX; Trimethylenetrinitramine; 1,3,5-Trinitro-1,3,5-triazacyclohexane; Trinitrotrimethylenetriamine

CAS Registry Number: 121-82-4; 2691-41-0

RTECS$^{®}$Number: XY9450000

UN/NA & ERG Number: UN0072/(RDX, wetted)/112

EC Number: 204-500-1

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade) *(Hexolite, RDX; RDX & HMX mixture, 121-82-4; HMX, 2691-41-0)*.

Carcinogenicity: EPA: Possible Human Carcinogen.

Explosive Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexahydro-1,3,5-trinitro-s-triazine is a white crystalline compound; Boiling point = >260°C; Freezing/Melting point = 203−204°C; Exothermic decomposition = 100°C; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability (explosive), Reactivity (see incompatibilities). Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Those involved in the manufacture of this material and its handling in munitions and solid-propellant manufacture. It is also used as a rat poison; a powerful military explosive; a base charge for detonators; and in plastic explosives.

Incompatibilities: Heat, physical damage, shock, and detonators. Detonates on contact with mercury fulminate. Keep away from other explosives, combustibles, oxidizers (such as chlorates, nitrates, perchlorates, permanganates, peroxides; bromine, chlorine, and fluorine), reducing agents, and aqueous alkaline solutions.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1.5 mg/m^3 TWA; 3 mg/m^3 STEL [skin].

ACGIH TLV$^{®}$[1]: 0.5 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 40 mg/m^3

Australia: TWA 1.5 mg/m^3; STEL 3 mg/m^3, [skin], 1993; Belgium: TWA 1.5 mg/m^3; STEL 3 mg/m^3, [skin], 1993; Denmark: TWA 1.5 mg/m^3, [skin], 1999; Finland: TWA 1.5 mg/m^3; STEL 4.5 mg/m^3, [skin], 1999; France: VME 1.5 mg/m^3, [skin], 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; Norway: TWA 1.5 mg/m^3, 1999; the Philippines: TWA 0.4 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Switzerland: MAK-W 1.5 mg/m^3, [skin], 1999; United Kingdom: TWA 1.5 mg/m^3; STEL 3 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV$^{®}$: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyclonite in ambient air[60] ranging from 15 μg/m^3 (North Dakota) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (Connecticut) to 36 μg/m^3 (Nevada). This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, skin, and respiratory tract. Skin contact causes a burning sensation and rash. Other symptoms include headache, nausea, vomiting, loss of appetite, weakness, confusion, dizziness. LD_{50} = (oral-rat) 100 mg/kg (moderately toxic).

Long Term Exposure: Repeated exposure can cause irritability, sleeplessness, seizures, anorexia, kidney damage. Exposure to high levels can damage the nervous system.

Points of Attack: Eyes, skin, central nervous system.

Medical Surveillance: Examination of the nervous system. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. Neoprene™ gloves and plastic clothing are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use chemical cartridge respirator. *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Explosive. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Detached storage in a secure area is recommended. Store in tightly closed containers in a cool well-ventilated area away from other explosives, combustibles, or strong oxidizers (such as chlorine, bromine, and fluorine). Also keep cyclonite away from shock and heat sources. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: RDX, Wetted must bear the label "EXPLOSIVES 1.1D." It falls in Hazard Class 1.1D.

Spill Handling: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Initial isolation and protective action distances:
Small Spill: 1800 feet/500 m
Large Spill: 2500 feet/800 m
Fire: 1600 m (1 mile)

Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover spill with soda ash, mixed and sprayed with water. Place into bucket of water and allow to stand for 2 h. Do not operate radio transmitters or electronic detonator in spill area. Ventilate area of spill or leak after cleanup is complete. Keep Cyclonite out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyclonite is a highly dangerous explosion hazard, especially at high temperatures. In case of a fire, immediately evacuate area. An evacuation distance of 1 mile is recommended. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour over soda ash, neutralize and flush to sewer with water. Also HMX may be recovered from solid propellant waste.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Cyclonite*. Trenton, NJ

Cyclopentadiene C:1780

Molecular Formula: C_5H_6

Synonyms: 1,3-Cyclopentadiene; Pentole; Pyropentylene; R-Pentene

CAS Registry Number: 542-92-7

RTECS®Number: GY1000000

UN/NA & ERG Number: UN1993/128

EC Number: 208-835-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyclopentadiene is a flammable, colorless liquid with a sweet odor, like turpentine. Molecular weight = 66.10; Specific gravity (H_2O:1): 0.8; Boiling point = 42.0°C; Freezing/Melting point = −85°C; Vapor pressure = 400 mmHg at 20°C; Flash point = 25°C (oc); Autoignition temperature = 640°C. Insoluble in water.

Potential Exposure: Compound Description: Human Data. Cyclopentadiene is used as an intermediate in the manufacture of resins, insecticides, fungicides, and other chemicals.

Incompatibilities: Forms explosive mixture with air. Should be stored at −20 to 0°C. Converted (dimerized) to higher boiling dicyclopentadiene upon standing in air and at 32°F/0°C; this conversion may be violent and exothermic; this reaction is accelerated by peroxides or trichloroacetic acid. Reacts violently with potassium hydroxide. Violent reaction with strong oxidizers, strong acids, dinitrogen tetroxide, magnesium. Incompatible with alkaline earth metals, nitrogen oxides. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 75 ppm/200 mg/m^3 TWA.
NIOSH REL: 75 ppm/200 mg/m^3 TWA.
ACGIH TLV®[1]: 75 ppm/203 mg/m^3 TWA.
No TEEL available.
NIOSH IDLH: 750 ppm.

Australia: TWA 75 ppm (200 mg/m^3), 1993; Austria: MAK 75 ppm (200 mg/m^3), 1999; Belgium: TWA 75 ppm (203 mg/m^3), 1993; Denmark: TWA 75 ppm (200 mg/m^3), 1999; Finland: TWA 75 ppm (200 mg/m^3); STEL 115 ppm (310 mg/m^3), 1999; France: VME 75 ppm (200 mg/m^3), 1999; Hungary: TWA 20 mg/m^3; STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 200 mg/m^3, 2003; Norway: TWA 40 ppm (110 mg/m^3), 1999; the Philippines: TWA 75 ppm (200 mg/m^3), 1993; Poland: TWA 200 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 75 ppm (200 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 75 ppm TWA. Several states have set guidelines or standards for cyclopentadiene in ambient air[60] ranging from 2.0−4.0 mg/m^3 (North Dakota) to 3.3 mg/m^3 (Virginia) to 4.0 mg/m^3 (Connecticut) to 4.76 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2523.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, skin, and respiratory tract. Skin contact causes a burning sensation and rash.

Long Term Exposure: Exposure may damage the liver and kidneys. Exposure can cause a skin allergy to develop. If allergy develops, even low exposures may cause symptoms.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do NOT induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *Up to 750 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with cyclopentadiene you should be trained on its proper handling and storage. Cyclopentadiene must be stored to avoid contact with strong oxidizing agents because violent reactions occur. Cyclopentadiene must be stored at temperatures below 0°C or it may undergo an explosive chemical reaction. Sources of ignition, such as smoking and open flames, are prohibited where cyclopentadiene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Flammable liquids, n.o.s. require a label of "FLAMMABLE LIQUIDS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Cyclopentadiene*. Trenton, NJ

Cyclopentane C:1790

Molecular Formula: C_5H_{10}
Synonyms: Pentamethylene
CAS Registry Number: 287-92-3
RTECS®Number: GY2390000
UN/NA & ERG Number: UN1146/128
EC Number: 206-016-6 [*Annex I Index No.:* 601-030-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, N; Risk phrases: R11; R52/53; Safety phrases: S2; S16; S29; S33; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Cyclopentane is a colorless liquid. Molecular weight = 70.15; Specific gravity = (H_2O:1) = 0.75; Boiling point = 49°C; Freezing/Melting point = − 93.6°C; Vapor pressure = 400 mmHg at 31°C; Relative vapor density (air = 1) = 2.42: Flash point = −37.2°C; Autoignition temperature = 361°C. Explosive limits in air: LEL = 1.1%; UEL = 8.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Cyclopentane is used as a solvent.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Contact with strong oxidizers may cause fire and explosion.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.87 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 600 ppm/1720 mg/m^3 TWA.
ACGIH TLV®[1]: 600 ppm/1720 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 600 ppm
PAC-1: 1800 ppm
PAC-2: 3840 ppm
PAC-3: 15,000 ppm

Australia: TWA 600 ppm (1720 mg/m^3), 1993; Belgium: TWA 600 ppm (1720 mg/m^3), 1993; Denmark: TWA 300 ppm (850 mg/m^3), 1999; France: VME 600 ppm

(1720 mg/m^3), 1999; the Netherlands: MAC-TGG 1720 mg/m^3, 2003; Norway: TWA 300 ppm (850 mg/m^3), 1999; Switzerland: MAK-W 600 ppm (1720 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 600 ppm. Several states have set guidelines or standards for cyclopentane in ambient air[60] ranging from 17.0 mg/m^3 (Connecticut) to 17.2−25.8 mg/m^3 (North Dakota) to 29.0 mg/m^3 (Virginia) to 41.0 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Vermont[61] has set a guideline for cyclopentane in drinking water of 30.7 mg/L.

Determination in water: No method available. Octanol−water coefficient: Log $K_{ow} = 3.12$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short Term Exposure: Vapors are irritating to eyes, nose, and throat. If inhaled, will cause dizziness, nausea, vomiting, difficult breathing, or loss of consciousness. Ingestion irritates the stomach. Contact with the liquid is irritating to eyes and skin. This chemical can be absorbed through the skin, thereby increasing exposure. This compound is moderately toxic by ingestion and inhalation. Ingestion causes irritation of the stomach, and aspiration produces severe lung irritation and rapidly developing pulmonary edema. Contact with liquid irritates eyes and skin. Cyclopentane is a nervous system depressant. Alcohol consumption synergistically increases the toxic effects of this compound.

Long Term Exposure: Cyclopentane can cause drying and cracking of the skin.

Points of Attack: Eyes, nose, throat, respiratory system, stomach, and nervous system.

Medical Surveillance: Consider possible irritant effects to the skin and respiratory tract in preplacement and periodic examinations as well as any renal or liver complications.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting, guard against aspiration. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclopentane you should be trained on its proper handling and storage. Before entering confined space where cyclopentane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Use only nonsparking tools and equipment, especially when opening and closing containers of cyclopentane. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." The Hazard Class is 3 and the Packing Group is II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a

hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Water may be ineffective because of low flash point. Do not extinguish fire unless flow of chemical can be stopped. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Cyclopentane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Cyclopentane*. Trenton, NJ

Cyclopropane C:1800

Molecular Formula: C_3H_6

Synonyms: Ciclopropano (Spanish); Cyclopropane, liquified; Trimethylene

CAS Registry Number: 75-19-4

RTECS®Number: GZ0690000

UN/NA & ERG Number: UN1027/115

EC Number: 200-847-8 [*Annex I Index No.:* 601-016-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Cyclopropane is a gas. Molecular weight = 42.09; Boiling point = −34°C; Freezing/Melting point = −127°C; Flash point = flammable gas. Flammable limits: LEL = 2.4%; UEL = 10.4%; Autoignition temperature = 498°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0.

Potential Exposure: Cyclopropane is used as an anesthetic and to make other chemicals.

Incompatibilities: Forms explosive mixture with air. Heat, flame, or contact with oxidizers can cause fire and explosion hazard. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 200 ppm
PAC-1: 600 ppm
PAC-2: 4000 ppm
PAC-3: 60,000 ppm

Determination in Air: Charcoal adsorption followed by workup with CS_2, and analysis by gas chromatography. Use NIOSH Analytical Method #1500 for hydrocarbons.

Harmful Effects and Symptoms

Short Term Exposure: Cyclopropane can affect you when breathed in. Cyclopropane is used as a surgical anesthetic. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause coma and death. Liquid can cause frostbite. May affect the nervous system; and cause heart-rate disorders.

Medical Surveillance: EKG, examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: *Clothing:* Avoid skin contact with Cyclopropane. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissue. *Eye protection:* Wear gas-proof goggles, unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full face-piece respiratory protection is worn.

Respirator Selection: Where there is potential for exposure to cyclopropane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclopropane you should be trained on its proper handling and storage. Before entering confined space where this gas may be present, check to make sure that an explosive concentration does not exist. Cyclopropane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and oxygen, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Outside or detached storage is recommended. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Cyclopropane, liquefied, requires a “FLAMMABLE GAS” label. It falls in Hazard Class 2.1 and there is no Packing Group.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyclopropane is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Cyclopropane*. Trenton, NJ

Cyclosarin (Agent GF, WMD) C:1795

Molecular Formula: $C_7H_{14}FO_2P$; $CH_3PO(F)OC_6H_{11}$

Synonyms: CMPF; Cyclohexyl methylphosphonofluoridate; *O*-Cyclohexyl-methylphosphonofluoridate; Cyclohexyl sarin; Cyclosarin; Cyclosin; GF; Methyl cyclohexylfluorophosphonate; Phosphonofluoridic acid, methyl-, cyclohexyl ester

CAS Registry Number: 329-99-7; 1445-76-7

RTECS®Number: Not established

UN/NA & ERG Number: UN2810/153

EC Number: Not established

Regulatory Authority and Advisory Bodies

Report any release of WMD to National Response Center 1-800-424-8802.

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g (*1445-76-7).*

While not a mandated "Federally listed" waste, GF is more toxic than most RCRA listed chemicals. However, GF is a "listed" hazardous waste in some states where it may have been stockpiled by the military.

Description: Cyclosarin (GF) is a liquid nerve agent/organophosphate containing fluoride. GF is a colorless liquid. The odor is variously described as nondescript, sweet, fruit-like. Odor threshold is about 12 mg/m^3. Molecular weight = 180.2 g/mol; Specific gravity = 1.133 g/mL at 20°C; Boiling point = 239°C; Freezing point = −30°C; Liquid density = 1.1327 at20°C; Vapor density (air = 1) = 6.2; Vapor pressure = 0.44 mmHg at 25°C; Volatility = 581 mg/m^3 at 25°C; Flash point = 94°C. Practically insoluble in water; solubility = 0.37% at 20°C.

History of the agent: Cyclosarin (GF) is believed to have been synthesized about the time of World War II by the Germans. Following the war, in the early 1950s, both the United States and Great Britain undertook a systematic study of potential nerve agents including GF. Some sources in the United States suggest that interest in GF was stimulated by work undertaken in an "iron curtain country." However, for various reasons related to its lower toxicity and relatively high cost, it was never manufactured. Iraq is believed to have produced large quantities of cyclosarin for use as a chemical weapon. Iraq fielded artillery projectiles filled with cyclosarin (GF) and sarin (GB). Animal tests did not find GF−GB mixtures to have any special effects as the toxicity range was approximately intermediate between the two agents.

Potential Exposure: A quick-acting and lethal cholinesterase inhibitor and casualty agent. Females appear to be more susceptible to nerve agent effects. Small percentages of general population have genetic traits that may increase susceptibility.

Incompatibilities: Fairly stable. Cyclosarin (GF) is hydrolyzed by water; rapidly hydrolyzed in the presence of heat and alkalies; by dilute solution of aqueous sodium hydroxide. Contact with alkaline conditions produces isopropyl alcohol and polymer substances. Contact with acid conditions produce hydrogen fluoride; alkaline conditions produce isopropyl alcohol and polymers. When heated to decomposition or on contact with steam, it emits very toxic fumes of fluorides and phosphorus oxides. Reasonably stable when stored in steel at normal temperatures; slightly corrosive to steel when heated.

Persistence of Chemical Agent: Cyclosarin has intermediate persistence [as persistent as Tabun (Agent GA)]. GF evaporates about 20 times more slowly than water. Heavily splashed liquid persists 1 or 2 days under average weather conditions.[AFM 3−9] Approximately 20 times more persistent than sarin (GB).[AFM 3−9] Following (for reference and calculation) are persistence rates for sarin (GB): Summer: 10 min to 24 h; Winter: 2 h to 3 days.

Permissible Exposure Limits in Air: Conversion factor: 1 ppm = 7.4 mg/m^3°C = 0.56 × (°F − 32).

IDLH: 0.05 mg/m^3[US Army].

STEL: 5.0×10^{-5} mg/m^3.

Worker Population Limit (WPL) = 3.0×10^{-5} mg/m^3 (8-h TWA).

General Population Limit (GPL) = 1.0×10^{-6} mg/m^3 (24-h TWA lifetime chronic value).

Protective Action Criteria (PAC)*

TEEL-0: 0.0000600 ppm

PAC-1: **0.00020** ppm

PAC-2: **0.0024** ppm

PAC-3: **0.018** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Acute Exposure Guideline Levels (AEGLs)

Level 1: potential discomfort; nondisabling; reversible.

10 min—0.00049 ppm; 30 min—0.00028 ppm; 1 h—0.0002 ppm; 4 h—0.0001 ppm; 8 h—0.00050 ppm.

Level 2: Irreversible or other serious, long-lasting effects; impaired ability to escape; potential delayed recovery.

10 min—0.0062 ppm; 30 min—0.0035 ppm; 1 h—0.0024 ppm; 4 h—0.0013 ppm; 8 h—0.00091 ppm.

Level 3: Life threatening; possible death.

10 min—0.053 ppm; 30 min—0.027 ppm; 1 h—0.018 ppm; 4 h—0.0098 ppm; 8 h—0.0071 ppm.

Determination in Air: Air sampling is a good indicator of other pathways (e.g., off-gassing from soil) and is useful in risk analysis since it has health-based exposure limits. Onsite and downwind sampling should be conducted within 6 in. above potentially contaminated surfaces/soil to assess any off-gassing hazard as well as at breathing zone level (e.g., 5 feet) to assess potential public health inhalation exposures. Appropriate solid phase sorbent medium (e.g., tubes, PUF samplers) and SUMMA canisters can be used for sample collection and subsequent laboratory analysis.

Permissible Concentration in Water: Unknown.

Determination in Water: G-agents are unlikely to persist in water. If analysis is performed, standard EPA volatile water sampling methods should be used. Contact pollution control authorities and advise shutting water intakes. Although G-agent contamination of large water sources is unlikely, there are military screening levels to determine if smaller, contained water supplies (e.g., water buffalo, tank truck) have been contaminated. Acceptable levels for troops drinking 5−15 L/day of a contaminated supply for 7 days are 4−12 μg/L. This level is a reasonable value to use for the general population since their consumption rate is considerably less.[NRT]

Determination in Soil: Industrial Exposure Scenario = 5.2−8.2 mg/kg; Residential Exposure Scenario = 0.22−0.31 mg/kg.[NRT]

Routes of Entry: Enters the body primarily through the respiratory tract, but is highly toxic through the skin and digestive tract. *Inhalation* (a primary exposure route; inhalation of very small concentrations can produce effects), *Skin* [especially toxic from contact with liquid agent; usually moderate to severe localized effects (e.g., sweating) and systemic effects. Effects can also result from absorption of vapors through skin]. *Eyes* [the most sensitive target organs of nerve agent exposure: miosis (reduction in pupil size) will typically be the first sign of exposure]. *Ingestion* (overall systemic effects).[NRT]

Harmful Effects and Symptoms

Cyclosarin (Agent GF) is a quick-acting chemical warfare nerve agent/nerve gas. Both the liquid and the vapor can kill you. Small amounts can injure in seconds, and can quickly lead to death. *Note:* Sarin is 26 times more deadly than cyanide gas and 20 times more deadly than Potassium cyanide. A single drop, if vaporized, can kill every person in an enclosed room![USCG]

Short Term Exposure: A strong cholinesterase inhibitor. Eye/skin toxicity: Very high; Rate of action: Very rapid. Physiological action: Cessation of breath—death may follow. Detoxification rate: Low.[ANSER] LD_{50} = (subcutaneous-rat) 0.225 mg/kg. Median lethal dose (mg-min/m^3): 2500 by skin (vapor) or 350 (liquid); 35 inhaled. Median incapacitating dose: 25 inhaled. LD_{50} = (subcutaneous, mice) reported from 16 μg/kg to 400 μg/kg (compared to Sarin: LD_{50} = (mice) 200 μg/kg). (*Note*: Sarin: *A single drop on the skin can cause death. Death may occur within 15 min after fatal dose is absorbed*). See also Sarin (Agent GB) at S:0130.

Long Term Exposure: May cause neuropsychiatric effects (as long as a year or more following acute manifestation) and possible EEG changes. Both are documented as acute manifestations of nerve agent poisoning; mild neuropsychiatric changes occur after even low-dose nerve agent exposure. The duration of the neuropsychiatric effects after nerve agent exposure is less well documented, but available information suggests that these effects persist for several weeks or possibly several months. Studies of EEG changes following organophosphate nerve agent exposure found differences between the exposed and control populations but suggested no relationship between their findings and alterations in brain function.[MACBW]

Points of Attack: Skin, eyes, lungs.

Medical Surveillance: Annual physical and respiratory function examinations and a baseline cholinesterase.[NRT]

Decontamination: *Important*: The rapid physical removal of a chemical agent is essential. If one does not have the equipment and/or training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. If time is available, decontaminate outer personal protection equipment (PPE) with a dilute household bleach solution†. Use warm soapy water instead of dilute bleach for decon of bare skin. Use caution to avoid hypothermia in children and the elderly. *Patients exposed to liquid:* All visible droplets should be blotted (not wiped) away using an absorbent material (e.g., paper towels, facial tissues, etc.); if available, towelettes moistened with a neutralizing solution should be used. Absorbent powders may also be used for removal of droplets (in the absence of standard absorbents, field expedients such as flour may be useful). GF should be decontaminated by washing in available clean water at least 3 times. Skin decontamination may be unnecessary if the exposure was to GF vapor only. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Wash off the diluted bleach solution after 15 min. Hair should be thoroughly cleaned using soap and water, with care being taken to prevent wash water from getting into the victim's eyes, open wounds, or mouth. Remember that the water used to decontaminate victims is dangerous. Be sure to decontaminate the victims as much as possible before releasing them from the decon area to prevent them from spreading the nerve gas. Rinse the eyes, mucous membranes, or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction. *Patients exposed to nerve agent by vapor (only)*: should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; take care to prevent wash water from getting into the victim's eyes, open wounds, or mouth. *Surface decontamination* (nonporous surfaces, vehicles, etc.): Use hypochlorite bleach slurries or dilute alkalis. *Confined spaces*: Use steam and ammonia.

†The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach (sodium hypochlorite [NaOCl] or calcium hypochlorite [$Ca(OCl)_2$]); (2) "DS2 solution" (2% NaOH; 70% diethylene triamine; 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

†Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

First Aid: The immediate treatment for nerve agent intoxication is intravenous injection of 2 mg atropine sulfate (intramuscular injection should be considered if the patient is hypoxic and ventilation cannot be initiated, as there is a risk of ventricular fibrillation). This should be followed by additional injections of atropine at 10−15-min intervals, continuing until bradycardia has been reversed (e.g., until the heart rate is at 90 beats/minute). If breathing has stopped, a mechanical respirator should be used to ventilate the patient. *Do not attempt mouth-to-mouth resuscitation.* If possible, oxygen or oxygen-enriched air should be used for ventilation. If possible, monitor cardiac activity.

Notes for physician and medical personnel: Oximes (pralidoxime salts, obidoxime) may be of use in restoring acetylcholinesterase activity. Obidoxime may be used to treat GF intoxication; however, it may cause liver damage. Animal studies indicate that the oxime Hi-6 may be significantly superior to other oximes in the treatment of GF intoxication, but it is not widely available. Therefore pralidoxime salts should be used, with a slow intravenous infusion of 500 mg to 1 g being given initially. Diazepam may be administered to control convulsions. It also has value in controlling the victim's fear. An initial dose of 5 mg may be followed by additional doses at 15-min intervals up to a total of 15 mg.[CDC]

Other effective antidote: National Response Team (NRT) lists atropine and (if more severe) 2-PAM Chloride injections; atropine eye drops.[NRT]

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. *Outer suit*: Tychem F, Butyl rubber, LV, Responder, TK, Tyvek®-F, or Reflector decontamination suits. *Gloves*: Butyl rubber gloves, M-3 and M-4 Norton, or Chemical Protective Set. See: *http://www2.dupont.com/Personal_Protection/en_US/assets/downloads/tychem/permguide82004.pdf*. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. Contact lenses should NOT be worn when working with this chemical.

Medical personnel treating casualties should avoid direct (skin-to-skin) contact; protective gear including breathing protection should be worn when treating casualties prior to decontamination. *Latex gloves are not adequate protection*. Casualties should be decontaminated as rapidly as possible (see the section on decontamination). Remove casualties from exposure as rapidly as possible. *Casualties must not be moved into clean treatment areas where unmasked/ungloved personnel are working until decontamination is complete.* During decontamination operations there should also be PPE/respiratory measures to minimize potential exposures to associated chlorine vapors.

Respirator Selection: *When the types of inhalation hazards and their concentrations are unknown or anticipated to be high*, hazard evaluation responders must use NIOSH- or European Standard EN 149-approved chemical, biological, radiological, and nuclear (CBRN) self-contained breathing apparatus (SCBA) respirators. The CBRN APR full-face respirator provides a lower level of protection than the SCBA and its use is generally allowed once conditions are understood and exposures are determined to be at lower levels. Once the level of danger is established and where there is potential for exposure to the chemical, use a NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full-face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full-face-piece operated in pressure-demand or other positive-pressure mode. The M40 Series (which replaced the M17A1 protective mask) mask provides respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen-deficient environment and is *not approved for civilian use*. It does not afford protection against industrial toxics, such as ammonia and carbon monoxide.

Storage: Reasonably stable in steel at normal temperatures. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone A] require a shipping label of "POISONOUS/TOXIC MATERIALS." Inhalation Hazard. Passenger aircraft/rail: "FORBIDDEN"; Cargo aircraft only: "FORBIDDEN". It falls in DOT Hazard Class 6.1. The packaging and shipping of samples are subject to strict regulations established by the Department of Transportation (DOT), Centers for Disease Control and Prevention (CDC), United States Postal Service (USPS), Occupational Safety and Health Administration (OSHA), and International Air Transport Association (IATA).

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt. %). Scoop up all material and place in a fully removable head drum with a high-density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10 wt. % sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate, and Supertropical Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

GF, when used as a weapon

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.7

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 800/240
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 3.2/5.2

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (½ mile) in all directions; also, consider initial evacuation for 800 m (½ mile) in all directions.

Fire Extinguishing: When heated to decomposition it emits toxic fumes of phosphorus oxides and fluorine. When heated, vapors may form explosive mixtures with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Water, fog, foam, CO_2; Avoid using extinguishing methods that will cause splashing or spreading of the GA. Poisonous gases, including hydrogen cyanide, oxides of nitrogen, oxides of phosphorus, carbon monoxide, and hydrogen cyanide, may be produced in fire. Respiratory protection is required. Positive-pressure, full face-piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Complete protection required; have decontaminants available (bleach, alkali) and atropine. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Grossly liquid-contaminated materials should be decontaminated and containerized and labeled in accordance with DOT and EPA requirements as a hazwaste. Wastewater solution from decon should be analyzed to ensure no residual agent is present. The National Response Plan, ESF-3 designates United States Army Corps of Engineers (USACE) as the primary agency to manage contaminated debris. USACE and the Department of Defense (DOD) typically use safety procedures prior to transport that include “head space” (off gas) monitoring around containers prior to shipment to ensure no leakage/off-gassing. Typically waste will be transported in accordance with state requirements to a designated disposal facility, such as an RCRA-permitted hazardous waste facility (typically an incinerator). Wastewater solution from the decontamination process will be analyzed to ensure no residual agent is present. It is likely that the solution will not contain residual agents and therefore not need to be classified as a hazardous waste but sampling must be used to verify. Chlorinated wastewater may need to be treated/neutralized prior to disposal.[NRT] US munitions stockpiles of G-agent are/have undergone destruction/disposal in the states of Utah, Oregon, Arkansas, Alabama, and

Kentucky. State/local plans to address potential releases from US Army properties are in place at these sites.

References

The Riegle Report*:* A Report of Chairman Donald W. Riegle, Jr. and Ranking Member Alfonse M. D'Amato of the Committee on Banking, Housing and Urban Affairs with Respect to Export Administration, United States Senate, 103rd Congress, 2d Session, May 25, 1994

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

US Army Field Manual (DA FM) 3-9 (PCN 320 008457 00); US Navy Publication No P-467; US Air Force Manual No 355-7; *Potential Military Chemical/Biological Agents and Compounds*; Headquarters, Department of the Army, Headquarters, Department of the Navy, Headquarters, Department of the Air Force; Washington, DC, December 1990

Sidell, F. R. *Medical Aspects of Chemical and Biological Warfare*, Borden Institute, Walter Reed Army Medical Center, Washington, DC; Office of The Surgeon General, United States Army, Falls Church, Virginia; United States Army Medical Department Center and School, Fort Sam Houston, Texas; United States Army Medical Research and Materiel Command, Fort Detrick, Frederick, Maryland, Uniformed Services University of the Health Sciences, Bethesda, Maryland, 1997[MACBW]

CDC/NIOSH. *The Emergency Response Safety and Health Database.* <http://www.cdc.gov/NIOSH/ershdb/EmergencyResponseCard_29750015.html>

National Response Team. (2009). *Quick Reference Guides (QRGs) for Chemical Warfare Agents: Cyclosarin*, Various Agencies, Key References Cited/ Several sources were used in developing the QRGs. Because most references are considered "secondary" sources, comparisons among multiple sources helped to verify information. When conflicting information was found between listed references, a determination was made as to what was more correct and up-to-date, based on publication date and level of peer-review.

Cyhexatin C:1810

Molecular Formula: $C_{18}H_{34}O_4Sn$

Common Formula: $(C_6H_{11}O)_3SnOH$

Synonyms: Plictran®; Tricyclohexylhydroxystannane and ENT 27395-X; Tricyclohexyltin hydroxide

CAS Registry Number: 13121-70-5

RTECS®Number: WH8750000

UN/NA & ERG Number: UN2786 (Organotin pesticides, solid, toxic)

EC Number: 236-049-1 [*Annex I Index No.:* 050-002-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), listed as "severe pollutant."

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 1/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as tin compounds; Canada, CEPA Prohibited Export Substance List.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/21/22; R50/53; Safety phrases: S2; R13; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Cyhexatin is a colorless to white, nearly odorless, crystalline powder. Molecular weight = 385.16; Boiling point = 227°C (decomposes); Freezing/Melting point = 195−198°C. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Organometallic, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as an agricultural chemical and pesticide. Those involved in the manufacture, formulation, and application of this acaricide (miticide).

Incompatibilities: Keep away from strong oxidizers, ultraviolet light, some organic compounds (e.g., chloroform, acetone, xylene).

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Sn]/m^3/0.32 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: 0.1 mg/m^3 (as Sn) [skin] (measured as the, inhalable fraction); Pregnancy Risk Group D.

NIOSH IDLH: 80 mg/m^3 [25 mg[Sn]/m^3].

Australia: TWA 0.1 mg[Sn]/m^3, [skin], 1993; TWA 5 mg/m^3, 1993; Austria: MAK 0.1 mg[Sn]/m^3, [skin], 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 0.1 mg [Sn]/m^3, [skin], 1999; TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Hungary: STEL 0.1 mg[Sn]/m^3, [skin], 1993; Norway: TWA 0.1 mg[Sn]/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; the Philippines: TWA 0.1 mg[Sn]/m^3, 1993; Russia: STEL 0.02 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.1 mg[Sn]/m^3, KZG-W 0.2 mg[Sn]/m^3, [skin], 1999; Thailand: TWA 0.1 mg [Sn]/m^3, 1993; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyhexatin in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

NIOSH IDLH is 80 mg/m^3 [25 mg/m^3 (as Sn)].

Determination in Air: Filter/XAD-2® (tube); CH_3COOH/CH_3CN; High-pressure liquid chromatography/graphite furnace atomic absorption spectrometry; NIOSH Analytical Method (IV) #5504, Organotin.

Permissible Concentration in Water: No criteria set. Fish Tox (ppb): 0.083480 MATC; EXTRA HIGH; FISH STV (Sediment Toxicity Value): INTERMEDIATE.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory system. Symptoms of exposure include headache, vertigo (an illusion of movement), sore throat, cough, abdominal pain, vomiting, skin burns, pruritus. Cyhexatin is moderate in acute oral toxicity to animals. This is in contrast to alkyl tin compounds with smaller (methyl and ethyl) radicals which are highly toxic. A diet including 6 mg/kg of body weight of cyhexatin for 2 years showed no effect in rats. LD_{50} = (oral-rat) 180 mg/kg (moderately toxic).

Long Term Exposure: This chemical has been shown to cause liver and kidney damage in animals. Human Toxicity: 5.250 ppb; HIGH.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: Complete Blood Count (RBC Hemolysis), electrocardiogram, especially on workers over 40 years, glaucoma, liver function tests, urine (chemical/metabolite). For organotins, preplacement and periodic examinations should include the skin, eyes, blood, central nervous system, liver and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 3.2 mg/m³:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 8 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 16 mg/m³:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 80 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area away from oxidizers.

Shipping: Organotin pesticides, solid, toxic, require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Organotin Compounds*, NOSH Document No. 77−115

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (December 2002). *Hazardous Substances Fact Sheet: Cyhexatin*. Trenton, NJ

D

2,4-D D:0100

Molecular Formula: $C_8H_6Cl_2O_3$
Common Formula: $Cl_2C_6H_3OCH_2COOH$
Synonyms: Acetic acid (2,4-dichlorophenoxy)-; Acide 2,4-dichlorophenoxyacetique (French); Acido 2,4-diclorofenoxiacetico (Spanish); Agrotect; Amidox; Amoxone; Aqua-Kleen; Barrage; BH 2,4-D; Brush-Rhap; B-Selektonon; Bush killer; Chipco turf herbicide "D"; Chloroxone; Citrus fix; Crop rider; Crotilin; D 50; Dacamine; 2,4-d Acid; Debroussaillant 600; Decamine; Ded-Weed; Ded-Weed LV-69; Deherban; Desormone; Dichlorophenoxyacetic acid; 2,4-Dichlorophenoxyacetic acid, salts and esters; 2,4-Dichlorphenoxyacetic acid; (2,4-Dichlor-phenoxy)-essigsaeure (German); Dicopur; Dicotox; Dinoxol; DMA-4; Dormone; 2,4-D phenoxy pesticide; 2,4-D, Salts and esters; Emulsamine BK; Emulsamine E-3; ENT 8,538; Envert 171; Envert DT; Esteron; Esteron 44 weed killer; Esteron 76 BE; Esteron 99; Esteron 99 concentrate; Esteron brush killer; Esterone four; Estone; Farmco; Fernesta; Fernimine; Fernoxone; Ferxone; Foredex 75; Formula 40; Hedonal; Hedonal (herbicide); Herbidal; Ipaner; Krotiline; Lawn-Keep; Macrondray; Miracle; Monosan; Mota maskros; Moxone; Netagrone; Netagrone 600; NSC 423; 2,4-PA (in Japan); Pennamine; Pennamine D; Phenox; Pielik; Planotox; Plantgard; Rhodia; Salvo; Spritz-Hormin/2,4-D; Spritz-Hormit/2,4-D; Super D weedone; Superormone concentre; Transamine; Tributon; Trinoxol; U 46; U 46DP; U-5043; Vergemaster; Verton; Verton 2D; Verton D; Vertron 2D; Vidon 638; Visko; Visko-Rhap; Visko-Rhap low drift herbicides; Visko-Rhap low volatile 4L; Weed-AG-Bar; Weedar; Weedar-64; Weed-B-Gon; Weedez wonder bar; Weedone; Weedone LV4; Weed-Rhap; Weed tox; Weedtrol
CAS Registry Number: 94-75-7
RTECS® Number: AG6825000
UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152
EC Number: 202-361-1 [*Annex I Index No.*: 607-039-00-8]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.
US EPA Gene-Tox Program, Positive: *In vivo* cytogenetics—nonhuman bone marrow; Positive: *In vitro* cytogenetics—human lymphocyte; Positive: *B. subtilis* rec assay; *E. coli* polA without S9; Positive: V79 cell culture—gene mutation; Positive: *S. cerevisiae* gene conversion; Negative: *D. melanogaster*—whole sex chrom. loss; Negative: *D. melanogaster*—nondisjunction; Negative: Histidine reversion—Ames test; Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: Carcinogenicity—mouse/rat; Mammalian micronucleus.
US EPA, FIFRA 1998 Status of Pesticides: Supported.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Water Pollution Standard Proposed (EPA, Mexico)[35] (Maine, Minnesota).[61]
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
Reportable Quantity (RQ): 100 lb (45.5 kg).
US EPA Hazardous Waste Number (RCRA No.): U240, D016.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 10.0 mg/L.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.72; Nonwastewater (mg/kg), 10.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (10).
Safe Drinking Water Act: MCL, 0.1 mg/L; MCGL, 0.07 mg/L; Regulated chemical (47 FR 9352) as 2,4-D.
CERCLA/SARA 313: Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada, Drinking Water Quality, 0.1 mg/L IMAC.
Mexico, Drinking Water Criteria, 0.1 mg/L.
European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R37; R41; R43; Safety phrases: S2; S24; S25; S26; S36/37/39; S46; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: 2,4-Dichlorophenoxyacetic acid is a white to yellow crystalline powder with a slight phenolic odor. Molecular weight = 221.04; Specific gravity (H_2O:1) = 1.57; Boiling point = decomposes below BP at 158°C; Freezing/Melting point = 138°C; Vapor pressure = 53 Pa at 160°C; 8×10^{-6} mmHg[EPA]; 0.4 mmHg at 160°C.[NIOSH] Slightly soluble in water; solubility = 0.05%. The taste and odor threshold in water is 3.13 mg/L.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. 2,4-Dichlorophenoxyacetic acid was introduced as a plant growth-regulator in 1942. It is registered in the United States as a herbicide for control of broadleaf plants and as a plant growth regulator. Thus, workers engaged in manufacture, formulation, or application are affected, as may be citizens in areas of application. The Vietnam war era defoliant, Agent Orange, was a mixture of 2,4-D and 2,4,5-T.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00004-7

Incompatibilities: A weak acid, incompatible with bases. Decomposes in sunlight or heat, forming hydrogen chloride and phosgene. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

OSHA PEL: 10 mg/m^3 TWA.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 100 mg/m^3

2,4-D, including salts and esters

DFG MAK: 1 mg/m^3, inhalable fraction TWA; Peak limitation Category II(8) [skin]; Pregnancy Risk Group C.

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 10 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, [skin], 1993; France: VME 10 mg/m^3, 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; the Philippines: TWA 10 mg/m^3, 1993; Poland: MAC (TWA) 7 mg/m^3, MAC (STEL) 20 mg/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, KZG-W 50 mg/m^3, 1999; Thailand: TWA 10 mg/m^3, 1993; Turkey: TWA 10 mg/m^3, 1993; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] set a MAC of 0.02 mg/m^3 in ambient air in residential areas on a momentary basis and 0.01 mg/m^3 on a daily average basis for the sodium salt of 2,4-D. Several states have set guidelines or standards for 2,4-D in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 105 μg/m^3 (Pennsylvania) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Collection on a glass fiber filter and analysis by HPLC with UV detection. Use NIOSH Analytical Method #5001.[18]

Permissible Concentration in Water: The United States[35] has set a MPC in bottled water intended for human consumption of 0.1 mg/L. Mexico[35] has set levels in ambient water of 0.1 mg/L in estuaries and 0.01 mg/L in coastal waters.

Russia[43] has set a MAC of 1.0 mg/L in water bodies used for drinking purposes for the sodium salt and 0.62 mg/L in water bodies used for fishery purposes. A no-observed-adverse-effect-level (NOAEL) of 1 mg/kg/day has been determined,[47] which results in the calculation of a lifetime health advisory of 0.070 mg/L. This level has been proposed by EPA[62] as a maximum level in drinking water. Drinking water levels for Canada and Mexico are 0.1 mg/L. States which have set guidelines for 2,4-D in drinking water[61] include Minnesota at 70 μg/L and Maine at 100 μg/L.

Determination in Water: Fish Tox = 4247.00420 ppb MATC (VERY LOW). Octanol−water coefficient: Log K_{ow} = 2.81

Routes of Entry: Inhalation, skin absorption, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation of the mouth, nose and throat, headache, nausea, vomiting, and diarrhea at levels above 10 mg/m^3. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch, and stupor. Severe exposures may result in death. *Skin:* Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. *Eyes:* Irritation may occur. *Ingestion:* The oral dose required to produce symptoms is about 1/12 oz (1/2 teaspoon). Increasing amounts may result in increasingly severe symptoms as listed above. Death has resulted from as little as 1/5 oz. Survival for more than 48 h is usually followed by complete recovery, although symptoms may last for several months.

Long Term Exposure: Workers exposed to 2,4-D in the manufacturing process over a 5−10-year period at levels above 10 mg/m^3 complained of weakness, rapid fatigue, headache, and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, 2,4-D may affect human reproduction. Human Tox = 70.00000 ppb MCL (Low).

Points of Attack: Skin, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination of the nervous system. NIOSH lists the following tests: blood plasma, urine (chemical/metabolite) 24-h collection.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): natural rubber gloves, Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *100 mg/m^3:* [Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-D, you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area. Keep away from oxidizers, heat, and sunlight. A regulated, marked area should be established where this chemical is stored in compliance with OSHA Standard 1910.1045.

Shipping: Phenoxy pesticides, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." 2,4-D falls in DOT Hazard Class 6.1 and Packing Group III. A DOT-regulated marine pollutant.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2,4-Dichlorophenoxyacetic acid ester may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride, carbon monoxide, and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration of phenoxys is effective in 1 s at 982°C, using a straight combustion process or at 482°C using catalytic combustion. Over 99% decomposition was reported when small amounts of 2,4-D were burned in a polyethylene bag. See "Reference"[22] for additional detail. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). 2,4-*Dichlorophenoxy Acetic Acid*: *Health and Environmental Effects Profile No. 77*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 2,4-D*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Sax N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 49−52 (1981) and 7, No. 6, 11−46 (1987)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: 2,4-D*. Trenton, NJ

Dacarbazine D:0110

Molecular Formula: $C_6H_{10}N_6O$
Synonyms: Deticene; DIC; (Dimethyltriazeno)imidazole-carboxamide; 4-(3,3-Dimethyl-1-triazeno)imidazole-5-carboxamide; 4-(5)-(3,3-Dimethyl-1-triazeno)imidazole-5(4)-carboxa mide; 4-(Dimethyltriazeno)imidazole-5-carboxamide; 5-(3,3-Dimethyl-1-triazeno)imidazole-4-carboxamide; 5-(3,3-Dimet hyltriazeno)imidazole-4-carboxamide; 5-(Dimethyltriazeno) imidazole-4-carboxamide; 5-(3,3-Dimethyl-1-triazenyl)-1H-imidazole-4-carboxamide; DTIC; DTIC-Dome; NCI-C047 17; NSC-45388
CAS Registry Number: 4342-03-4
RTECS® Number: NI3950000
UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151
EC Number: 224-396-1
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Limited Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat; NTP: Reasonably anticipated to be a human carcinogen.
California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 1/29/99.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Dacarbazine is an ivory-colored crystalline solid. Molecular weight = 182.22; Freezing/Melting point = reported at 205°C.
Potential Exposure: Dacarbazine is used in cancer chemotherapy, as an antineoplastic agent in the treatment of certain skin cancers, and occasionally in the therapy of other neoplastic diseases which have become resistant to alternative treatment.
Health professionals who handle this drug (for example, pharmacists, nurses, and physicians) may possibly be exposed during drug preparation, administration, or cleanup; however, the risks can be avoided through use of appropriate containment equipment and work practices.[10] People receiving dacarbazine in treatment are also exposed.
Incompatibilities: Strong oxidizers. Explosive decomposition reported at 250–255°C.
Permissible Exposure Limits in Air
No standards or TEEL available.
Harmful Effects and Symptoms
Long Term Exposure: There is sufficient evidence that dacarbazine is carcinogenic in experimental animals. Rats given dacarbazine orally or intraperitoneally developed tumors of the breast, thymus, spleen, and brain in a minimum of 18 weeks after initial exposure. Intraperitoneal administration of dacarbazine to mice produced tumors in the lung, blood-producing tissue, and uterus.
First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20–30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dacarbazine you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from light. A regulated, marked area should be established where this chemical is stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicines, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Daminozide D:0120

Molecular Formula: $C_6H_{12}N_2O_3$

Common Formula: $(CH_3)_2NNHCOCH_2CH_2COOH$

Synonyms: Alar®; Alar®-85; Aminozide®; B-9; B995; Bernsteinsaeure-2,2-dimethylhydrazid (German); B-Nine; Butanedioic acid mono(2,2-dimethylhydrazide); Dimas*; N*-Di methyl amino-β-carbamyl propionic acid*; N*-(Dimethylam ino)succinamic acid*; n*-Dimethylamino-succinamidsaeure (German); DMASA; DMSA; Kylar; NCI-C03827; SADH; Succinic acid 2,2-dimethylhydrazide; Succinic-1,1-dimethyl hydrazide

CAS Registry Number: 1596-84-5

RTECS® Number: WM9625000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 216-485-9 [*Annex I Index No.:* 607-171-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat.[9]

California Proposition 65 Chemical: Cancer 1/1/90; methylhydrazine and its salts 7/1/92.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R40; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Daminozide is a colorless crystalline solid. Molecular weight = 160.22; Freezing/Melting point = 157−164°C; Vapor pressure = 1×10^{-8} mmHg at 20°C.

Potential Exposure: Daminozide is a plant growth regulator used on certain fruits (especially apples) to improve the balance between growth and fruit production and to improve fruit quality and synchronize maturity. US sales were halted in 1989 because of health considerations.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set. Fish Tox = 31007.43129000 pbbMATC, Very Low.

Harmful Effects and Symptoms

The acute oral LD_{50} for rats is 8400 mg/kg (insignificantly toxic). However, daminozide metabolizes to diamethylhydrazine which is a proven carcinogen in animal tests. It has a low dermal irritation potential and it is neither teratogenic nor mutagenic.[55] It is not an acute toxicant to fish or wildlife. Human Tox = 40.22989 ppb CHCL (Chronic Human Carcinogen Level) (INTERMEDIATE).

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with daminozide you should be trained on its proper handling and storage. Store in a cool, dry place, or in a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Daminozide may be classified as Toxic solids, organic, n.o.s., requiring a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Daunomycin D:0130

Molecular Formula: $C_{27}H_{29}NO_{10}$

Synonyms: 13,057 R.P.; Acetyladriamycin; Cerubidin; Daunamycin; Daunomicina (Spanish); Daunorubicin; Daunorubicine; DM; FI6339; Leukaemmycin C; 5,12-Naphthacenedione, 8-Acetyl-10-(3-amino-2,3,6-trideoxy-α-L-lyxohexopyranosyl)oxy-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8-*cis*)-; NCI-C04693; NSC-82151; RP 13057; Rubidomycin; Rubidomycine; Rubomycin C; Rubomycin C-1; Streptomyces

CAS Registry Number: 20830-81-3

RTECS® Number: HB7875000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 244-069-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, 1987, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (ipr); clear evidence: rat, no evidence, mouse, 1977.

US EPA Hazardous Waste Number (RCRA No.): U059.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Daunomycin is a thin red, needle-shaped material. Molecular weight = 527.6; Freezing/Melting point = 190°C (decomposes). Soluble in water.

Potential Exposure: An antibiotic. It is used as a medicine for treating cancer.

Permissible Exposure Limits in Air

No standards or TEEL set.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if swallowed.

Long Term Exposure: It may cause cancer in humans and may be teratogenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with daunomycin you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Medicines, solid, toxic, n.o.s. require a label of “POISONOUS/TOXIC MATERIALS.” They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Daunomycin*. Trenton, NJ

DDT D:0140

Molecular Formula: $C_{14}H_9Cl_5$

Synonyms: Agritan; Anofex; Arkotine; Azotox; Benzene, 1,1′-(2,2,2-Trichloroethylidene)bis(4-chloro); α,α-Bis(*p*-chlorophenyl)-β,β,β-trichlorethane; 1,1-Bis-(*p*-chlorophenyl)-2,2,2-trichloroethane; 2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane; Bosan supra; Bovidermol; Chlorophenothan; α-Chlorophenothane; Chlorophenothane; Chlorophenotoxum; Citox; Clofenotane; *p,p*′-DDT; 4,4′ DDT; Dedelo; Deoval; Detox; Detoxan; Dibovan; *p,p*′-Dichlorodiphenyltrichloroethane; 4,4′-Dichlorodiphenyltrichloroethane; Dichlorodiphenyltrichloroethane; Dichlorodiphenyl trichloroethane 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; Diclorodifeniltricloroetano (Spanish); Dicophane; Didigam; Didimac; Diphenyltrichloroethane; Dodat®; Dykol®; ENT1,506; Estonate; Ethane, 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)-; Genitox®; Gesafid®; Gesapon®; Gesarex®; Gesarol®; Guesarol®; Gyron®; Havero-Extra®; Ivoran®; Ixodex®; Kopsol®; Mutoxin; NCI-C00464; Neocid®; OMS 16; Parachlorocidum; PEB1; Pentachlorin; Pentech; Pzeidan; Rukseam; Santobane; 1,1,1-Trichlor-2,2-bis(4-chlor-phenyl)-aethan (German); 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane; Trichlorobis(4-chlorophenyl)ethane; 1,1,1-Trichloro-2,2-di(4-chlorophenyl)-ethane; Zeidane; Zerdane

CAS Registry Number: 50-29-3

RTECS® Number: KJ3325000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 200-024-3 [*Annex I Index No.:* 602-045-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence. Group 2B, 1991; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; *In vitro* cytogenetics—nonhuman; Positive: *D. melanogaster*—partial sex chrom. loss; Positive: V79 cell culture—gene mutation; Negative: Host-mediated assay; Sperm morphology—mouse; Negative: *D. melanogaster* sex-linked lethal; *S. cerevisiae*—homozygosis; Inconclusive: *D. melanogaster*—whole sex chrom. loss; Inconclusive: *D. melanogaster*—nondisjunction; Rodent dominant lethal; Inconclusive: Mammalian micronucleus; *E. coli* polA without S9.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U061.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0039; Nonwastewater (mg/kg), 0.087.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Chemical: Cancer 10/1/87 (DDT); Developmental/Reproductive toxin (female) 5/15/98 (*p,p′*-DDT).

Canada, Drinking Water Quality, 0.03 mg/L MAC.

Mexico, Drinking Water Criteria, 0.001 mg/L.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

List of Stockholm Convention POPs: Annex B (Restriction).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R40; R48/25; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: DDT is a waxy solid or slightly off-white powder of indefinite melting point with a weak, chemical odor. Molecular weight = 354.58; Boiling point = 260°C; Freezing/Melting point = 107−109°C; Flash point = 72−75°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Poor solubility in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. DDT is a low-cost broad-spectrum insecticide. However, following an extensive review of health and environmental hazards of the use of DDT, US EPA decided to ban further use of DDT in December 1972. This decision was based on several properties of DDT that had been well evidenced[1]: DDT and its metabolites are toxicants with long-term persistence in soil and water[2]; it is widely dispersed by erosion, runoff and volatization[3]; and the low water solubility and high lipophilicity of DDT result in concentrated accumulation of DDT in the fat of wildlife and humans which may be hazardous.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard. Incompatible with salts of iron or aluminum, and bases. Do not store in iron containers.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA; Suspected occupational carcinogen. Reduce exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 1 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1 mg/m^3 TWA measured as the inhalable fraction [skin]; Peak Limitation Category II (8).

Arab Republic of Egypt: TWA 1 mg/m^3, 1993; Australia: TWA 1 mg/m^3, 1993; Austria: MAK 1 mg/m^3, [skin], 1999; Belgium: TWA 1 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3, [skin], 1999; France: VME 1 mg/m^3, continuous; carcinogen, 1999; India: TWA 1 mg/m^3, 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.1 mg/m^3; STEL 0.8 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, 1993; Switzerland: MAK-W 1 mg/m^3, [skin], 1999; Thailand: TWA 1 mg/m^3, 1993; Turkey: TWA 1 mg/m^3, [skin], 1993; United Kingdom: TWA 1 mg/m^3; STEL 3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[43] set a MAC of 0.005 mg/m^3 for ambient air in residential areas on a momentary basis and 0.001 mg/m^3 on a daily average basis. Several states have set guidelines or standards for DDT in ambient air[60] ranging from 1.8 μg/m^3 (Pennsylvania) to 2.38 μg/m^3 (Kansas) to 5.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (North Dakota) to 16.0 μg/m^3 (Virginia) to 24 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #S-274.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0010 μg/L as a 24-h average; never to exceed 1.1 μg/L. *To protect saltwater aquatic life:* 0.0010 μg/L as a 24-h average; never to exceed 0.13 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is imposed by a level of 0.24 ng/L (0.00024 μg/L). Various states have set guidelines and standards for DDT in drinking water[61] ranging from guidelines of 0.42 μg/L (Kansas) to 0.83 μg/L (Maine) to 1.0 μg/L (Minnesota) and a standard of 50 μg/L (Illinois). Russia set a MAC of 0.1 mg/L in water used for domestic purposes and zero in surface water for fishing.[35]

Canada has set a water quality MAC of 0.03 mg/L. Mexico[35] has set a MPC of 0.001 mg/L in drinking water supply; of 0.006 mg/L in estuaries and 0.6 μg/L in coastal waters.

Determination in Water: Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 6.36$.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Can cause irritation. 500−4200 mg/m^3 has produced dizziness. *Skin:* Can cause irritation in very high concentrations. DDT can be absorbed through the skin if dissolved in vegetable oils or other solvents. *Eyes:* Can cause irritation. *Ingestion:* 1/30−1/4 oz has caused nausea, vomiting, headache, and convulsions. Other symptoms include weakness, restlessness, dizziness, a lack of coordination, numbness of face and extremities, abdominal pain, diarrhea, tremors, and death. Symptoms may be delayed from 30 min to 3 h. Estimated lethal dose is between 1 teaspoon and 1 oz. Can cause a prickling or tingling sensation in the mouth, tongue, lower face, nausea, vomiting, confusion, a sense of apprehension, weakness, loss of muscle control, tremors, paresthesia tongue, lips, face, dizziness, confusion, malaise (vague feeling of discomfort), headache, fatigue, convulsions, paresis hands. High exposures can cause convulsions and death.

Long Term Exposure: DDT may cause liver and kidney damage. Prolonged or repeated exposure can cause irritation of the eyes, skin, and throat. Occupational exposure to DDT has been associated with changes in genetic material. DDT levels build up and stay in the body for long periods of time. Exposure to DDT and aldrin may increase retention of DDT in the body. DDT causes cancer in laboratory animals. Whether it causes cancer in humans is unknown.

Points of Attack: Eyes, skin, central nervous system, kidneys, liver, peripheral nervous system. Cancer site in animals: liver, lung, and lymphatic system.

Medical Surveillance: Serum DDT level. Urine *dichlorodiphenyl acetic acid* level. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: (No longer manufactured). Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Any barrier will prevent contamination from the dry chemical. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DDT you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong bases, and heat. Should not be stored in iron containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: For organochlorine pesticides, solid, toxic, n.o.s. This chemical requires a shipping label of “POISONOUS/TOXIC MATERIALS.” DDT falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not dry sweep. Use vacuum (use special HEPA vacuum, NOT a standard shop-vacuum) or a wet method to reduce dust during cleanup. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including toxic chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration has been successfully used on a large scale for several years; huge incinerator equipments with scrubbers to catch HCl, a combustion product, are in use at several facilities, such as Hooker Chemical, Dow Chemical, and other producers of chlorinated hydrocarbon products. One incinerator operates at 900−1400°C with air and steam added which precludes formation of Cl_2. A few companies also constructed incinerator−scrubber combinations of smaller size, e.g., a system built by Garver-Davis, Inc., of Cleveland, Ohio, for the Canadian government, can handle 200−500 lb DDT per day as a kerosene solution. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *DDT: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *DDT: Health and Environmental Effects Profile No.* 60. Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 51−54 (1981) and 5, No. 1, 12−20 (1985)

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: DDT.* Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: DDT.* Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Decaborane D:0150

Molecular Formula: $B_{10}H_{14}$

Synonyms: Boron hydride; Decaborane; Decaborano (Spanish); Decarboron tetradecahydride

CAS Registry Number: 17702-41-9; *(alt.)* 1304-02-5

RTECS® Number: HD1400000

UN/NA & ERG Number: UN1868/134

EC Number: 241-711-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Decaborane is a colorless solid with a bitter odor. The odor threshold is 0.06 ppm. Molecular weight = 122.24; Specific gravity (H_2O:1) = 0.94; Boiling point = 212.7°C; Freezing/Melting point = 99.4°C; Flash point = 80°C (cc); Vapor pressure = 0.2 mmHg at 25°C; Autoignition temperature = 149°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Very slightly soluble in cold water; slowly hydrolyzes. Reacts with hot water.

Potential Exposure: Decaborane is used as a catalyst in olefin polymerization, in rocket propellants, in gasoline additives, and as a vulcanizing agent for rubber.

Incompatibilities: May ignite SPONTANEOUSLY on exposure to air. Decomposes slowly in hot water. Incompatible with oxidizers, oxygenated solvents, dimethyl sulfoxide (reaction may be violent). Carbon tetrachloride, ethers, halocarbons, halogenated compounds form shock-sensitive mixtures. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 0.05 ppm/0.3 mg/m^3 TWA [skin].

NIOSH REL: 0.05 ppm/0.3 mg/m^3 TWA; 0.15 ppm/0.9 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.05 ppm/0.25 mg/m^3 TWA; 0.15 ppm/0.75 mg/m^3 [skin] STEL.

NIOSH IDLH: 15 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.3 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 15 mg/m^3

DFG MAK: 0.05 ppm/0.25 mg/m^3, Peal Limitation Category II(2) [skin].

Australia: TWA 005 ppm (0.3 mg/m^3); STEL 0.15 ppm, [skin], 1993; Austria: MAK 0.05 ppm (0.3 mg/m^3), [skin], 1999; Belgium: TWA 0.05 ppm (0.25 mg/m^3); STEL 0.15 ppm, [skin], 1993; Denmark: TWA 0.05 ppm (0.3 mg/m^3), [skin], 1999; Finland: TWA 0.05 ppm (0.25 mg/m^3); STEL 0.15 ppm, [skin], 1999; France: VME 0.05 ppm (0.3 mg/m^3), [skin], 1999; Hungary: TWA 0.3 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.3 mg/m^3, 2003; Norway: TWA 0.05 ppm

(0.3 mg/m^3), 1999; the Philippines: TWA 0.05 ppm (0.3 mg/m^3), [skin], 1993; Switzerland: MAK-W 0.05 ppm (0.25 mg/m^3), KZG-W 0.1 ppm, [skin], 1999; Turkey: TWA 0.05 ppm (0.3 mg/m^3), [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.15 ppm/ 0.75 mg/m^3 [skin]. Several states have set guidelines or standards for decaborane in ambient air[60] ranging from 3-9 μg/m^3 (North Dakota) to 5 μg/m^3 (Virginia) to 6 μ/m^3 (Connecticut) and 7 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Vapor exposure may cause clouding of the eyes with loss of vision. Contact can cause severe eye burns and may also irritate the skin. Signs and symptoms of acute exposure to decaborane may include tightness in the chest, dyspnea (shortness of breath), cough, and wheezing. Nausea and pulmonary edema may also occur. Neurological effects of acute exposure include dizziness, headache, weakness, a lack of coordination, muscle spasms, tremor, and seizures. Exposure to decaborane may irritate or burn the skin, eyes, and mucous membranes. Exposure can cause restlessness, headaches, dizziness, and nausea. High concentrations can cause muscle twitching, convulsions, unconsciousness, and death. High or repeated exposures may damage the liver and kidneys. Decaborane can be absorbed through the skin, thereby increasing exposure.

Long Term Exposure: May cause damage to the central nervous system, liver, and kidneys.

Points of Attack: Central nervous system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Any barrier will prevent contamination from the dry chemical. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/ clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 3 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 7.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 15 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* PD: PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with decaborane you should be trained on its proper handling and storage. Decaborane must be stored to avoid contact with oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, or halogenated compounds, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and water. Heat can cause an explosion. Contact with water can slowly produce flammable hydrogen gas. Detached storage is preferable. Sources of ignition, such as smoking and open flames, are prohibited where decaborane is handled, used, or stored.

Shipping: Decaborane must be labeled: "FLAMMABLE SOLID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. For small quantities, sweep into paper or other suitable material, place in appropriate container, and burn in safe place (such as fume hood). Large quantities may be reclaimed. If reclamation is not practical, dissolve in flammable solvent (such as alcohol) and atomize in suitable combustion chamber.

Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: cover with water, sand or earth; shovel into metal container and keep material under water. *Large spills*: dike for later disposal and cover with wet sand or water. Clean up only under supervision of an expert. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. The solid can self-ignite in oxygen, and mixtures with oxidizing materials can be explosive. Use dry chemical or CO_2 extinguishers. Avoid halogenated extinguishing agents, as they can react violently. Poisonous gases are produced in fire, including hydrogen and boron oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

References

Sax N. I., Ed. (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 64−65

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Decaborane.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Decaborane*. Trenton, NJ

Decabromodiphenyl ether D:0160

Molecular Formula: $C_{12}Br_{10}O$

Synonyms: AFR 1021; Benzene, 1,1′-oxybis(2,3,4,5,6-pentabromo-); Berkflam B 10E; Bis(pentabromophenyl) ether; BR 55N; Bromkal 81; Bromkal 82-ODE; Bromkal 83-1ODE; DE83; DE 83R; Decabrom; Decabromobiphenyl ether; Decabromobiphenyl oxide; Decabromodiphenyl oxide (EPA); Decabromophenyl ether; EB 10FP; EBR 700; Ether, bis(pentabromophenyl); FR 300; FR 300BA; FRP 53; FR-PE; 1,1′-Oxybis(2,3,4,5,6-pentabromobenzene); Pentabromophenyl ether; Planelon DB 100; Saytex 102; Saytex 102E; Tardex 100

CAS Registry Number: 1163-19-5

RTECS® Number: KN3525000

UN/NA & ERG Number: UN3077/171

EC Number: 214-604-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1990, NTP: Carcinogenesis Studies (feed); some evidence, rat; equivocal evidence, mouse (NTP: TR-309,86); EPA: Suggestive evidence of carcinogenic potential.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada National Pollutant Release Inventory (NPRI).

As polybrominated biphenyls (PBB)

RCRA Section 261 Hazardous Constituents, waste number not listed.

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080(50); 8250(100).

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer; Reproductive toxin.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DBDPO is a white to off-white powder. Molecular weight = 959.9. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: It is used as a fire retardant for thermoplastics and man-made fibers.

Incompatibilities: Contact with strong oxidizers may cause a fire and explosion hazard. Ethers have a tendency to form unstable and explosive peroxides.

Permissible Exposure Limits in Air

AIHA WEEL of 5 mg/m^3 TWA.

No TEEL available.

Routes of Entry: Inhalation, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. DBDPO irritates the eyes, skin, and respiratory tract.

Long Term Exposure: This chemical can accumulate in the body and may cause liver damage. Thyroid enlargement (goiter) may occur. There is limited evidence that this chemical causes cancer in animals; it may cause liver cancer NTP: some closely related polybrominated biphenyl compounds have been shown to damage the developing fetus.

Points of Attack: Liver, thyroid.

Medical Surveillance: Liver and thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with DPDPO you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer this chemical from drums or other storage containers to process containers. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Do not dry sweep. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Decabromodiphenyl Ether*. Trenton NJ

Demeton D:0170

Molecular Formula: $C_8H_{19}O_3PS_2$

Synonyms: *demeton:* Bay 10756; Bayer 10756; Bayer 8169; Demetona (Spanish); Demeton-O + Demeton-S; Demox; Denox; Diethoxy thiophosphoric acid ester of 2-ethylmercaptoethanol; *O,O*-Diethyl-2-ethylmercaptoethyl thiophosphate, diethoxythiophosphoric acid; *O,O*-Diethyl *S*-2-(ethylthio) ethyl phosphorothioate mixed with phosphorothioic acid, *O, O*-diethyl *O*-2-(ethylthio)ethyl ester; E-1059; ENT 17295; Mercaptophos (in former USSR); Phosphorothioic acid,*O, O*-diethyl *O*-2-(ethylthio)ethyl ester, mixed with *O,O*-diethyl *S*-2-(ethylthio)ethyl phosphorothioate; Systemox; Systox; UL *demeton-S:* Bay 18436; Bayer 18436; Bayer 25/154; *O, O*-Dimethyl-*S*-(2-aethtyl-thio-aethyl)-monothiophosphat (German); *O,O*-Dimethyl *S*-(2-eththioethyl) phosphorothioate; *O,O*-Dimethyl *S*-[2-(eththio)ethyl] phosphorthioate; Dimethyl *S*-(2-eththioethyl) thiophosphate; *O,O*-Dimethyl *S*-ethylmercaptoethyl thiophosphate; *O,O*-Dimethyl *S*-ethylmercaptoethyl thiophosphate, thiolo-isomer; *O,O*-Dimethyl-*S*-(3-thia-pentyl)-monothiophosphat (German); Duratox;

S-[2-(Ethylthio)ethyl] *O,O*-dimethyl phosphorothioate; *S*-[2-(Ethylthio)ethyl]dimethyl phosphorothiolate; *S*-[2-(Ethy lthio)ethyl] *O,O*-dimethyl thiophosphosphate; Isometas ystox; Isomethylsystox; Metaisoseptox; Metaisosystox; Metasystox Forte; Methyl demeton thioester; Methyl isosystox; Methyl-mercaptofos teolovy; Thiophosphate de *O, O*-dimethyle et de *S*-2-ethylthioethyle (French)

CAS Registry Number: 298-03-3 (demeton-O); 126-75-0 (demeton-S); 8065-48-3 (mixture); (*alt.* mixture) 8000-97-3; (*alt.* mixture) 8058-73-9

RTECS® Number: TF3150000 (mixture); TF3125000 (demeton-O); FT3130000 (demeton-S)

UN/NA & ERG Number: UN3017 (organophosphorus pesticide, liquid, poisonous, flammable)/131; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 204-801-8 [*Annex I Index No.:* 015-029-00-4] (demeton-S); 206-053-8 [*Annex I Index No.:* 015-028-00-9] (demeton-O); [*Annex I Index No.:* 015-118-00-8] (mixture)

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; Histidine reversion—Ames test; Positive: *S. cerevisiae*—homozygosis; Positive/dose response: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *E. coli* polA without S9; *D. melanogaster* sex-linked lethal.

Banned or Severely Restricted (in agriculture) (Germany and Russia).[13]

US EPA, FIFRA 1998 Status of Pesticides: Canceled (mixture).

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

For Demeton and Demeton-S:

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

uropean/International Regulations (*O-; 298-03-3* & *mixture 8065-48-3*): Hazard Symbol: T+, N; Risk phrases: R27/28; R50; Safety phrases: S1/2; 28; S36/37; S45; S60; S61; (*S; 126-75-0*): Hazard Symbol: T+, N; Risk phrases: R27/28; Safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Demeton is a light brown liquid with an odor of sulfur compounds; Freezing/Melting point ≤ -13°C. Molecular weight = 516.92; Boiling point = 134°C at 2 mmHg at 20°C; Flash point = 45°C; Explosive limits: LEL = 1%; UEL = 5.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description (mixture): Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Drug. Those involved in the manufacture, formulation, and application of this systemic insecticide and acaricide.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers, strong bases, soluble mercury, other pesticides, and water.

Permissible Exposure Limits in Air

8065-48-3

OSHA PEL: 0.1 mg/m^3 TWA [skin].

NIOSH REL: 0.1 mg/m^3 TWA [skin].

8065-48-3

ACGIH TLV®[1]: 0.01 mg/m^3 TWA, inhalable fraction and vapor [skin]; BEI$_A$: Acetylcholinesterase-inhibiting pesticides; methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

919-86-8

ACGIH TLV®[1]: 0.01 mg/m^3 TWA, inhalable fraction and vapor [skin] sensitizer; BEI$_A$: Acetylcholinesterase-inhibiting pesticides; methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

NIOSH IDLH: 10 mg/m^3.

Protective Action Criteria (PAC) *mixture*

TEEL-0: 0.1 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 10 mg/m^3

Protective Action Criteria (PAC) *demeton-S*

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 200 mg/m^3

DFG MAK: [skin]; BAT information, as acetylcholine esterase inhibitors.

Australia: TWA 0.01 ppm (0.1 mg/m^3), [skin], 1993; Austria: MAK 0.01 ppm (0.1 mg/m^3), [skin], 1999; Belgium: TWA 0.01 ppm (0.11 mg/m^3), [skin], 1993; Finland: STEL 0.1 ppm (0.3 mg/m^3), [skin], 1999; France: VME 0.01 ppm (0.1 mg/m^3), [skin], 1999; India: TWA 0.01 ppm (0.1 mg/m^3), [skin], 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Russia: STEL 0.02 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.01 ppm (0.1 mg/m^3), [skin], 1999; Thailand: TWA 0.1 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 mg/m^3 [skin]. States which have set guidelines or standards for Demeton in ambient air[60] include North Dakota at 1.0 μg/m^3 and Connecticut and Nevada at 2.0 μ/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #5514.

Permissible Concentration in Water: A MAC of 0.01 mg/L in water bodies used for domestic purposes has been set in the former USSR.[35,43]

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Demeton can be absorbed through the skin, thereby increasing exposure. Demeton may cause effects on the nervous system by cholinesterase-inhibiting effect, causing convulsions, respiratory failure, and possible death. High exposure (above OEL) may result in unconsciousness and death. Acute exposure to Demeton may produce the following symptoms of exposure: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. This material is a cholinesterase inhibitor. It is readily absorbed through the skin and is extremely toxic. Probable human lethal oral dose is 5−50 mg/kg or 7 drops to 1 teaspoonful for a 150-lb. person. Acute dose is believed to be 12−20 mg by oral route. The effects may be delayed. Medical observation is indicated.

Long Term Exposure: May cause mutations. May damage the developing fetus. May damage the nervous system causing sensation of "pins and needles" in the hands and feet. May cause depression, irritability, and personality changes. Cumulative effect is possible. Demeton may affect cholinesterase, causing significant depression of blood cholinesterase.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m^3*: Sa (APF = 10) (any supplied-air respirator). *2.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with demeton you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases, water, soluble mercury, and other pesticides. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, flammable, flash point not $<23°C$ require a "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID" label. It falls in Packing Group II and Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur oxides and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The thiono- and thiolo-isomers of this mixture are 50% hydrolyzed in 0.75 and 0.85 min, respectively at 20°C and pH 13. At pH 9 and 70°C, the half life of Demeton is 1.25 h, but at pH $1-5$ it is over 11 h. Sand and rushed limestone may be added together with a flammable solvent; the resultant mixture may be burned in a furnace with afterburner and alkaline scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Demeton*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Demeton*. Trenton, NJ

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Demeton*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Demeton-methyl D:0180

Molecular Formula: $C_6H_{15}O_3PS_2$

Synonyms: Bay 15203; Bayer 21/116; Demethon-methyl; Duratox®; ENT18,862; *S*(and *O*)-2-(Ethylthio)ethyl *O,O*-dimethyl phosphorothioate; Metasystox®; Methyl demeton; Methyl mercaptophos; Methyl systox; Phosphorothioic acid, *O*-2-(ethylthio)ethyl *O,O*-dimethyl ester mixed with *S*-2-(ethylthio)ethyl *O,O*-dimethyl phosphorothioate

CAS Registry Number: 8022-00-2

RTECS® Number: TG1760000

UN/NA & ERG Number: UN3018 (organophosphorus pesticides, liquid, toxic)/152

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Restricted in many countries) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Demeton-methyl is a colorless to pale yellow oily liquid with an unpleasant odor. It is a mixture of Demeton-S and Demeton-O and may be formulated in a flammable organic solvent that may alter the physical properties shown here. Molecular weight = 230.30. Specific gravity (H_2O:1) = 1.2; Boiling point = decomposes below 100°C.

Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.03−0.3% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. An organophosphate insecticide. Those engaged in the manufacture, formulation, and application of the insecticide and acaricide on agricultural and horticultural crops.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA [skin] inhalable fraction and vapors (2006); BEI: methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

Not TEEL available.

DFG MAK: 0.5 ppm/4.8 mg/m^3 TWA; Peak Limitation Category II(2) [skin].

Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: MAK 0.05 ppm (0.5 mg/m^3), [skin], 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; France: VME 0.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, [skin], 2003; Russia: STEL 0.1 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.05 ppm (0.5 mg/m^3), [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m^3 [skin].

Determination in Air: None listed. Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: No criteria set. Octanol−water coefficient: Log K_{ow} = 1.32.

Routes of Entry: Inhalation, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Methyl demeton can be fatal by skin contact even if there is no feeling of irritation. Exposure can cause rapid, fatal organophosphate poisoning. Acute exposure to this chemical may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness, vomiting, diarrhea, abdominal pain, loss of coordination, seizures, coma, and death. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Eye contact may cause irritation.

Long Term Exposure: May cause mutations. In animal studies this chemical causes a decrease in fertility and is toxic to the animal fetus. See also “Demeton” entry.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning. Contact local poison control center for additional guidance.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: None listed by NIOSH for Methyl demeton. *Herewith, for reference only, is the requirement for (8065-48-3) Demeton: 1 mg/m^3*: Sa (APF = 10) (any supplied-air respirator). *2.5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m*^{3}: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. See "Demeton" for guidance.

Shipping: This may depend on the carrier solvent and its flammability. For organophosphorus pesticides, liquid, toxic, the required label is "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including oxides of phosphorus and sulfur, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis or incineration.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 68-69 (as meta-systox)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Demeton-S-Methyl*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Methyl Demeton.* Trenton, NJ

2,4-DES-sodium D:0190

Molecular Formula: $C_8H_7Cl_2NaO_5$

Common Formula: $Cl_2C_6H_3O(CH_2)_2OSO_3Na$

Synonyms: Crag® herbicide 1; Crag® Sesone; 2,4-Des-Na; 2,4-Des-natrium (German); 2-(2,4-Dichlorophenoxy)ethanol hydrogen sulfate sodium salt; 2,4-Dichlorophenoxyethyl sulfate, sodium salt; Disul; Disul-NA; Disul-sodium; Natrium-2,4-dichlorphenoxyathylsulfat (German); SES; Sesone; Sodium-2-(2,4-dichlorophenoxy)ethyl sulfate; Sodium-2,4-dichlorophenoxyethyl sulphate; Sodium-2,4-dichlorophenyl cellosolve sulfate

CAS Registry Number: 136-78-7

RTECS® Number: KK4900000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152

EC Number: 205-259-5 [*Annex I Index No.:* 016-025-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R38; Safety phrases: S2; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sesone or Crag® pesticide is a colorless, odorless, crystalline solid. It is a noncombustible solid, but commercial products may be formulated using flammable organic solvents, which can change the physical properties shown here. Molecular weight = 309.13; Freezing/Melting point = 245°C (decomposes); Vapor pressure = 0.1 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 26% at 25°C.

Potential Exposure: Compound Description: Primary Irritant. Used as corrosion inhibitor, pharmaceutical intermediate, and emulsifier. Those involved in manufacture, formulation, and application of this herbicide as well as citizens in the area of application.

Incompatibilities: Strong oxidizers, acids.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.

ACGIH TLV®[1]: 10 mg/m^3 TWA; Not Suspected as a Human carcinogen, as Sesone.

NIOSH IDLH: 500 mg/m^3.

No TEEL available.

The Netherlands: MAC-TGG 7.4 mg/m^3, 2003; Russia: STEL 5 mg/m^3 [skin] 1993; United Kingdom: TWA 2 ppm (7.4 mg/m^3); STEL 6 ppm (22 mg/m^3), 2000. Several states have set guidelines or standards for sesone in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #S-356 (II-5).

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. High levels of exposure may cause central nervous system effects, convulsions. May affect the kidneys and liver.

Long Term Exposure: May cause liver and kidney damage.

Points of Attack: Eyes, skin, central nervous system, liver, kidneys.

Medical Surveillance: Liver function. Kidney function. Tests of nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator (N, R, or P filters). *100 mg/m^3*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100, or Sa (APF = 10) (any supplied-air respirator). *250 mg/m^3*: PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or Sa:Cf (APF = 25) (any powered, air-purifying respirator with a dust and mist filter). *500 mg/m^3*: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter)* or SaF (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode)*; PaprTHie (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaT: Cf (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.) *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and acids. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Phenoxy pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until clean up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sesone is hydrolyzed by alkali to $NaHSO_4$ and apparently dichlorophenoxyethanol. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Diacetone alcohol D:0200

Molecular Formula: $C_6H_{12}O_2$

Common Formula: $(CH_3)_2C(OH)CH_2COCH_3$

Synonyms: Acetonyldimethylcarbinol; Diacetonalkohol (German); Diacetone-alcool (French); Diacetone, 4-hydroxy-4-methyl-2-pentatone, 2-methyl-2-pentanol-4-one; Diketone alcohol; Dimethylacetonylcarbinol; 4-Hydroxy-2-keto-4-methylpentane; 4-Hydroxyl-2-keto-4-methylpentane; 4-Hydroxy-4-methyl-pentan-2-on (German); 4-Hydroxy-4-methyl-2-pentanone; 4-Hydroxy-4-methylpentan-2-one; 4-Methyl-4-hydroxy-2-pentanone; 2-Methyl-2-pentanol-4-one; 2-Pentanone, 4-hydroxy-4-methyl-; tyranton

CAS Registry Number: 123-42-2

RTECS® Number: SA9100000

UN/NA & ERG Number: UN1148/129

EC Number: 204-626-7 [*Annex I Index No.:* 603-016-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R36; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diacetone alcohol is a colorless liquid with a mild, minty odor. Odor threshold = 0.28 ppm. Molecular weight = 116.16; Specific gravity (H_2O:1) = 0.94; Boiling point = 168°C; Freezing/Melting point = −43.8°C; Vapor pressure = 1 mmHg at 20°C; Flash point = 64°C; 58°C (acetone free); 64°C (commercial grade). Explosive limits: LEL = 1.8%; UEL = 6.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. It is used as a solvent for pigments, cellulose esters, oils, and fats. It is used in hydraulic brake fluids and in antifreeze formulations.

Incompatibilities: Strong oxidizers, strong alkalis.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.75 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/240 mg/m^3 TWA.

NIOSH REL: 50 ppm/240 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/238 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 50 ppm

PAC-2: 50 ppm

PAC-3: 1800 ppm

DFG MAK: 20 ppm/96 mg/m^3 TWA; Peak Limitation Category I(2) [skin] Pregnancy Risk Group D.

NIOSH IDLH: 1800 ppm [LEL].

Australia: TWA 50 ppm (240 mg/m^3), 1993; Austria: MAK 50 ppm (240 mg/m^3), 1999; Belgium: TWA 50 ppm (238 mg/m^3), 1993; Finland: TWA 50 ppm (240 mg/m^3); STEL 75 ppm (360 mg/m^3), 1999; France: VME 50 ppm (240 mg/m^3), 1999; the Netherlands: MAC-TGG 120 mg/m^3, 2003; Norway: TWA 25 ppm (120 mg/m^3), 1999; Russia: STEL 100 mg/m^3, 1993; Sweden: NGV 25 ppm (120 mg/m^3), KTV 20 ppm (240 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (240 mg/m^3), 1999; Turkey: TWA 50 ppm (240 mg/m^3), 1993; United Kingdom: TWA 50 ppm (241 mg/m^3); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for diacetone alcohol in ambient air[60] ranging from 0.03 mg/m^3 (Nevada) to 2.4−3.6 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 4.8 mg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method #1402, Method #1405, or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause corneal tissue damage. Contact can irritate the skin, causing a burning sensation. It can cause you to become dizzy, lightheaded, and to pass out.

Long Term Exposure: Repeated contact may lead to skin rash. Exposure may damage the liver, kidneys, and the blood cells. Although there is no evidence involving this chemical, many similar solvents can cause nerve and brain damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Complete blood count. NIOSH lists: expired air; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Noeprene rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *1800 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diacetone alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) or strong alkalis (such as sodium hydroxide or potassium hydroxide) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where diacetone alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of diacetone alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Shipping: Diacetone alcohol must be labeled: "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Diacetone Alcohol*. Trenton, NJ

Dialifor D:0210

Molecular Formula: $C_{14}H_{17}ClNO_4PS_2$

Synonyms: *n*-[2-Chloro-1-(diethoxyphosphinpthioylthio) ethyl]phthalimide; *S*-[2-Chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl phosphorodithioate; *S*-(2-Chloro-1-phthalimidoethyl) *O,O*-diethyl phosphorodithioate; Dialifos; *O,O*-Diethyl *S*-(2-chloro-1-phthalimidoethyl) phosphorodithioate; *O,O*-Diethyl phosphorodithioate *S*-ester with *n*-(2-chloro-1-mercaptoethyl) phthalimide; ENT 27,320; Hercules 14503; Phosphorodithioic acid, *S*-[2-chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl ester; Phosphorodithioic acid, 5-[2-chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl ester; Phosphorodithioic acid, *S*-(2-chloro-1-phthalimidoethyl) *O,O*-diethyl ester; Torak

CAS Registry Number: 10311-84-9

RTECS® Number: TD5165000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 233-689-3 [*Annex I Index No.:* 015-088-00-6]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Malaysia, Germany).[13]

Very Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant, as Dialifos.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T + , N; Risk phrases R24; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Dialifor is a crystalline solid. The commercial product may also be available as a colorless oil. Molecular weight = 393.86; Freezing/Melting point (solid) = 68°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Strong bases. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 5 mg/m^3

Determination in Air: No method available.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 4.7.

Routes of Entry: Inhalation, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: This material is highly toxic (the LD$_{50}$ for rats is 5 mg/kg). This material can cause serious symptoms, and in extreme cases, death by respiratory arrest. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous

system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dialifor you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." Dialifor falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including phosphorus, sulfur, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis or incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 43−45

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dialifor*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Diallate D:0220

Molecular Formula: $C_{10}H_{17}Cl_2NOS$

Common Formula: $[(CH_3)_2CH]_2NCOSCH_2CCl{=}CHCl$

Synonyms: Avadex; Bis(1-methylethyl)carbamothioic acid, *S*-(2,3-dichloro-2-propenyl) ester; Carbamothioic acid, bis (1-methylethyl) *S*-(2,3-dichloro-2-propenyl) ester; CP 15,336; DATC; 2,3-DCDT; Diallat (German); Di-allate; Diallate carbamate herbicide; *S*-(2,3-Dichloroallyl) diisopropylthiocarbamate; *S*-2,3-Dichloroallyl di-isopropyl(thiocarbamate); *S*-2,3-Dichloroallyl diisopropylthiocarbamate; *S*-2,3-Dichloroallyldiisopropyl thiocarbamate; Dichloroallyldiisopropyl thiocarbamate; 2,3-Dichloroallyl *N,N*-Diisopropylthiolcarbamate; 2,3-Dichloro-2-propene-1-thiol, isopropylcarbamate; *S*-(2,3-Dichloro-2-propenyl)bis(1-methylethyl) carbamothioate; Diisopropylthiocarbamic acid, -(2,3-dichloroallyl) ester; Di-isopropylthiolocarbamate des-(2,3-dichloro allyle) (French); 2-Propene-1-thiol, 2,3-dichloro-, diisopropylcarbamate

CAS Registry Number: 2303-16-4

RTECS® Number: EX8225000

UN/NA & ERG Number: UN2992 (Carbamate pesticides, liquid, toxic)/151

EC Number: 218-961-1 [*Annex I Index No.:* 006-019-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animals Sufficient Evidence; Human No Adequate Data, Group 3, 1998.

US EPA Hazardous Waste Number (RCRA No.): U062.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R50/53; Safety phrases: S2; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diallate is a brown liquid. Molecular weight = 270.21; Boiling point = 150°C at 9 mmHg; Freezing/Melting point = 25−30°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 14 mg/L at 25°C.

Potential Exposure: Those involved in the manufacture, formulation, and application of this thiolcarbamate re-emergence herbicide.

Incompatibilities: Alkalis.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: Russia[43] set a MAC of 0.03 mg/L in water used for domestic purposes.[35,43]

Routes of Entry: Inhalation, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can irritate and possibly cause burns. Inhalation caused irritation of the respiratory tract with chest tightness and/or difficulty breathing. Higher levels can affect the nervous system. Nausea, vomiting, diarrhea, abdominal pain, reduced muscle coordination, blurred vision, muscle twitching, convulsions, coma, and possible death.

Long Term Exposure: High or repeated exposures can cause liver and kidney damage. There is limited evidence that diallate causes liver cancer in animals.

Points of Attack: Skin, eyes, nervous system.

Medical Surveillance: Lung function tests. Kidney and liver function tests. Examination of the nervous system. Interview exposed person for brain effects, including memory, mood, concentration, headaches, malaise, and altered sleep patterns.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diallate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalies. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pesticides, solid, toxic, n.o.s. must bear a "POISONOUS/TOXIC MATERIALS" label. They fall in DOT Hazard Class 6.1 and diallate falls in Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including sulfur oxides, nitrogen oxides, and chlorides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land burial is acceptable for small quantities. Larger quantities can be incinerated.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 50−53

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Diallate*. Trenton, NJ

2,4-Diaminoanisole D:0230

Molecular Formula: $C_7H_{10}N_2O$

Common Formula: $H_3COC_6H_3(NH_2)_2$

Synonyms: 3-Amino-4-methoxyaniline; 1,3-Benzenediami ne, 4-methoxy-; C.I. 76050; C.I. Oxidation base 12; 2,4-DA A; 2,4-Diamineanisole; *m*-Diaminoanisole; 2,4-Diamin oanisole; 1,3-Diamino-4-methoxybenzene; 2,4-Diamino-1-methoxybenzene; 2,4-Diaminophenyl methyl ether; Furro L; 4-Methoxy-1,3-benzenediamine; *p*-Methoxy-*m*-phenylenediamine; 4-Methoxy-*m*-phenylenediamine; 4-Methoxy-1,3-phenylenediamine; 4-MMPD; Pelagol DA; Pelagol grey L; Pelagol L; *m*-Phenylenediamine, 4-methoxy-

sulfate: Anisole, 2,4-diamino-, hydrogen sulfate; Anisole, 2,4-diamino-, sulfate; 1,3-Benzenediamine, 4-methoxy, sulfate (1:1); C.I. 76051; C.I. Oxidation base 12A; 2,4-DAA Sulfate; 2,4-Diaminoanisole sulphate; 2,4-Diamino-anisol sulphate; 2,4-Diamino-1-methoxybenzene; 1,3-Diamino-4-methoxybenzene sulphate; 2,4-Diamino-1-methoxybenzene sulphate; 2,4-Diaminosole sulphate; Durafur brown MN; Fouramine BA; Fourrine 76; Fourrine SLA; Furro SLA; 4-Methoxy-1,3-benzenediamine sulfate; 4-Methoxy-1,3-benzenediamine sulfate (1:1); 4-Methoxy-1,3-benzenediamine sulphate; 4-Methoxy-*m*-phenylenediamine sulfate; *p*-Methoxy-*m*-phenylenediamine sulphate; 4-Methoxy-*m*-phenylenediamine sulphate; 4-MMPD sulphate; NAKO TSA;

NCI-C01989; Oxidation base 12A; Pelagol BA; Pelagol grey; Pelagol grey SLA; Pelagol SLA; Renal SLA; Ursol SLA; Zoba SLE

CAS Registry Number: 615-05-4; 39156-41-7 (sulfate)

RTECS® Number: ST2690000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s./151 [or] Dye intermediates, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 210-406-1 [*Annex I Index No.:* 612-200-00-0]; 254-323-9 [*Annex I Index No.:* 612-200-00-0] (sulfate).

Regulatory Authority and Advisory Bodies

615-05-4

Carcinogenicity: IARC: Human No Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1998.

39156-41-7 (sulfate)

Carcinogenicity: NTP: Reasonably anticipated to be a human carcinogen.

Banned or Severely Restricted (Sweden).[35]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol (*includes sulfate*): T, N; Risk phrases: R45; R22; R68; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*615-05-4*): 3—Highly water polluting.

Description: 2,4-Diaminoanisole is a needle-like solid. Molecular weight = 138.19; Freezing/Melting point 67−68°C. The sulfate is an off-white to violet powder. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0 (includes sulfate). Soluble in water.

Potential Exposure: The principal use of 2,4-diamino-anisole (and its salts such as the sulfate) as a component of oxidation (permanent) hair and fur dye formulations. Human exposure to 2,4-diaminoanisole sulfate may possibly occur through skin absorption at chemical and dye production facilities, as well as through dermal contact in persons using hair dyes containing the chemical.

Incompatibilities: Sulfates react violently with aluminum and magnesium.

Permissible Exposure Limits in Air

NIOSH (*2,4-Diaminoanisole and its salts*): Potential human carcinogen; Reduce exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.

No standards or TEEL available.

DFG MAK: [skin] Carcinogen Category 2.

This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact may cause irritation and possible eye damage. High exposures to the sulfate can cause poisoning with trembling, diarrhea, trouble breathing, and even death.

Long Term Exposure: The sulfate can cause both skin and lung allergies to develop. There is sufficient evidence for the carcinogenicity of 2,4-diaminoanisole sulfate in experimental animals. In rats, dietary administration of the technical grade 2,4-diaminoanisole sulfate increased the incidence of cancers of the skin and the associated glands and of thyroid cancers in each sex. In mice, dietary administration of 2,4-diaminoanisole sulfate induced thyroid tumors in each sex. Female rats exposed to technical-grade 2,4-diaminoanisole sulfate in the feed developed tumors of the thyroid, mammary, clitoral, and pituitary glands.

Points of Attack: Skin, eyes, lungs.

Medical Surveillance: Evaluation by a qualified allergist. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Gloves are usually worn by hairdressers when applying hair dyes. Beyond that, NIOSH recommends minimization of exposure. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DAA sulfate you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from aluminum and magnesium.

Shipping: Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s. or Toxic solids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

National Institute for Occupational Safety and Health. (January 13, 1978). *2,4-Diaminoanisole in Hair and Fur Dyes*, Current Intelligence Bulletin No. 19. Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 2,4-Diaminoanisole Sulfate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: 2,4-Diaminoanisole*. Trenton, NJ

4,4′-Diamino-diphenyl-methane D:0250

Molecular Formula: $C_{13}H_{14}N_2$

Common Formula: $H_2NC_6H_4CH_2C_6H_4NH_2$

Synonyms: 4-(4-Aminobenzyl)aniline; Ancamine TL; Aniline, 4,4′-methylenedi-; Araldite hardener 972; Benzenamine, 4,4′-methylenebis-; Benzenamine, 4,4′-methylenebis- (aniline); Bis-*p*-aminofenylmethan; Bis (*p*-aminophenyl)methane; Bis(4-aminophenyl)methane; Bis (aminophenyl)methane; Curithane; DADPM; DAPM; DDM; DDV; *p,p*′-Diaminodifenylmethan; *p,p*′-Diaminodi phenylmethane; 4,4′-Diaminodiphenylmethane; Diamino diphenylmethane; Di-(4-aminophenyl)methane; Dianilin emethane; 4,4′-Diphenylmethanediamine; Epicure DDM; Epikure DDM; HT 972; Jeffamine AP-20; MDA; 4,4′-Methylenebis(aniline); Methylenebis(aniline); 4,4′-Methy lenebis(Benzeneamine); *p,p*′-Methylenedianiline; Methy lenedianiline; 4,4′-Methylenedibenzenamine; 4,4′-Metilen dianilina (Spanish); Sumicure M; Tonox

CAS Registry Number: 101-77-9; 13552-44-8 (dichloride salt)

RTECS® Number: BY5425000

UN/NA & ERG Number: UN2651/153

EC Number: 202-974-4 [*Annex I Index No.:* 612-051-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1998; NTP (*101-77-9 & 13552-44-8*): 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; OSHA: Potential human carcinogen; NIOSH: Potential occupational carcinogen.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1050).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations (*101-77-9*): Hazard Symbol: T, N; Risk phrases: R45-R39/23/24/25; R43; R48/20/21/22; R68; R51/53; Safety phrases: S53; S45; S61.

European/International Regulations: not listed in Annex I (*dichloride salt*).

WGK (German Aquatic Hazard Class) (*101-77-9*): 3—Highly water polluting.

Description: 4,4′-Diaminodiphenylmethane is a pale yellow crystalline solid (turns light brown on contact with air) with a faint amine-like odor. Molecular weight = 198.29; Boiling point = 398°C; Freezing/Melting point = 92°C; Vapor pressure = 2×10^{-7} mmHg at 25°C; Flash point = 221°C (cc). Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Used as an intermediate and as a curing agent. Approximately 99% of the DDM produced is consumed in its crude form (occasionally containing not more than 50% DDM and ply-DDM) at its production site by reaction with phosgene in the preparation of isocyanates and polyisocyanates. These isocyanates and polyisocyanates are employed in the manufacture of rigid polyurethane foams which find application as thermal insulation. Polyisocyanates are also used in the preparation of the semiflexible polyurethane foams used for automotive safety cushioning. DDM is also used as an epoxy hardening agent, a raw material in the production of polyurethane elastomers, in the rubber industry as a curative for Neoprene™ and as an antifrosting agent (antioxidant) in footwear, a raw material in the production of Quana® nylon, and as a raw material in the preparation of poly(amide-imide) resins (used in magnet wire enamels).

Incompatibilities: A weak base. Strong oxidizers may cause a fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: 0.010 ppm TWA; 0.100 ppm STEL. Potential human carcinogen. See 29CFR1910.1050.

NIOSH REL: Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.1 ppm/0.81 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.01 ppm

PAC-1: 0.1 ppm

PAC-2: 0.6 ppm

PAC-3: 5 ppm

DFG MAK: [skin]; danger of skin sensitization; Carcinogen Category 2; BLW information available.

Australia: TWA 0.1 ppm (0.8 mg/m^3), [skin], 1993; Austria: carcinogen, 1999; Belgium: TWA 0.1 ppm (0.81 mg/m^3), [skin], carcinogen, 1993; Denmark: TWA 0.1 ppm (0.8 mg/m^3), 1999; Japan: 0.4 mg/m^3, [skin], 2B carcinogen, 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Norway: TWA 0.1 ppm (0.8 mg/m^3), 1999; United Kingdom: LTEL 0.1 ppm (0.8 mg/m^3); STEL 0.5 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for MDA in ambient air[60] ranging from zero (North Dakota) to 0.4 μg/m^3 (Kansas) to 0.8 μ/m^3 (Virginia) to 2.67 μg/m^3 (New York) to 4.0 μg/m^3 (South Carolina) to 8.0 μg/m^3 (Connecticut) to 19.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #ID-57; or, special filter; potassium hydroxide/methanol; high-pressure liquid chromatography/ultraviolet/electrochemical detection; NIOSH Analytical Method (IV) #5029.

Determination in Water: No criteria set. Octanol−water coefficient: Log K_{ow} = 1.6.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. A single large exposure or repeated smaller exposures can cause serious liver disease (toxic hepatitis) with symptoms of fever, upper abdominal pain, jaundice, dark urine, fatigue, and loss of appetite.

Long Term Exposure: 4,4′-Methylene dianiline can cause liver damage and may damage the kidneys. Repeated or prolonged contact with skin may cause skin sensitization and dermatitis. Causes thyroid and bladder cancer in animals; a possible carcinogen in humans.

Points of Attack: Liver, kidneys, skin. In animals: bladder cancer.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode; or, any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus. *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical is an animal carcinogen and Suspected Human Carcinogen. It requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including aniline and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

National Institute for Occupational Safety and Health. (July 25, 1986). *Current Intelligence Bulletin 47: 4,4′-Methylenedianiline (MDA)*. Cincinnati, Ohio

Occupational Health and Safety Administration. (May 12, 1989). *Occupational Exposure to 4,4′-Methylenedianiline (MDA)*, Federal Register 54, No. 91, 20672−20741

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: 4,4′-Methylene Dianiline*. Trenton, NJ

Diatomaceous earth D:0260

Molecular Formula: O_2Si

Common Formula: SiO_2

Synonyms: Amorphous silica; Diatomaceous silica; Diatomite, uncalcined; Precipitated amorphous silica; Silica, amorphous diatomaceous earth; Silicon dioxide (amorphous)

CAS Registry Number: 61790-53-2; 7631-86-9 (silica, amorphous, hydrated); *(alt.)* 12750-99-1; *(alt.)* 29847-98-1; *(alt.)* 37337-67-0; *(alt.)* 54511-18-1; *(alt.)* 56748-40-4;*(alt.)* 67016-73-3

RTECS® Number: HL8600000; VV7311000 (natural)

UN/NA & ERG Number: No citation

EC Number: 231-545-4 (silicon dioxide)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997; NIOSH (*Silica, amorphous silica, fused*): Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Diatomaceous earth is a transparent to gray, odorless amorphous powder. Molecular weight = 60.78; Specific gravity (H_2O:1) = 2.20; Boiling point = 2230°C; Freezing/Melting point = 1710°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen. Diatomaceous earth is used as a filtering agent and as a filler in construction materials, pesticides, paints, and varnishes. The calcined version (which has been heat-treated) is the most dangerous and contains crystallized silica and should be handled as silica. See also other entries on silica.

Incompatibilities: High temperatures causes the formation of crystalline silica. Incompatible with fluorine, oxygen difluoride, chlorine difluoride.

Permissible Exposure Limits in Air

Diatomaceous earth, uncalcined and Silica, amorphous precipitated and gel

OSHA PEL: *either one of the methods:* 20 mppcf [millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques] *or* 80 mg/m^3 divided by the value "%SiO_2," TWA.

NIOSH REL: 6 mg/m^3 TWA.

ACGIH TLV®[1]: Withdrawn for the following: *silica amorphous, precipitated and gel; silica fume; silica fused; diatomaceous earth, calcined.*

NIOSH IDLH: 3000 mg/m^3.

Protective Action Criteria (PAC)

Diatomaceous earth; (silica-amorphous diatomaceous)

TEEL-0: 6 mg/m^3

PAC-1: 18 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK (*diatomaceous earth, uncalcined)*: 4 mg/m^3, inhalable fraction; Pregnancy Risk Group C.

Austria: MAK 4 mg/m^3, 1999; Norway: TWA 1.5 mg/m^3 (respirable dust), 1999; Switzerland: MAK-W 4 mg/m^3, 1999; Thailand: TWA 80 mg/m^3, 1993; United Kingdom: TWA 6 mg/m^3,, total dust, 2000; TWA 1.2 mg/m^3, (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 3 mg/m^3 (respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica). Russia[43] set a MAC of 2 mg/m^3 in work-place air.

Determination in Air: Filter; Low-temperature ashing; X-ray diffraction spectrometry; NIOSH Analytical Method (IV) #7501.[58]

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Unknown at this time.

Long Term Exposure: Exposure can cause permanent scarring of the lungs, especially if diatomaceous earth has been calcined (heat-treated). Symptoms include shortness of breath and cough. This can begin anywhere from months to years after exposure. The name of this disease is silicosis. With heavy exposure, individuals may become respiratory cripples. This can be fatal.

Points of Attack: Lungs.

Medical Surveillance: Before first exposure to calcined diatomaceous earth and at regular times after, the following are recommended: Medical examination of the lungs. Lung function tests. Chest X-ray (every 2−5 years).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *30 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *60 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *150 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *300 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *3000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or

SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This material is not singled out by DOT[19] in its Performance-Oriented Packaging Standards.

Spill Handling: Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1985). *Hazardous Substances Fact Sheet: Diatomaceous Earth*. Trenton, NJ

Diazepam D:0270

Molecular Formula: $C_{16}H_{13}ClN_2O$

Synonyms: Alboral; Aliseum; Amiprol; Ansiolin; Ansiolisina; Apaurin; Apozepam; Assival; Atensine; Atilen; 2H-1,4-Benzodiazepin-2-one,7-chloro-1,3-dihydro-1-methyl-5-phenyl-bialzepam; Calmocitene; Calmpose; Cercine; Ceregulart; 7-Chloro-1,3-dihydro-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one; 7-Chloro-1-methyl-5-3H-1,4-benzodiazepin-2(1H)-one; 7-Chloro-1-methyl-2-oxo-5-phenyl-3H-1,4-benzodiazepine; 7-Chloro-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one; 7-Chloro-1-methyl-5-phenyl-3H-1,4-benzodiazepin-2(1H)-one; 7-Chloro-1-methyl-5-phenyl-1,3-dihydro-2H-1,4-benzodiazepin-2-one; Condition; DAP; Diacepan; Diapam; Diazemuls; Diazepam; Diazetard; Dienpax; Dipam; Dipezona; Domalium; Duksen; Duxen; E-Pam; Eridan; Faustan; Freudal; Frustan; Gihitan; Horizon; Kabivitrum; Kiatrium; LA-III; Lembrol; Levium; Liberetas; Methyl diazepinone; 1-Methyl-5-phenyl-7-chloro-1,3-dihydro-2H-1,4-benzodiazepin-2-one; Morosan; Noan; NSC-77518; Pacitran; Paranten; Paxate; Paxel; Plidan; Quetinil; Quiatril; Quievita; Relaminal; Relanium; Relax; Renborin; RO 5-2807; S.A.R.L.; Saromet; Sedipam; Seduksen; Seduxen; Serenack; Serenamin; Serenzin; Setonil; Sibazon; Sonacon; Stesolid; Stesolin; Tensopam; Tranimul; Tranqdyn; Tranquirit; Umbrium; Unisedil; Usempax AP; Valeo; Valitran; Valium; Valium R; Vatran; Velium; Vival; Vivol; WY-3467; Zipan

CAS Registry Number: 439-14-5

RTECS® Number: DF1575000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 207-122-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

California Proposition 65 Developmental/Reproductive toxin 1/1/92.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diazepam is a yellow crystalline powder. Molecular weight = 284.75; Freezing/Melting point = 125−126°C. Insoluble in water.

Potential Exposure: Those involved in the manufacture, packaging, or consumption of this widely used tranquilizing drug.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: When used as a medial drug, diazepam can cause drowsiness and difficulty with coordination, concentration, and balance. It may also cause irritability, anxiety, weakness, headaches, upset stomach, and joint pains. Less common side effects include jaundice, skin rashes, or a drop in the white blood cell count. These effects might also occur from work-place exposure due to breathing in dust during packaging or manufacture. LD_{50} = (oral-rat) 352 mg/kg (moderately toxic).

Long Term Exposure: Diazepam is a probable teratogen and may be a mutagen. Handle with extreme caution. Sudden discontinuing of the exposure following high exposure for at least 3 months may cause shakiness, irritability, and possibly convulsions.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for diazepam level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to diazepam, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diazepam you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. If you are required to work in a sterile environment, you require specific training.

Shipping: As Medicine, solid, toxic, n.o.s., diazepam requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire, including chlorine and oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1995). *Hazardous Substances Fact Sheet: Diazepam*. Trenton, NJ

Diazinon D:0280

Molecular Formula: $C_{12}H_{21}O_3N_2SP$

Synonyms: AG-500; AI3-19507; Alfa-Tox; Antigal; Antlak; Basudin; Basudin 10 G; Basudin E; Bazuden; Caswell No. 342; Dazzel; *O,O*-Diaethyl-*O*-(2-isopropyl-4-methyl-pyrimidin-6-yl)-monothiophosphat (German); *O,O*-Diaethyl-*O*-(2-isopropyl-4-methyl-6-pyrimidyl)-thionopho sphat (German); Dianon; Diaterr-Fos; Diazajet; Diazatol; Diazide; Diazinon AG 500; Diazinone; Diazitol; Diazol; Dicid; Diethyl 2-isopropyl-4-methyl-6-pyrimidinl phosphorothionate; Diethyl 4-(2-isopropyl-6-methylpyrimidinl) phosphorothionate; *O,O*-Diethyl *O*-2-isopropyl-6-methyl-pyrimidin-4-yl phosphorothionate; *O,O*-Diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothionate; *O,O*-Diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidyl) thionophosphate; Diethyl 2-isopropyl-4-methyl-6-pyrimidylthionophosphate; *O,O*-Diethyl 2-isopropyl-4-methylpyrimidyl-6-thiophosphate; *O,O*-Diethyl *O*-6-methyl-2-isopropyl-4-pyrimidinyl phosphorthioate; *O,O*-Diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorthioate; Dimpylate; Dipofene; Diziktol; Dizinon; Dyzol; ENT 19,507; EPA pesticide chemical code 057801; Exodin; G-24480; G 301; Gardentox; Geigy 24480; Isopropylmethylpyrimidyl diethyl thiophosphate; *O*-2-Isopropyl-4-methylpyrimyl *O,O*-diethyl phosphorothioate; Kayazinon; Kayazol; NA 2783 (DOT); NCI-C08673; Neocidol; Neocidol (oil); Nipsan; Nucidol; Oleodiazinon; Phosphoric acid, *O,O*-diethyl *O*-6-methyl-2-(1-methylethyl)-4-pyrimidinyl ester; Phosphorothioate, *O,O*-diethyl *O*-6-(2-isopropyl-4-methylpyrimidyl); Phosphorothioic acid, *O,O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) ester; Phosphorothioic acid, *O,O*-diethyl *O*-(isopropylmethylpyrimidyl) ester; Phosphorothioic acid, *O,O*-diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] ester; 4-Pyrimidinol, 2-isopropyl-6-methyl-, *O*-ester with *O,O*-diethyl phosphorothioate; Root Guard; Sarolex; Spectracide; Spectracide 25EC; Srolex; Thiophosphate de *O,O*-diethyle et de *O*-2-isopropyl-4-methyl 6-pyrimidyle

(French); Thiophosphoric acid 2-isopropyl-4-methyl-6-pyrimidyl diethyl ester

CAS Registry Number: 333-41-5

RTECS® Number: TF3325000

UN/NA & ERG Number: UN3018 (organophosphorus pesticides, liquid, toxic)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 206-373-8 [*Annex I Index No.:* 015-040-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat; Histidine reversion—Ames test; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Canada, Drinking Water Quality, 0.02 mg/L MAC.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S24/25; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Diazinon is a combustible, colorless, oily liquid with a faint amine odor. Technical grade is pale to dark brown. Commercial formulations may use carrier solvents which can change the physical properties listed here. Molecular weight = 304.38; Boiling point = decomposes below BP at 120°C; 83−84°C at 0.002 mmHg; Flash point = 82°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.004%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Producers, formulators, and applicators of this nonsystemic pesticide and acaricide. Diazinon is used in the United States on a wide variety of agricultural crops, ornamentals, domestic animals, lawns and gardens, and household pests.

Incompatibilities: Hydrolyzes slowly in water and dilute acid. Reacts with strong acids and alkalis with possible formation of highly toxic tetraethyl thiopyrophosphates. Incompatible with copper-containing compounds. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; TLV-BEI$_A$ issued (2000), Acetylcholinesterase-inhibiting pesticides.

No TEEL available.

DFG MAK: 0.1 mg/m^3 (measured as the inhalable fraction); Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C.

Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; Hungary: STEL 0.1 mg/m^3, [skin], 1993; India: TWA 0.1 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Norway: TWA 0.1 mg/m^3, 1999; Russia: STEL 0.2 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for diazinon in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides. See also OSHA Analytical Method 62.[58]

Permissible Concentration in Water: Canada set a MAC of 0.02 mg/L. Russia set a MAC of 0.3 mg/L in water bodies for domestic purposes. The US EPA has determined a NOAEL of 0.05 mg/kg/day which gives a long-term health advisory of 0.0175 mg/L and a lifetime health advisory of 0.00063 mg/L. Several states have set guidelines for Diazinon in drinking water[61] ranging from 4 μg/L (Maine) to 14 μg/L (California and Kansas).

Determination in Water: By Methylene chloride extraction followed by gas chromatography. Octanol−water coefficient: Log K_{ow} = 3.12.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Diazinon can affect you when breathed in and quickly enters the body by passing through the skin. May cause skin and eye irritation. Exposure can cause organophosphate poisoning with headache, sweating, nausea and vomiting, diarrhea, muscle twitching, and possible death. It is a moderately toxic organophosphate chemical. LD_{50} = (oral-rat) 66 mg/kg (moderately toxic).

Long Term Exposure: Diazinon may damage the developing fetus. Exposure can cause severe organophosphate poisoning with headache, sweating, nausea and vomiting, diarrhea, loss of coordination, and death. Diazinon may affect the liver.

Points of Attack: Eyes, respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver function tests. Examination of the nervous system. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3} use a NIOSH/MSHA- or European Standard EN149-approved respirator with a pesticide cartridge. The prefilter should be a high-efficiency particulate filter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator.

Where there is potential for high exposures, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from water, and oxidizers, such as peroxides, nitrates, permanganates, chlorates, and perchlorates.

Shipping: Organophosphorus pesticides, liquid, toxic n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and diazinon in Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect for reclamation or absorb in vermiculate, dry sand, earth or a similar material. Dispose by absorbing in vermiculite, dry sand, earth or a similar material, and depositing in an approved facility. *Do not use water*, as toxic gases may be produced. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Diazinon decomposes on heating above 120°C producing toxic fumes including phosphorous oxides and sulfur oxides. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Diazinon is hydrolyzed in acid media about 12 times as rapidly as parathion and at about the same rate as parathion in alkaline media. In excess water this compound yields diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine. With insufficient water, highly toxic tetraethyl monothiopyrophosphate is formed. Therefore, incineration would be a preferable ultimate disposal method with caustic scrubbing of the incinerator effluent.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (March 1998). *Hazardous Substances Fact Sheet: Diazinon*. Trenton, NJ

US Environmental Protection Agency. (August 1987). *Health Advisory: Diazinon*. Washington, DC: Office of Drinking Water

Sax N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 5, 36−43

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Diazomethane D:0290

Molecular Formula: CH_2N_2

Synonyms: Azimethylene; Azomethylene; Diazirine; Diazometano (Spanish); Diazonium methylide; Methane, diazo-

CAS Registry Number: 334-88-3

RTECS® Number: PA7000000

EC Number: 206-382-7 [*Annex I Index No.:* 006-068-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.[9]

US EPA Gene-Tox Program, Positive: *N. crassa*—reversion; *S. cerevisiae*—reversion; Positive/limited: Carcinogenicity—mouse/rat.

Banned or Severely Restricted (Belgium, Sweden) (UN).[13]

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R 45; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diazomethane is a flammable, yellow gas, or a liquid under pressure. Molecular weight = 42.05; Boiling point = −22.7°C; Freezing/Melting point = −145°C; Autoignition temperature = 100°C (explodes). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Decomposes in water; reaction.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Diazomethane is a powerful methylating agent for acidic compounds, such as carboxylic acids, phenols, and enols. It is used in pesticide manufacture and pharmaceutical manufacture.

Incompatibilities: Heat (at about or above 100°C), shock, friction, concussion, sunlight, or other intense illuminations may cause explosions. Contact with alkali metals, drying agents, such as calcium sulfate, or rough edges (such as ground glass) may cause explosions.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.72 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.2 ppm/0.4 mg/m^3 TWA.

NIOSH REL: 0.2 ppm/0.4 mg/m^3 TWA.

ACGIH TLV®[1]: 0.2 ppm/0.34 mg/m^3 TWA; Suspected Human Carcinogen.

NIOSH IDLH: 2 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.2 ppm

PAC-1: 0.6 ppm

PAC-2: 2 ppm

PAC-3: 2 ppm

DFG MAK: Carcinogen Category 2.

Australia: TWA 0.2 ppm (0.4 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Finland: TWA 0.2 ppm (0.4 mg/m^3), 1999; France: VME 0.2 ppm (0.4 mg/m^3), 1993; Hungary: carcinogen, 1993; India: STEL 0.4 mg/m^3 [skin] 1993; Norway: TWA 0.2 ppm (0.4 mg/m^3), 1999; Russia: TWA 0.2 ppm (0.4 mg/m^3), 1993; Switzerland: MAK-W 0.2 ppm (0.35 mg/m^3), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for diazomethane in ambient air[60] ranging from 1.3 μg/m^3 (New York) to 2.0 μ/m^3 (South Carolina) to 4.0 μg/m^3 (Florida and North Dakota) to 7.0 μg/m^3 (Virginia) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #2515.[18]

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5.5 μg/L, based on health effects.

Routes of Entry: Inhalation, ingestion, skin and eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Cough, shortness of breath, headaches, flushed skin, fever, chest pain, pulmonary edema, pneumonitis, asthma, eye irritation. It is extremely toxic. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause severe lung damage with symptoms of coughing, chest pain, shortness of breath, fever, and fatigue. Exposure to the gas or liquid can cause severe skin burns and eye damage. Contact with the liquid can cause frostbite.

Long Term Exposure: Repeated exposures, even at low levels, may cause an asthma-like lung allergy. This chemical is a possible human carcinogen.

Points of Attack: Respiratory system, lungs, eyes, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal at first if the person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy. Consider chest X-ray after acute overexposure. NIOSH lists the following tests: blood gas analysis, chest X-ray, electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Frostbite: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2 ppm:* Sa (APF = 10) (any supplied-air respirator)* or SCBA (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Diazomethane must be stored to avoid contact with alkali metals, such as lithium, sodium, or potassium, or drying agents, such as calcium sulfate, since violent reactions occur. Safety barriers or shields should be used to protect workers from accidental explosions. Sources of ignition, such as smoking and open flames, are prohibited where diazomethane is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more diazomethane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of diazomethane. Wherever diazomethane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Diazomethane is not specifically covered in DOT's Performance-Oriented Packaging Standards.[19]

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. If in liquid form, allow to vaporize or absorb the spilled chemical by using a sponge and water. Decompose chemically with a 10% ceric ammonium nitrate solution. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable and explosive gas. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical or sand to extinguish fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose chemically with ceric ammonium nitrate under constant agitation and cooling.[24]

References

Sax N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 55

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Diazomethane*. Trenton, NJ

Dibenz(a,h)anthracene D:0300

Molecular Formula: $C_{22}H_{14}$

Synonyms: AI3-18996; 1,2: 5,6-Benzanthracene; 1,2,5,6-DBA; DBA; 1,2,5,6-Dibenzanthracene; 1,2: 5,6-Dibenz(a) anthracene; 1,2: 5,6-Dibenzanthracene; Dibenzanthracene; Dibenz(a,h)antraceno (Spanish); 1,2: 5,6-Dibenzoanthracene

CAS Registry Number: 53-70-3

RTECS® Number: HN2625000

UN/NA & ERG Number: UN3077/171

EC Number: 200-181-8 [*Annex I Index No.:* 601-041-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human No Adequate Data, *probably carcinogenic to humans*, Group 2A, 1998; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; *N. crassa*—forward mutation; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: V79 cell culture-gene mutation; Positive/dose response: SHE—clonal assay; Inconclusive: Cell transform.—mouse prostate; *In vivo* SCE—nonhuman; Inconclusive: *In vitro* UDS—human fibroblast.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as polynuclear aromatic hydrocarbons (PAH).

US EPA Hazardous Waste Number (RCRA No.): U063.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 8.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

List of Stockholm Convention POPs: Annex C (Unintentional production and release) as polychlorinated dibenzofurans (PCDFs).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dibenz(a,h)anthracene is a colorless, crystalline solid. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 278.36; Boiling point = 524°C; Freezing/Melting point = 267−270°C. Hazard Identification (based on

NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Dibenz(a,h)anthracene is a chemical substance formed during the incomplete burning of fossil fuel, garbage, or any organic matter and is found in smoke in general; it condenses on dust particles and is distributed into water and soil and on crops. DB(a,h)A is a polycyclic aromatic hydrocarbon (PAH) and is also a component of coal tar pitch, which is used in industry as a binder for electrodes, and creosote is used to preserve wood. PAHs are also found in limited amounts in bituminous materials and asphalt used in industry and for paving.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Dibenz(a,h)anthracene falls in the category of coal tar pitch volatiles.

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 15 mg/m^3

DFG MAK: [skin] Carcinogenic Category 2; Germ Cell Mutation Category 3A.

France: carcinogen, 1993; Norway: TWA 0.04 mg/m^3, 1999; Poland: TWA 0.004 mg/m^3, 1999.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: Under the priority toxic pollutant criteria, the recommended level for the protection of human health is zero. Various levels have been set forth for various lifetime cancer risks.[6] Kansas has set a guideline for BDA in drinking water of 0.029 μg/L.[61]

Determination in Water: Extraction with methylene chloride may be followed by measurement by gas chromatography coupled with mass spectrometry.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Long Term Exposure: DB(a,h)A is a toxic chemical and is a probable carcinogen in humans. It has caused cancer in laboratory animals when it is ingested or applied to their skin. Because DB(a,h)A causes cancer in animals, it is likely that humans exposed in the same manner would develop cancer as well. DB(a,h)A may affect the skin, resulting in photosensitization.

Points of Attack: Respiratory system, skin, bladder, kidneys.

Medical Surveillance: NIOSH lists: complete blood count; chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. See the entry on "Coal Tar Pitch Volatiles." A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The "Acridine" standard may be used for this chemical. The required label is "POISONOUS/TOXIC MATERIALS." It would fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See the entry on: "Coal Tar Pitch Volatiles." Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Public Health Service. (October 1987). *Toxicological Profile for Dibenz(a,h)Anthracene*. Atlanta, Georgia: Agency for Toxic Substances & Disease Registry

Sax N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 6, 94−104

Eller P. M., & Cassinelli M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

Dibenzofuran D:0310

Molecular Formula: $C_{12}H_8O$

Synonyms: (1,1′-Biphenyl)-2,2′-diyl oxide; 2,2′-Biphenylene oxide; 2,2′-Biphenylyleme oxide; Dibenzo(b, d)furan; Dibenzofurano (Spanish); Diphenylene oxide

CAS Registry Number: 132-64-9

RTECS® Number: HP4450000

UN/NA & ERG Number: UN3077/171

EC Number: 205-071-3

Regulatory Authority and Advisory Bodies

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) *as dibenzofurans.*

Persistent Organic Pollutants (UN) as dibenzofurans (chlorinated).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, CEPA Toxic Substances.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dibenzofuran is a white crystalline powder. Molecular weight = 168.20; Boiling point = 285°C−288°C; Freezing/Melting point = 85−87°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Very slightly soluble in water.

Potential Exposure: This material is used as an insecticide and in organic synthesis to make other chemicals. It is derived from coal tar creosote.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

132-64-9

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Dibenzofuran can be absorbed through the skin, thereby increasing exposure. Exposure irritates the eyes, skin and respiratory tract. Poisonous if ingested. See also entry on "Coal Tar."

Long Term Exposure: Repeated contact may cause skin growths, rashes, and changes in skin color. Exposure to sunlight may make rash worse.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. Environmentally hazardous solid, n.o.s. requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: Dibenzofuran.* Trenton NJ

Dibenzyldichlorosilane D:0320

Molecular Formula: $C_{14}H_{14}Cl_2Si$

Common Formula: $(C_6H_5CH_2)_2SiCl_2$

Synonyms: Dichlorobis(phenylmethyl)silane

CAS Registry Number: 18414-36-3

RTECS® Number: VV2977000

UN/NA & ERG Number: UN2434/156

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, *based on other chlorosilanes listed.*

WGK (German Aquatic Hazard Class): No value assigned.

Description: A colorless, corrosive liquid. Hazard Vapor pressure = <1. Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Reacts with water.

Potential Exposure: This material is used as an intermediate in the production of silicone polymers.

Incompatibilities: Combustible materials. Contact with water, steam, or moisture produces corrosive hydrogen chloride gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Based on six other dichlorosilanes (for reference only)

TEEL-0: 0.3 ppm

PAC-1: 0.9 ppm

PAC-2: 11 ppm

PAC-3: 47 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: The health effects are not well known at this time. However, closely related chemicals cause irritation of the eyes, nose, throat, and lungs. Dibenzyl dichlorosilane is a corrosive chemical and can cause severe eye and skin burns. This substance can give off corrosive hydrogen chloride gas on contact with water, steam, or moisture. It is possible that higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Although it is not known if this chemical causes lung problems, similar corrosive or highly irritating substances may affect the lungs.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Dibenzyldichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials and any form of moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Dibenzyldichlorosilane requires a "CORROSIVE" label.[19] It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Fire Extinguishing: Dibenzyldichlorosilane may burn but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Dibenzyl Dichlorosilane*. Trenton, NJ

Diborane D:0330

Molecular Formula: B_2H_6

Synonyms: Boroethane; Boron hydride; Diborane (6); Diborane hexanhydride; Diborano (Spanish); Diboron hexahydride

CAS Registry Number: 19287-45-7

RTECS® Number: HQ9275000

UN/NA & ERG Number: UN1911/119

EC Number: 242-940-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (≥1.00% concentration). *Theft hazard* 15 (≥2.67% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diborane is a compressed, colorless, flammable gas with a nauseating, sickly-sweet odor. The odor threshold = 2.5 ppm. Molecular weight = 27.67; Specific gravity (air = 1) = 0.96; Boiling point = −92.5°C; Freezing/Melting point = −165.5°C; Vapor pressure = 39.5 atm at 17°C; Relative vapor density (air = 1) = 0.97; Flash point = −90°C (flammable gas); Autoignition temperature = 40−50°C. Explosive limits: LEL = 0.8%; UEL = 88%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 3. Reacts with water forming hydrogen gas and boric acid.

Potential Exposure: Compound Description: Mutagen. Diborane is used as the source of boron in the semiconductor industry, as a catalyst for olefin polymerization, a rubber vulcanizer, a reducing agent, a flame-speed accelerator, a chemical intermediate for other boron hydrides, as a doping agent, in rocket propellants, and in the conversion of olefins to trialkyl boranes and primary alcohols.

Incompatibilities: A strong reducing agent. Unstable above 8°C. The presence of contaminants may lower the autoignition temperature; ignition may take place at, or below, room temperature. Diborane can polymerize forming liquid pentaborane. It ignites spontaneously in moist air; and on contact with water, hydrolyzes exothermically forming hydrogen and boric acid. Contact with halogenated compounds (including fire extinguishers) may cause fire and explosion. Contact with aluminum, lithium, and other active metals forms hydrides which may ignite spontaneously. Incompatible with aluminum, carbon tetrachloride, nitric acid, nitrogen trifluoride, and many other chemicals. Reacts with oxidized surfaces. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.13 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.1 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm/0.11 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: 0.15 ppm

PAC-2: **1.0** ppm

PAC-3: **3.7** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: No numerical value established. Data may be available.

NIOSH IDLH: 15 ppm.

Australia: TWA 0.1 ppm (0.1 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.1 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.11 mg/m^3), 1993; Finland: TWA 0.1 ppm (0.1 mg/m^3); STEL 0.3 ppm (0.3 mg/m^3), 1999; France: VME 0.1 ppm (0.1 mg/m^3), 1999; Japan: 0.01 ppm (0.012 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; the Philippines: TWA 0.1 ppm (0.1 mg/m^3), 1993; Russia: STEL 0.1 mg/m^3, 1993; Switzerland: MAK-W 0.1 ppm (0.1 mg/m^3), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.1 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.12 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm. Several states have set guidelines or standards for diborane in ambient air[60] ranging from 30 μg/m^3 (North Dakota) to 50 μg/m^3 (Virginia) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Method (IV) #6006.

Permissible Concentration in Water: No criteria set. (Diborane reacts on contact with water as noted above.)

Routes of Entry: Inhalation, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Diborane is the least toxic of the boron hydrides. In acute poisoning, the symptoms are similar to "metal fume fever": tightness, heaviness and burning in chest, coughing, shortness of breath, chills, fever, pericardial pain, nausea, shivering, and drowsiness. Signs appear soon after exposure or after a latent period of up to 24 h and persist for 1−3 days or more. Pneumonia may develop later. Reversible liver and kidney changes were seen in rats exposed to very high gas levels. This has not been noted in humans. Subacute poisoning is characterized by pulmonary irritation symptoms, and if this is prolonged, central nervous system symptoms, such as headaches, dizziness, vertigo, chills, fatigue, muscular weakness, and only infrequent transient tremors, appear. Convulsions do not occur. NIOSH lists symptoms as chest tightness, precordial pain, shortness of breath, nonproductive cough; nausea, headache, lightheadedness, vertigo (an illusion of movement), chills, fever, fatigue, weakness, tremor, muscle fasciculation. In animals: liver, kidney damage, pulmonary edema, hemorrhage.

Long Term Exposure: Prolonged exposure may cause lung damage. Chronic exposure leads to wheezing, dyspnea, tightness, dry cough, rales, and hyperventilation which persist for several years.

Points of Attack: Respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure has occurred, the following may be useful: liver and kidney function tests. Examination of the nervous system. NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 1 ppm*: Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 ppm:* SCBAF (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SaF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaT: Cf (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 15 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diborane must be stored to avoid contact with air, active metals, such as aluminum and lithium;

halogenated compounds, such as chlorine; and oxidizing agents, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, since violent reactions occur. Containers should be dry, clean, and free of oxygen. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. Containers are usually stored in "dry ice" or are refrigerated in some other way. Diborane can ignite spontaneously in moist air at room temperature. Use dry nitrogen purge in any transfer. Sources of ignition, such as smoking and open flames, are prohibited where diborane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of diborane. Wherever diborane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Diborane must be labeled: "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3 and Packing Group I. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If possible, dilute the leak with an inert gas and exhaust through a fume hood. If source is a cylinder and the leak cannot be stopped in place, specially trained personnel may be able to remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Diborane and diborane, compressed

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.8/1.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.7/4.3

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a highly flammable and reactive gas; it will ignite without warning in moist air at room temperature. Poisonous gases are produced in fire, including boron and hydrogen at higher temperatures and hydrogen and boron hydrides at lower temperatures. Approach fire with extreme caution; consider letting it burn. Do not extinguish fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Stop the flow of gas and use water spray to protect personnel during the shut-off. Use water from an unmanned source to keep fire-exposed containers cool. Diborane may react violently with halogenated extinguishing agents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

References

Sax N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 105–107

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diborane.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Diborane*. Trenton, NJ

Dibromobenzene D:0340

Molecular Formula: $C_6H_4Br_2$
Synonyms: Benzene dibromide; Benzene, dibromo-; *o*-Dibromobenzene
CAS Registry Number: 26249-12-7
RTECS® Number: CZ1780000
UN/NA & ERG Number: UN2514/130
EC Number: 247-544-7
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Dibromobenzene is a heavy colorless liquid with a pleasant aromatic odor. Molecular weight = 235.94; Boiling point = 225.5°C; Freezing/Melting point = 7°C; Flash point = 47°C. Insoluble in water.
Potential Exposure: Dibromobenzene is used as a solvent for oils and in organic synthesis.
Incompatibilities: Strong oxidizers.
Permissible Exposure Limits in Air
No TEEL available.
Russia[43] set a MAC value of 0.2 mg/m^3 for ambient air in residential areas on a momentary basis.
Routes of Entry: Inhalation, passing through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Exposure can irritate the eyes, nose, and throat. High levels can cause you to feel dizzy, lightheaded, and to pass out. Contact can irritate the eyes and skin.
Long Term Exposure: Similar chemicals can cause liver damage.
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to dibromobenzene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with dibromobenzene you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where dibromobenzene is used, handled, or stored, in a manner that could create a potential fire or explosion hazard.
Shipping: Dibromobenzene requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many

directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with flue gas scrubbing.

Reference

New Jersey Department of Health and Senior Services. (April 2006). *Hazardous Substances Fact Sheet: Dibromobenzene*. Trenton, NJ

Dibromochloromethane D:0350

Molecular Formula: $CHBr_2Cl$

Synonyms: CDBM; Chlorodibromomethane; Clorodibromometano (Spanish); NCI-C55254

CAS Registry Number: 124-48-1

RTECS® Number: PA6360000

UN/NA & ERG Number: UN3082/171

EC Number: 204-704-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3; EPA: Possible Human Carcinogen.

Water Pollution Standard Proposed (EPA) (Illinois).[61]

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

Safe Drinking Water Act: Priority List (55 FR 1470).

Safe Drinking Water Act: MCL 0.10 mg/L, as trihalomethanes.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Reportable Quantity (RQ): 100 lb (45.4 kg).

California Proposition 65 Chemical: delisted as a cancer agent 10/29/99.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dibromochloromethane is a clear colorless liquid. Molecular weight = 208.29; Boiling point = 119−120°C; Freezing/Melting point = −22°C. Also reported as ≤20°C.

Potential Exposure: Dibromochloromethane is used as a chemical intermediate in the manufacture of fire extinguishing agents, aerosol propellants, refrigerants, and pesticides. Dibromochloromethane has been detected in drinking water in the United States. It is believed to be formed by the haloform reaction that may occur during water chlorination. Dibromochloromethane can be removed from drinking water via treatment with activated carbon. There is a potential for dibromochloromethane to accumulate in the aquatic environment because of its resistance to degradation. Volatilization is likely to be an important means of environmental transport.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 150 mg/m^3

Permissible Concentration in Water: The Maximum Contaminant Level (MCL) for total trihalomethanes (including dibromochloromethane) in drinking water has been set by the US EPA at 0.10 mg/L (44 RF 68624). Illinois has set a guideline for CDBN in drinking water[61] of 1.0 μg/L.

Harmful Effects and Symptoms

Short Term Exposure: Very little toxicity information is available. It is, however, an irritant and narcotic. Symptoms include dizziness, headache, liver and kidney damage.

Long Term Exposure: May cause liver and kidney damage. Dibromochloromethane gave positive results in mutagenicity tests with *Salmonella typhimurium* TA 100. LD_{50} = (oral-rat) 848 mg/kg (slightly toxic).

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: Liver and kidney function tests.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves (nitrile gloves may provide protection[52]) and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers under an inert atmosphere, away from light, in a refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including chlorine and bromine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be destroyed by high-temperature incinerator equipped with an HCl scrubber.

References

US Environmental Protection Agency. (April 30, 1980). *Dibromochloromethane: Health and Environmental Effects Profile No. 61*. Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 2, 61−63

Dibromochloropropane D:0360

Molecular Formula: $C_3H_5Br_2Cl$

Common Formula: $CH_2BrCHBrCH_2Cl$

Synonyms: BBC 12; 1-Chloro-2,3-dibromopropane; 3-Chloro-1,2-dibromopropane; DBCP; 1,2-Dibrom-3-chlor-propan (German); Dibromchlorpropan (German); Dibromochloropropane; 1,2-Dibromo-3-cloropropano (Spanish); Fumagone; Fumazone; NCI-C00500; Nemabrom; Nemafume; Nemagon; Nemagon 20; Nemagon 90; Nemagone; Nemagone 20G; Nemagon soil fumigant; Nemanax; Nemapaz; Nemaset; Nematocide; Nematox; Nemazon; OS 1897; Oxy DBCP; Propane, 1,2-dibromo-3-chloro-; SD 1897

CAS Registry Number: 96-12-8

RTECS® Number: TX8750000

UN/NA & ERG Number: UN2872/159

EC Number: 202-479-3 [*Annex I Index No.:* 602-021-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; NTP: Carcinogenesis Bioassay (inhalation); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; *E. coli* polA without S9; Positive: Histidine reversion—Ames test; Sperm morphology—human IARC: Human Inadequate Evidence, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999.

Banned or Severely Restricted (several countries) (UN).[35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1044).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U066.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (100); 8240 (5); 8270 (10).

Safe Drinking Water Act: MCL, 0.0002 mg/L; MCLG, zero; Regulated chemical (47FR9352).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 7/1/87; reproductive, male 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; B3 combustible liquid; D1A Very toxic material causing immediate and serious toxic effects; D2A Very toxic material causing other toxic effects.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DBCP is an amber to brown liquid (a solid below 6°C/43°F) with a strong, pungent odor. It has an odor and taste threshold at 0.01 mg/L in water. Molecular weight = 236.35; Specific gravity (H_2O:1): 2.1; Boiling point = 196°C (decomposes); Freezing/Melting point = 6.1°C; Vapor pressure = 0.8 mmHg at 20°C; Flash point = 77°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.1%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. DBCP has been used in agriculture as a fumigant for control of nematodes since 1955, being supplied for such use in the forms of liquid concentrate, emulsifiable concentrate, powder, granules, and solid material. A rebuttable presumption against registration for pesticide uses was issued by US EPA on September 22, 1977, on the basis of oncogenicity and reproductive effects. Then, as of November 3, 1977, the EPA in a further action, suspended all registrations of end-use products, subject to various specific restrictions.

Incompatibilities: Reacts with oxidizers and chemically active metals (i.e., aluminum, magnesium, and tin alloys). Attacks some rubber materials and coatings. Corrosive to metals.

Permissible Exposure Limits in Air

OSHA PEL: [1910.1044] TWA 0.001 ppm.

NIOSH REL: Carcinogen; Limit exposure to lowest feasible concentration.

Protective Action Criteria (PAC)

TEEL-0: 0.001 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 2.

Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000. Argentina: TWA of 0.25 mg/m^3; STEL 0.75 mg/m^3. Sweden set no limits; it simply stated that DBCP is a carcinogenic substance and should be avoided. Russia[43] set a MAC of 0.0004 mg/m^3 for ambient air in residential areas on a momentary basis and 0.00003 mg/m^3 on a daily average basis. Several states have set guidelines or standards for DBCP in ambient air[60] ranging from zero (North Dakota) to 0.05 μg/m^3 (Connecticut) to 1.0 μg/m^3 (Pennsylvania).

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes. The US EPA[47] has set both a 1-day health advisory of 0.2 mg/L and a 10-day health advisory of 0.02 mg/L for a 10-kg child. Longer-term health advisories could not be calculated because of the carcinogenicity of DBCP. EPA has recently proposed[62] a maximum drinking water level of 0.0002 mg/L (0.2 μg/L). Several states have set guidelines for DBCP in drinking water[61] ranging from 0.025 μg/L (Arizona) to 0.25 μg/L (Minnesota) to 0.5 μg/L (Wisconsin) to 1.0 μg/L (California).

Determination in Water: By purge-and-trap gas chromatography.[47] Octanol−water coefficient: Log $K_{ow} = 2.96$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms include severe local irritation to eyes, skin, and mucous membranes. Nausea and vomiting may occur after ingestion. Exposure to DBCP can cause headache, nausea, vomiting, weakness, lightheadedness, unconsciousness, and possible death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: The possible effects on the health of employees chronically exposed to repeated or lower exposures of DBCP may include sterility, diminished renal function, degeneration, and cirrhosis of the liver. DBCP is a probable carcinogen in humans. It has been shown to cause stomach, breast, tongue, and nasal cavity cancer in animals. May damage the testes and decrease fertility in males and females. Repeated exposure can damage the eyes, causing clouding of lens or cornea, open sores on the skin, and liver and kidney damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys, spleen, reproductive system, digestive system.

Medical Surveillance: Medical surveillance shall be made available to employees as outlined below:

Comprehensive preplacement or initial medical and work histories with emphasis on reproductive experience and menstrual history. Comprehensive physical examination with emphasis on the genito-urinary tract including testicle size and consistency in males. Semen analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum luteinizing hormone (LH) may be carried out if, in the opinion of the responsible physician, they are indicated. In addition, screening tests of the renal and hepatic systems may be considered. A judgment of the worker's ability to use positive-pressure respirators. Employees shall be counseled by the physician to ensure that each employee is aware that DBCP has been implicated in the production of effects on the reproductive system including sterility in male workers. In addition, they should be made aware that cancer was produced in some animals. While the relevancy of these findings is not yet clearly defined, they do indicate that both employees and employers should do everything possible to minimize exposure to DBCP. Periodic examinations containing the elements of the preplacement or initial examination shall be made available at least on an annual basis. Examinations of current employees shall be made available as soon as practicable after the promulgation of standards for DBCP. Medical surveillance shall be made available to any worker suspected of having been exposed to DBCP. Pertinent medical records shall be maintained for all employees subject to exposure to DBCP in the workplace. Such records shall be maintained for 30 years and shall be available to medical representatives of the US Government, the employer, and the employee. *NIOSH mandated tests:* blood serum: follicle stimulating hormone, luteinizing hormone, total estrogen (females); genito-urinary tract: testicle size, sperm count. NIOSH also lists the following tests: blood serum: follicle stimulating hormone, luteinizing hormone serum, multiphasic analysis, testosterone; complete blood count; pulmonary function tests; sperm count; thyroid function test/thyroid profile; urinalysis (routine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20−30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Contact local poison control center for advice about inducing vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Note: Protective clothing shall be resistant to the penetration and to the chemical action of dibromochloropropane. Additional protection, including gloves, bib-type aprons, boots, and overshoes, shall be provided for, and worn by, each employee during any operation that may cause direct contact with liquid dibromochloropropane. Supplied-air hoods or suits resistant to penetration of dibromochloropropane shall be worn when entering confined spaces, such as pits or storage tanks. In situations where heat stress is likely to occur, supplied-air suits, preferably cooled, are recommended. The employer shall ensure that all personal protective clothing is inspected regularly for defects and is maintained in a clean and satisfactory condition by the employee.

Respirator Selection: Engineering controls shall be used wherever airborne dibromochloropropane concentrations needed to be kept below the recommended occupational exposure limit. Compliance with this limit may be achieved by the use of respirators under the following conditions only: during the time necessary to install or test the required engineering controls; for nonroutine operations, such as emergency maintenance or repair activities; during emergencies when air concentrations of dibromochloropropane may exceed the recommended occupational exposure limit. When a respirator is permitted, NIOSH recommends the following: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DBCP you should be trained on its proper handling and storage. Store in a refrigerator. Protect from alkalis and reactive metals. Protection from light is recommended for long-term storage. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: DBCP requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use incinerator equipped with afterburner and scrubber.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Dibromochloropropane*, NIOSH Document No. 78—115

Sax N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 55−57

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: DBCP*. Trenton, NJ

Dibutylamine D:0370

Molecular Formula: $C_8H_{19}N$

Synonyms: 1-Butanamine, *n*-butyl; *n*-butyl-1-butanamine; DBA; *n*-Dibutylamine; Di(*n*-butyl)amine; Di-*n*-butylamine (DOT); DNBA

CAS Registry Number: 111-92-2

RTECS® Number: HR7780000

UN/NA & ERG Number: UN2248/132

EC Number: 203-921-8 [*Annex I Index No.:* 612-049-00-0]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *In vitro* SCE—nonhuman; Positive/dose response: *In vitro* cytogenetics—nonhuman.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dibutylamine is a colorless liquid with an odor of ammonia. Molecular weight = 129.28; Boiling point = 159−161°C; Freezing/Melting point = −61.9 to −59°C; Flash point = 42−47°C; Autoignition temperature = 260°C. Explosive Limits: LEL = 1.1%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen, Primary Irritant. Used as a corrosion inhibitor and intermediate for emulsifiers, rubber products, dyes, and as insecticides.

Incompatibilities: Forms explosive mixture with air. Aqueous solution is a strong base. Incompatible with acids, acid chlorides, acid anhydrides, halogens, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution, strong oxidizers, reactive organic compounds. Attacks copper alloys, zinc, tin, tin alloys, galvanized steel. Also, carbon dioxide is listed as incompatible by the state of New Jersey.

Permissible Exposure Limits in Air
AIHA WEEL: 5 ppm/26.5 mg/m^3, Ceiling [skin].
Protective Action Criteria (PAC)
TEEL-0: 0.25 ppm
PAC-1: 0.75 ppm
PAC-2: 50 ppm
PAC-3: 50 ppm

Routes of Entry: Inhalation, through the skin, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: This chemical is corrosive. This chemical can be absorbed through the skin, thereby increasing exposure. Skin or eye contact can cause severe irritation and burns. Inhalation can cause irritation of the respiratory tract and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation; bronchitis may develop with coughing, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with dibutylamine you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Di-*n*-butylamine requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, hydrocarbons, amines, and carbon monoxide, are produced in fire. Use dry chemical, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Dibutylamine*. Trenton, NJ

Dibutylaminoethanol D:0380

Molecular Formula: $C_{10}H_{23}NO$

Common Formula: $(C_4H_9)_2NCH_2CH_2OH$

Synonyms: DBAE; β-Di-*N*-butylaminoethanol; 2-Di-*N*-butylaminoethanol; 2-Dibutylaminoethanol; Dibutylamin oethanol; 2-Di-*N*-butylaminoethyl alcohol; *N*,*N*-Dibutylethanolamine; *N*,*N*-Dibutyl-*N*-(2-hydroxyethyl) amine

CAS Registry Number: 102-81-8

RTECS® Number: KK3850000

UN/NA & ERG Number: UN2735 (amines, liquid, corrosive, n.o.s.)/153

EC Number: 203-057-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Di-*n*-butylaminoethanol is a colorless to yellowish liquid. Faint amine-like odor. Molecular weight = 173.33; Boiling point = 224−232°C; Freezing/Melting point = <−69°C; Flash point = 96°C; Autoignition temperature = 240°C. Explosive Limits: LEL = 0.9%; UEL = 5.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Solubility in water = 11.6 g/L at 25°C.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2 ppm/14 mg/m^3 TWA [skin].

ACGIH: 0.5 ppm/3.5 mg/m^3 TWA [skin]; TLV-BEI$_A$ issued; Acetylcholinesterase-inhibiting pesticides.

No TEEL available.

Australia: STEL of 4 ppm (28 mg/m^3). Several states have set guidelines or standards for dibutylaminoethanol in ambient air[60] ranging from 0.14 mg/m^3 (North Dakota) to 0.23 mg/m^3 (Virginia) to 0.28 mg/m^3 (Connecticut) to 0.333 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2007, aminoethanol compounds.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may burn the eyes and irritate the skin. The vapor can irritate the nose, throat, and bronchial tubes. LD_{50} = (oral-rat) 1070 mg/kg (slightly toxic).

Long Term Exposure: High or repeated exposure may damage the liver and kidneys. Related chemicals can cause lung allergy (asthma) or skin allergy, with rash. They can also cause a fluid buildup in the lungs with high exposures, which is a medical emergency. It is not known whether 2-*n*-dibutylaminoethanol has these effects.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof

chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with DBAE you should be trained on its proper handling and storage. 2-*N*-Dibutylaminoethanol must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions may occur. Sources of ignition, such as smoking and open flames, are prohibited where 2-*n*-dibutylaminoethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Dibutylaminoethanol must be labeled "CORROSIVE." It falls into DOT/UN Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2006). *Hazardous Substances Fact Sheet: 2-N-Dibutylaminoethanol.* Trenton, NJ

Di-*tert*-butyl-*p*-cresol D:0390

Molecular Formula: $C_{15}H_{24}O$

Common Formula: $[(CH_3)_3C]_2C_6H_2(CH_3)OH$

Synonyms: BHT; Butylated hydroxytoluene; DBPC; Dibutylated hydroxytoluene; 3,5-di-*tert*-butyl-4-hydroxytoluol; 4-Methyl-2,6-di-*tert*-butylphenol

CAS Registry Number: 128-37-0

RTECS® Number: GO7875000

EC Number: 204-881-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

Listed in the TSCA inventory.

US EPA Gene-Tox Program, Positive: *D. melanogaster*—whole sex chromosome loss; Negative: Histidine reversion—Ames test; Mouse-specific locus; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: *D. melanogaster*—reciprocal translocation; Inconclusive: Mammalian micronucleus; Sperm morphology—mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Listed by the following states: CA, NJ, PA, MA, MN.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (D2B, D2A); listed on Canada's DSL List.

European/International Regulations; Hazard Symbol: Xn; Risk phrases: R22: Harmful if swallowed; R36; R37; R38; Safety phrases: S24; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: BHT is a white to pale yellow crystalline solid or powder. Molecular weight = 220.39; Boiling point = 265°C; Freezing/Melting point = 70°C; Vapor pressure = .01 mmHg at 20°C; Flash point = 127°C (cc). Hazard Identification (based on NFPA-704 M Rating

System): Health 2, Flammability 1, Reactivity 0. Insoluble in water; solubility = 0.00004%.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. DBPC is used as a food and feed additive, flavor, and packaging material and as an antioxidant in human foods and animal feeds. It is also used as an antioxidant to stabilize petroleum fuels, rubber, and vinyl plastics.

Incompatibilities: Contact with oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 2 mg/m^3 TWA (intermittent, vapor, and aerosol); Not Classifiable as a Human carcinogen, as butylated hydroxytoluene (BHT) (2001).

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 400 mg/m^3

DFG MAK: 20 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2); Carcinogen Category 4; Pregnancy Risk Group C.

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 10 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, [skin], 1999; France: VME 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Switzerland: MAK-W 10 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH II-1,[1] P&CAM Method #226 and OSHA Analytical Method PV-2108.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 5.1.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. This compound has an acute oral LD_{50} for rats of 890 mg/kg which is classified as slightly toxic.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. BHT may cause liver damage. BHT may damage the developing fetus. Repeated exposure to high levels may affect the liver. BHT may cause changes in behavior and learning ability and reduce the blood's ability to clot, but this is not known for sure at this time. In animals: decreased growth rate, increased liver weight.

Points of Attack: Eyes, skin, liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with DBPC you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents (such as peroxides, permanganates, chlorates, perchlorates, and nitrates).

Shipping: No information available. BHT may be treated as Toxic solids, organic, n.o.s. This shipping name requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazards Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be

properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: DBPC is a combustible solid but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Water or foam may cause frothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: 2,6-Di-tert-Butyl-p-Cresol*. Trenton, NJ

Dibutyl phosphate D:0400

Molecular Formula: $C_8H_{18}NO_4P$

Common Formula: $(n\text{-}C_4H_9O)_2PO(ON)$

Synonyms: Dibutyl acid *o*-phosphate; Dibutyl acid phosphate; Di-*N*-butyl hydrogen phosphate; Di-*N*-butyl phosphate; Dibutyl phosphoric acid; Phosphoric acid, dibutyl ester

CAS Registry Number: 107-66-4

RTECS® Number: TB9605000

UN/NA & ERG Number: UN1760/154

EC Number: 203-509-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dibutyl phosphate is a pale amber to brown, odorless liquid. Molecular weight = 210.24; Specific gravity (H_2O:1) = 1.06; Boiling point = (decomposes) 135−138°C; Freezing/Melting point = −13°C; Vapor pressure ≈1 mmHg at 20°C; Flash point = 188°C (oc); Autoignition temperature = 420°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: This material is used as a catalyst in organic synthesis.

Incompatibilities: Dibutyl phosphate is a medium strong acid. Reacts with strong oxidizers. Attacks many metals forming flammable and explosive hydrogen gas. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 1 ppm/5 mg/m^3 TWA.

NIOSH REL: 1 ppm/5 mg/m^3 TWA; 2 ppm/10 mg/m^3 STEL.

ACGIH TLV®[1]: 1 ppm TWA inhalable fraction and vapor; 2 ppm STEL inhalable fraction and vapor [skin].

NIOSH IDLH: 30 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 2 ppm

PAC-2: 6 ppm

PAC-3: 30 ppm

DFG MAK: Germ Cell Mutation Category 3A.

Australia: TWA 1 ppm (5 mg/m^3); STEL 2 ppm, 1993; Belgium: TWA 1 ppm (8.8 mg/m^3); STEL 2 ppm (17 mg/m^3), 1993; Finland: TWA 1 ppm (8 mg/m^3); STEL 3 ppm (24 mg/m^3), [skin], 1999; France: VME 1 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Philippines: TWA 1 ppm (5 mg/m^3), 1993; Switzerland: MAK-W 1 ppm (8.5 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietman: ACGIH TLV®: STEL 2 ppm. Some states have set guidelines or standards for dibutyl phosphate in ambient air[60] ranging from 50−100 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5017.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.6−1.4.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate and burn the eyes. Inhalation can irritate the respiratory tract causing coughing, wheezing, and shortness of breath. Skin contact irritates the skin causing rash or burning sensation.

Long Term Exposure: Can cause drying and cracking of skin. Can cause lung irritation.

Points of Attack: Respiratory system, skin, eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. NIOSH lists the following tests: whole blood (chemical/metabolite); breath; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Viton™ gloves, suits. **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode. *Up to 30 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Dibutyl phosphate must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, and bromine, since violent reactions occur.

Shipping: Acids, liquid, n.o.s. must carry a "CORROSIVE" label. They fall in DOT Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dibutyl phosphate is a combustible liquid. Poisonous gases, including oxides of phosphorus, carbon monoxide, phosphine, and phosphoric acid are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 1998). *Hazardous Substances Fact Sheet: Dibutyl Phosphate.* Trenton, NJ

Dibutyl phthalate D:0410

Molecular Formula: $C_{16}H_{22}O_4$

Common Formula: $C_6H_4(COOC_4H_9)_2$

Synonyms: *o*-Benzenedicarboxylic acid, dibutyl ester; 1,2-Benzenedicarboxylic acid, dibutyl ester; Benzene-*o*-dicarboxylic acid di-*n*-butyl ester; Bis-*n*-butyl phthalate; BUFA; Butyl phthalate; *n*-Butyl phthalate (DOT); Celluflex DPB; DBP; DBP (ester); Di(*n*-butyl) 1,2-benzenedicarboxylate;

Dibutyl 1,2-benzene dicarboxylate; Dibutyl 1,2-benzenedicarboxylate; Di-*n*-butyl phthalate; Dibutyl *o*-phthalate; Elaol; Ergoplast FDB; Ftalato de *n*-butilo (Spanish); Genoplast B; Hexaplas M/B; Kodaflex dibutyl phthalate (DBP); Morflex-240; NLA-10; Palatinol C; Palatinol DBP; Phthalic acid, dibutyl ester; Polycizer DBP; PX 104; RC Plasticizer DBP Staflex DBP; Uniplex 150; Witcizer 300

CAS Registry Number: 84-74-2

RTECS® Number: TI0875000

UN/NA & ERG Number: UN3082/171

EC Number: 201-557-4 [*Annex I Index No.:* 607-318-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US EPA Gene-Tox Program, Negative: *S. cerevisiae*—reversion; Inconclusive: *In vitro* SCE—nonhuman.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U069.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10).

Reportable Quantity (RQ): 10 lb(4.55 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Developmental/Reproductive toxin (male, female) 2/2/05.

Canada, WHMIS, Ingredients Disclosure List, CEPA Priority Substance List, National Priority Release Inventory.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Dibutyl phthalate is a colorless oily liquid with a very weak aromatic odor. Molecular weight = 278.38; Specific gravity (H_2O:1) = 1.05; Boiling point = 344°C; Freezing/Melting point = −35°C; Vapor pressure = 0.00007 mmHg at 20°C; Flash point = 157°C; Autoignition temperature = 402°C; Explosive limits: LEL = 0.5% at 235°C; UEL = ≈2.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Corrosive. Practically insoluble in water; solubility = 0.001% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Used in making vinyl compounds, in plasticizing vinyl acetate emulsion systems, and in plasticizing cellulose esters. Also used as a lacquer solvent (nail polish remover) and insect repellent.

Incompatibilities: DBP is a medium strong acid. Reacts with strong oxidizers, strong alkalis, strong acids, nitrates. Attacks many metals forming flammable and explosive hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA.

NIOSH IDLH: 4000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.05 ppm/0.58 mg/m^3; Peak Limitation Category I(1) Pregnancy Risk Group: C.

Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; France: VME 5 mg/m^3, 1999; Hungary: TWA 2 mg/m^3; STEL 4 mg/m^3 [skin] 1993; India: TWA 5 mg/m^3, 1993; Japan: 5 mg/m^3, 1999; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, 1993; Sweden: NGV 3 mg/m^3, KTV 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3. Russia has set a limit of 0.1 mg/m^3 for ambient air on a once daily basis; the Czech Republic[35] has set ambient air limits at 0.8 mg/m^3 on a daily average basis and 2.4 mg/m^3 on a half-hour exposure basis.

Determination in Air: Use NIOSH Analytical Method (IV) #5020.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 940 μg/L on an acute basis and 3 μg/L on a chronic basis for all phthalate esters. On a chronic basis, as low as 2944 μg/L. *To protect human health:* 34,000 μg/L.[6] Several states have set guidelines for DBP in drinking water[61] ranging from 770 μg/L in Kansas to 2200 μg/L in Maine. Russia[43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes.

Determination in Water: Gas chromatography (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 4.7.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Highly corrosive. The substance irritates the eyes, skin, nasal passages, and upper respiratory system. May cause skin allergy, stomach irritation, light sensitivity.

Long Term Exposure: Unknown at this time. However, this chemical may cause lung problems. Di-*n*-butyl phthalate may also damage the developing fetus and testes (male reproductive glands).

Points of Attack: Eyes, respiratory system, gastrointestinal system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends butyl rubber; Neoprene™, nitrile rubber, and viton as good to excellent protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m³:* Any air-purifying full-face-piece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100. *125 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m³:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *4000 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Di-*n*-butyl phthalate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, or chlorine dioxide), strong alkalis (such as sodium hydroxide, potassium hydroxide, and lithium hydroxide), and strong acids (such as sulfuric acid, hydrochloric acid, and nitric acid) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where di-*n*-butyl phthalate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phthalic anhydride, are produced in fire. Use dry chemicals or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location,

use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be absorbed on vermiculite, sand, or earth and disposed of in a sanitary landfill. Alternatively, it may be incinerated.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Phthalate Esters: Ambient Water Quality Criteria.* Washington, DC

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Phthalates*, 97-103, Report PB-274-273. Cincinnati, OH

US Environmental Protection Agency. (April 30, 1980). *Di-n-Butyl Phthalate: Health and Environmental Effects Profile No. 62*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (February 1989). *Hazardous Substances Fact Sheet: Di-n-Butyl Phthalate*. Trenton, NJ

Sax N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 40−44

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Dicamba D:0420

Molecular Formula: $C_8H_6Cl_2O_3$

Common Formula: $Cl_2C_6H_2(OCH_3)COOH$

Synonyms: AI3-27556; *o*-Anisic acid, 3,6-dichloro-; Banex; Banlen; Banvel; Banvel 4S; Banvel 4WS; Banvel CST; Banvel herbicide; Banvel II herbicide; Benzoic acid, 3,6-dichloro-2-methoxy-; Brush Buster; Caswell No. 295; Compound B dicamba; Dianate; Dicamba benzoic acid herbicide; Dicambra; 3,6-Dichlor-3-methoxy-benzoesaeure (German); 3,6-Dichloro-*o*-anisic acid; 2,5-Dichloro-6-methoxybenzoic acid; 3,6-Dichloro-2-methoxybenzoic acid; EPA pesticide chemical code 029801; MDBA; Mediben; 2-Methoxy-3,6-dichlorobenzoic acid; Velsicol 58-CS-11; Velsicol compound R

CAS Registry Number: 1918-00-9

RTECS® Number: DG7525000

UN/NA & ERG Number: UN2769 (Benzoic derivative pesticides, solid, toxic)/151

EC Number: 217-635-6 [*Annex I Index No.:* 607-043-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; *E. coli* polA without S9; Negative: Histidine reversion—Ames test; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *D. melanogaster* sex-linked lethal.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, Drinking Water Quality, 0.12 mg/L MAC.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dicamba is a white or brown nonflammable, colorless, odorless solid. Molecular weight = 221.04; Specific gravity (H_2O:1) = 1.57; Boiling point = 195°C (decomposes below BP); Freezing/Melting point = 114−116°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Highly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Those involved in manufacture, formulation, and application of this postemergence herbicide. Used to control allual and perennial broad leaf weeds in corn, sorghum, small grain pastures, and noncroplands.

Incompatibilities: Incompatible with sulfuric acid, bases, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Dicamba decomposes in heat, producing toxic and corrosive fumes including hydrogen chloride.

Permissible Exposure Limits in Air

No TEEL available.

Russia: STEL 1 mg/m^3, [skin], 1993. Although no US exposure limits have been established, this chemical can be absorbed through the skin, thereby increasing exposure.

Permissible Concentration in Water: A no-adverse-effect level in drinking water has been calculated by NSA/NRC[46] at 0.009 mg/L. States which have set guidelines for dicamba in drinking water[61] include Maine at 9.0 μg/L and Wisconsin at 12.5 μg/L. Canada’s MAC in drinking water is 0.12 mg/L.

Determination in Water: A detection limit of 1 ppb for dicamba by electron-capture gas chromatography has been reported by NAS/NRC.[46] Octanol−water coefficient: Log K_{ow} = 2.2.

Routes of Entry: Ingestion, inhalation, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Dicamba irritates the eyes, skin, and respiratory tract. Exposure can cause nausea, vomiting, loss of appetite and weight, muscle weakness, and exhaustion. The acute toxicity of dicamba is relatively low. Dicamba produced no adverse effect when fed to rats at up to 19.3 and 25 mg/kg/day in subchronic and chronic studies. The no-adverse-effect dose in dogs was 1.25 mg/kg/day in a 2-year feeding study. Based on these data, an ADI was calculated at 0.0012 mg/kg/day. LD_{50} = (oral-rat) 1037 mg/kg (slightly toxic).

Long Term Exposure: May affect the liver.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dicamba you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, heat, and water.

Shipping: Benzoic derivative pesticides, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including chlorine and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land disposal or incineration are disposal options.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Dicamba*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Dicamba*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

US Department of Agriculture (USDA), Soil Conservation Service. (1990). *SCS/ARS/CES Pesticide Properties Database: Version 2.0.* Syracuse, NY

Dichloroacetic acid D:0430

Molecular Formula: $C_2H_2C_{l2}O_2$
Synonyms: Acetic acid, bichloro-; Acetic acid, dichloro-; Bichloroacetic acid; DCA; Dichlorethanoic acid
CAS Registry Number: 79-43-6
RTECS® Number: AG6125000
UN/NA & ERG Number: UN1764/153
EC Number: 201-207-0 [*Annex I Index No.*: 607-066-00-5]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data*, not classifiable as carcinogenic to humans*, Group 2B, 1995; EPA: Likely to produce cancer in humans.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
California Proposition 65 Chemical: Cancer 5/1/96; male 8/7/09.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: DCA is a corrosive, combustible, colorless liquid with a pungent odor. Molecular weight = 128.94; Specific gravity (H_2O:1) = 1.56; Boiling point = 193.8°C; Freezing/Melting point = 9.7−13.5°C; Vapor pressure = 1 mmHg at 44°C; Flash point = 110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Highly corrosive. Soluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Used as starting material for the production of glyoxylic, dialkyloxy acids, and sulfonamides. Also used as a fungicide, a medication, and a chemical intermediate in pharmaceuticals.
Incompatibilities: DCA is a medium strong acid, incompatible with nonoxidizing mineral acids, organic acids, bases, acrylates, aldehydes, alcohols, alkylene oxides, ammonia, aliphatic amines, alkanolamines, aromatic amines, amides, glycols, isocyanates, ketones. Attacks metals generating flammable hydrogen gas. Attacks some plastics, rubber, and coatings.
Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.5 ppm/2.64 mg/m^3 [skin]; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 10 ppm
PAC-2: 75 ppm
PAC-3: 200 ppm
DFG MAK: Germ Cell Mutation Category 3A.
Russia: STEL 4 mg/m^3, 1993.
Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = <1.0.
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short Term Exposure: Corrosive. Destructive to the eyes, skin, and tissues of the respiratory tract; causes severe irritation and burns. Eye contact may cause permanent damage. Higher exposures can cause chemical pneumonitis and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms can include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting.
Long Term Exposure: May cause damage to the developing fetus. May affect the liver and kidneys. May damage the nervous system causing numbness, "pins and needles," and/or weakness in the hands and feet. Repeated exposure may cause lung irritation, bronchitis. There is limited evidence that DCA causes liver cancer in animals.
Points of Attack: Lungs, liver, kidneys, nervous system.
Medical Surveillance: Liver and kidney function tests. Lung function tests. Examination of the nervous system. Consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved

respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with DCA you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: DCA must be labeled "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid, but does not readily ignite. Poisonous gases, including phosgene, hydrogen chloride, carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Dichloroacetic Acid*. Trenton NJ

Dichloroacetylene D:0440

Molecular Formula: C_2Cl_2

Common Formula: $ClC{\equiv}CCl$

Synonyms: DCA; Dichlorlethyne; Ethyne, dichloro-

CAS Registry Number: 7572-29-4

RTECS® Number: AP1080000

UN/NA & ERG Number: FORBIDDEN

EC Number: [*Annex I Index No.:* 602-069-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DCA is a volatile oil. It has a disagreeable, sweetish odor. A gas above 32°C/90°F. Molecular weight = 94.92; Boiling point = 32°C (explodes); Freezing/Melting point = −50°C to −66°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. DCA is not produced commercially. DCA is a possible decomposition product of trichloroethylene or trichloroethane. Also in closed circuit anesthesia with trichloroethylene, heat and moisture produced by soda-lime absorption of CO_2 may produce dichloroacetylene along with phosgene and CO.

Incompatibilities: Heat or shock may cause explosion. Violent reaction with oxidizers and strong acids (forms poisonous gases of phosgene and hydrogen chloride).

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 ppm/0.4 mg/m^3 Ceiling Concentration; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.1 ppm/0.39 mg/m^3 Ceiling Concentration; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: 10 ppm
PAC-3: 40 ppm

DFG MAK: Carcinogen Category 2.

Australia: TWA 0.1 ppm (0.4 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: STEL 0.1 ppm (0.39 mg/m^3), 1993; Finland: TWA 0.1 ppm (0.4 mg/m^3); STEL 0.3 ppm (1.2 mg/m^3), 1993; the Netherlands: MAC-continuous 0.4 mg/m^3, 2003; Norway: TWA 0.1 ppm (0.4 mg/m^3), 1999; United Kingdom: STEL 0.1 ppm (0.39 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for dichloroacetylene in ambient air[60] ranging from 3.2 μg/m^3 (Virginia) to 4.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada).

Determination in Air: The NIOSH pocket guide lists no methods. However, see NIOSH Analytical Method 1003, hydrocarbons, halogenated.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. Inhalation can irritate the respiratory tract with coughing, wheezing, and/or shortness of breath. Exposure can cause headache, loss of appetite, extreme nausea, vomiting, involvement of the trigeminal nerve and facial muscles causing paralysis of the face, and development of facial herpes. Higher exposure may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: There is limited evidence that DCA causes kidney cancer in animals. Dichloroacetylene can cause nervous system damage leading to weakness and behavioral changes and may affect the kidneys. May cause lung irritation and the development of bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Central nervous system; lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Avoid skin contact. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection: Wear splash-proof chemical goggles when working with liquid, unless full face-piece respiratory protection is worn. Wear gas-proof goggles, unless full face-piece respiratory protection is worn.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DCA you should be trained on its proper handling and storage. Dichloroacetylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Keep dichloroacetylene away from strong acids (such as hydrochloric, sulfuric, and nitric) because poisonous gases may be given off, including phosgene and hydrogen chloride. Store in tightly closed containers in a cool, well-ventilated area away from heat, potassium, sodium, and aluminum powders. Sources of ignition, such as smoking and open flames are prohibited where dichloroacetylene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of dichloroacetylene. Wherever dichloroacetylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dichloroacetylene is cited by DOT[19] as "FORBIDDEN."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichloroacetylene is a combustible liquid; becomes a gas above 32°C/90°F. It will explode before it reaches a temperature that is hot enough to burn. Poisonous gas is produced in fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Dichloroacetylene*. Trenton, NJ

Dichlorobenzalkonium chloride D:0450

Molecular Formula: C_8H_{17} to $C_{18}H_{37}$

Common Formula: $C_9H_{11}Cl_2N \cdot Cl$

Synonyms: Alkyl(C_6H_{18})dimethyl-3,4-dichlorobenzylammonium chloride; Alkyl(C_8H_{17} to $C_{18}H_{37}$) dimethyl-3,4-dichlorobenzyl ammonium chloride; Dichlorobenzalkonium chloride; Tetrosan®

CAS Registry Number: 8023-53-8

RTECS® Number: BO3200000

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: Dropped from listing in 1988.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichlorobenzalkonium chloride is a colorless, crystalline solid. Specific gravity (H_2O:1) = 0.89; Melting point = 33—34°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as an antiseptic, germicide, algicide, sterilizer, and deodorant.

Incompatibilities: Chlorides may be incompatible with acids, acid fumes. Esters may be incompatible with moisture and nitrates.

Permissible Exposure Limits in Air

No standard or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause vomiting, diarrhea, and abdominal pain. Ingestion causes burning pain in the mouth, throat, and abdomen with spitting of blood; drooling, vomiting; burns and ulcers in the mouth, throat, pharynx, and esophagus; shock, restlessness, confusion, weakness, apprehension; muscle weakness; difficulty in breathing; depression; bluing of the skin; and death from shock or asphyxiation. Ten percent (10%) concentrated aqueous solutions are irritating to the skin and concentrations as low as 0.1−0.5% are irritating to the eyes and mucous membranes. Concentrations ranging from 2% to 17.5% have caused dermal necrosis. Ingestion can cause corrosion of upper intestinal tract. Swelling of throat and lungs with fluid (edema) also can occur. Death can occur due to paralysis of respiratory muscles or circulatory collapse. The oral LD_{50} (oral-rat) = 730 mg/kg (slightly toxic).

Long Term Exposure: May cause liver and kidney damage. Repeated contact may cause allergic contact dermatitis to skin and allergic reaction in the lungs.

Points of Attack: Liver, kidneys, lungs, skin.

Medical Surveillance: Liver and kidney function tests. Lung function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If concentrated (10% or greater) solution is ingested, patient should swallow a large quantity of milk, egg whites, or gelatin solution. If breathing is difficult, give oxygen.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, acid fumes, moisture, and nitrates.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides, ammonia, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Dichlorobenzalkonium Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Dichlorobenzenes D:0460

Molecular Formula: $C_6H_4Cl_2$

Synonyms: *1,2-DCB:* Benzene, 1,2-dichloro-; Chloroben; Chloroden; Cloroben; DCB; *o*-Dichlorbenzol; Dichloricide; *o*-Dichlorobenzene; 1,2-Dichlorobenzene; Dichlorobenzene, *o*-; *o*-Dichlorobenzol; *o*-Diclorobenceno (Spanish); 1,2-Diclorobenceno (Spanish); Dilantin DB; Dilatin DB; Dizene; Dowtherm E; J100; NCI-C54944; ODB; ODCB; Orthodichlorobenzene; Orthodichlorobenzol; Special termite fluid; Termitkil; Ultramac S40

1,3-DCB: Benzene, *m*-dichloro-; Benzene, 1,3-dichloro-; *m*-Dichlorobenzene; *m*-Dichlorobenzol; *m*-Diclorobenceno (Spanish); 1,3-Diclorobenceno (Spanish); Metadichlorobenzene; *m*-Phenylene dichloro

1,4-DCB: Benzene, *p*-dichloro-; Benzene, 1,4-dichloro-; 1,4-Dichlorobenzol; *p*-Chlorophenyl chloride; Di-chloricide; *p*-Dichlorobenzene; *p*-Diclorobenceno (Spanish); 1,4-Diclorobenceno (Spanish); Evola; Paracide; Para Crystals; Paradi; Paradichlorobenzene; Paradow; Paramoth; Paranuggets; Parazene; PDB; Persia-Perazol; Santochlor; Santoclor

Mixed isomers: Amisia-Mottenschutz; Benzene, dichloro-; DCB; Dichlorobenzene (mixed isomers); Diclorobenceno (Spanish); Dilatin DBI; Mottenschutzmittel evau P; Mott-EX; Totamott

CAS Registry Number: 95-50-1 (*o*-DCB); 541-73-1 (*m*-DCB); 106-46-7 (*p*-DCB); 25321-22-6 (mixed isomers)

RTECS® Number: CZ4500000 (*o*-DCB); CZ4499000 (*m*-DCB); CZ4550000 (*p*-DCB); CZ4430000 (mixed isomers)

UN/NA & ERG Number: (*o*-DCB) UN1591/152; (*p*-DCB) UN3077/171; (*m*-DCB) UN3082/171 or UN2810/153

EC Number: 202-425-9 [*Annex I Index No.:* 602-034-00-7] (*o*-DCB); 208-792-1 [*Annex I Index No.:* 602-067-00-7]; 203-400-5 [*Annex I Index No.:* 602-035-00-2] (*p*-DCB); 246-837-7 (mixed isomers)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

m-DCB

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U071.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8020 (5); 8120 (10); 8270 (10).

Safe Drinking Water Act: Regulated chemical (47FR9352) as dichlorobenzene; Priority List (55FR1470).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; classification of B3, D1B on Canada's DSL List.

o-DCB

Carcinogenicity: IARC: Animal, No Cancer Evidence; Human, Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U070.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.088; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (5); 8120 (10); 8270 (10).

Safe Drinking Water Act: MCL, 0.6 mg/L; MCLG, 0.6 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, CEPA Priority Substance List, National Pollutant Release Inventory (NPRI); Drinking Water Quality 0.2 mg/L MAC and ≤ 0.003 mg/L AO.

p-DCB

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: Reasonably anticipated to be a human carcinogen.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U072; D027.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 7.5 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.090; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (5); 8120 (15); 8270 (10).

Safe Drinking Water Act: MCL, 0.075 mg/L; MCLG, 0.075 mg/L; Regulated chemical (47FR9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, CEPA Priority Substance List, National Pollutant Release Inventory (NPRI); Drinking Water Quality 0.005 mg/L MAC and ≤0.001 mg/L AO.

Mixed isomers

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority

Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/89; 20 μ/day NSRL.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; classification of B3, D2B, D2A; CEPA Priority Substance List, National Pollutant Release Inventory (NPRI); on Canada's DSL List.

European/International Regulations: Hazard Symbols: Xn, N; Risk phrases: R36; R40; R51/53; Safety phrases: S36/37; S46; S60.

Mexico, Drinking Water, 0.4 mg/L.

WGK (German Aquatic Hazard Class): 2—Water polluting (*all isomers*).

Description: There are three isomeric forms of dichlorobenzene (DCB):

m-DCB is a flammable liquid and vapor. Molecular weight = 147.00; Boiling point = 172°C; Flash point = 63°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

o-DCB is a colorless to pale yellow liquid with a pleasant, aromatic odor. Odor threshold = 0.30 ppm. Molecular weight = 147.00; Boiling point = 180°C; Freezing/Melting point = −17°C; Flash point = 60°C; 66°C (cc); Autoignition temperature: 648°C. Explosive limits: LEL = 2.2%; UEL = 9.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

p-DCB is a colorless or white solid with a mothball-like odor. Odor threshold = 0.18 ppm. Molecular weight = 147.00; Boiling point = 174°C; Freezing/Melting point = 53°C; Vapor pressure = 13 mmHg at 20°C; Flash point = 66°C. Insoluble in water. Explosive limits: LEL = 2.5%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: (*m*-isomer) Tumorigen, Mutagen, (*o*-isomer) Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant; (*p*-isomer) Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. The major uses of *o*-DCB are as a process solvent in the manufacturing of toluene diisocyanate and as an intermediate in the synthesis of dyestuffs, herbicides, and degreasers. *p*-Dichlorbenzene is used primarily as a moth repellant, a mildew control agent, space deodorant, and in insecticides, which accounts for 90% of the total production of this isomer. Information is not available concerning the production and use of *m*-DCB. However, it may occur as a contaminant of *o*- or *p*-DCB formulations. Both *o*- and *p*-isomers are produced almost entirely as by-products during the production of monochlorobenzene.

Incompatibilities: For *o*-DCB and *m*-DCB: acid fumes, chlorides, strong oxidizers, hot aluminum, or aluminum alloys. For *p*-DCB: strong oxidizers; although incompatibilities for this chemical may also include other materials listed for *o*-DCB.

Permissible Exposure Limits in Air

m-DCB

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 4 ppm

PAC-2: 30 ppm

PAC-3: 75 ppm

DFG MAK: 2 ppm/12 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

OSHA PEL: 50 ppm/300 mg/m^3 Ceiling Concentration.

NIOSH REL: 50 ppm/300 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 25 ppm TWA; 50 ppm STEL, not classifiable as a human carcinogen.

NIOSH IDLH: 200 ppm.

o-DCB

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 10 ppm

PAC-2: 10 ppm

PAC-3: 150 ppm

DFG MAK: 10 ppm/61 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C; BAT information available.

Australia: TWA 50 ppm (300 mg/m^3), 1993; Austria: MAK 50 ppm (300 mg/m^3), [skin], 1999; Belgium: STEL 50 ppm (301 mg/m^3), [skin], 1993; Finland: TWA 50 ppm (300 mg/m^3); STEL 75 ppm (450 mg/m^3), [skin], 1999; France: VLE 50 ppm (300 mg/m^3), 1999; Hungary: TWA 50 mg/m^3; STEL 100 mg/m^3, [skin], 1993; Japan: STEL 25 ppm (150 mg/m^3), 1999; the Netherlands: MAC-TGG 122 mg/m^3, 2003; Norway: TWA 25 ppm (150 mg/m^3), 1999; the Philippines: TWA 50 ppm (300 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3, MAC (ceiling) 300 mg/m^3, 1999; Russia: STEL 50 mg/m^3, 1993; Sweden: ceiling 50 ppm (300 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (300 mg/m^3), KZG-W 100 ppm (600 mg/m^3), 1999; Thailand: TWA 50 ppm (300 mg/m^3), 1993; Turkey: TWA 50 ppm (300 mg/m^3), 1993; United Kingdom: STEL 50 ppm (306 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 50 ppm.

o-DCB

OSHA PEL: 50 ppm/300 mg/m^3 Ceiling Concentration.

NIOSH REL: 50 ppm/300 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 25 ppm/150 mg/m^3 TWA; 50 ppm/301 mg/m^3 Ceiling Concentration.
DFG MAK: [skin]; Pregnancy Risk Group C.
p-DCB
OSHA PEL: 75 ppm/450 mg/m^3 TWA.
NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 10 ppm/60 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC)
TEEL-0: 10 ppm
PAC-1: 10 ppm
PAC-2: 30 ppm
PAC-3: 150 ppm
DFG MAK: [skin] Carcinogen Category 2; Pregnancy Risk Group 3B; BAT suspended 2003.
NIOSH IDLH: [Ca] 150 ppm.
Australia: TWA 75 ppm (450 mg/m^3); STEL 110 ppm, 1993; Austria: carcinogen, 1999; Belgium: TWA 75 ppm (451 mg/m^3); STEL 110 ppm (661 mg/m^3), 1993; Finland: TWA 75 ppm (450 mg/m^3); STEL 115 ppm (690 mg/m^3), [skin], 1999; France: VME 75 ppm (450 mg/m^3), VLE 110 ppm (675 mg/m^3), 1999; Japan: 50 ppm (300 mg/m^3), 2B carcinogen, 1999; the Netherlands: MAC-TGG 150 mg/m^3, 2003; the Philippines: TWA 75 ppm (450 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3, 1999; Russia: TWA 50 ppm, 1993; Sweden: NGV 75 ppm (450 mg/m^3), KTV 110 ppm (700 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (300 mg/m^3), KZG-W 100 ppm (600 mg/m^3), 1999; Turkey: TWA 75 ppm (450 mg/m^3), 1993; United Kingdom: TWA 25 ppm (153 mg/m^3); STEL 50 ppm (306 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[43] gives a MAC of 0.035 mg/m^3 for ambient air in residential areas on a once daily basis for *p*-DCB.[35]
Several states have set guidelines or standards for chlorobenzenes in ambient air[60] as follows:

State	***o*-DCB- (mg/m^3)**	***p*-DCB (mg/m^3)**
Connecticut	0	9.0
Indiana	1.5	–
Massachusetts	0.082	0.0042
Nevada	7.14	10.7
New York	1.0	–
North Carolina	–	67.5
North Dakota	3.0	6.75
South Carolina	–	4.5
Virginia	2.5	7.5

Determination in Air: Use NIOSH Analytical Method 1003 or OSHA Analytical Method 7.
Permissible Concentration in Water: *To protect freshwater aquatic life:* 1120 μg/L on an acute toxicity basis and 763 μg/L on a chronic basis. *To protect saltwater aquatic life:* 1970 μg/L on an acute toxicity basis. *To protect human health:* 400 μg/L for all isomers.[6] Russia[43] established a MAC of 0.002 mg/L for water bodies used for domestic purposes.[35,43] The US EPA[48] has derived lifetime health advisories for *o*- and *m*-DCB as 0.62 mg/L (620 μg/L) and for *p*-DCB of 0.075 mg/L (75 μg/L). EPA[62] has recently proposed a maximum level for *o*-DCB of 0.6 mg/L in drinking water. See also "Regulatory" section for drinking water criteria for Mexico and Canada. Several states have set guidelines and standards for chlorobenzenes in drinking water[61] as follows:

State	o-DCB (μg/L)	m-DCB (μg/L)	p-DCB- (μg/L)
Arizona	620	–	750
California	130	130	0.3–0.5
Kansas	620	620	–
Maine	85	–	27
Minnesota	620	–	750
New Jersey	600	600	6
Vermont	620	–	–
Wisconsin	1250	1250	5

Determination in Water: Gas chromatography (EPA Methods 601, 602, 612) or gas chromatography plus mass spectrometry (EPA Method 625). Gas-chromatographic methods have been developed for *p*-PDB with a sensitivity of 380 pg/cm peak high, and *p*-PDB concentrations as low as 1.0 ppb in water have been analyzed according to NAS/NRC. Octanol–water coefficient: Log K_{ow} (*p*-) = 3.37.
Routes of Entry: *o*-DCB: inhalation, skin absorption; ingestion; skin and/or eye contact. *p*-DCB: inhalation, ingestion, eye and skin contact.
Harmful Effects and Symptoms
Human exposure to dichlorobenzene is reported to cause hemolytic anemia and liver necrosis, and 1,4-dichlorobenzene has been found in human adipose tissue. In addition, the dichlorobenzenes are toxic to nonhuman mammals, birds, and aquatic organisms and impart an offensive taste and odor to water. The dichlorobenzenes are metabolized by mammals, including humans, to various dichlorophenols; some are as toxic as the dichlorobenzenes.
Exposure can damage blood cells. Contact can cause irritation of the skin and eyes. Prolonged contact can cause severe burns. It may damage the liver, kidneys, and lungs. Exposure can cause headache, dizziness, swelling of the eyes, hands and feet, and nausea. Higher levels can cause severe liver damage and death. Persons with preexisting pathology (hepatic, renal, central nervous system, blood) or metabolic disorders, who are taking certain drugs (hormones or otherwise metabolically active), or who are otherwise exposed to DCBs or related (chemically or biologically) chemicals by such means as occupation, or domestic use or abuse (e.g., pica or "sniffing") of DCB products, might well be considered at increased risk from exposure to DCBs.
Short Term Exposure: *o-DCB:* Can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, skin, and respiratory tract. Prolonged skin contact may

cause blisters. May affect the central nervous system. Exposure can cause headache and nausea. Higher exposure can cause dizziness, lightheadedness, and unconsciousness.

m-DCB: Can be absorbed through the skin, thereby increasing exposure. Symptoms are similar to *o*-DCB, and *m*-DCB may damage the red blood cells leading to low blood count.

p-DCB: Can be absorbed through the skin, thereby increasing exposure. Exposure can cause headache, dizziness, nausea, swelling of the hands and feet. Contact with the dust can irritate and burn the eyes and skin. Skin allergy may develop.

Long Term Exposure: *o-DCB:* Repeated or prolonged contact may cause skin sensitization and allergy. Long-term exposure may cause damage to the blood cells, liver, kidneys, and lungs.

m-DCB: Repeated or prolonged contact may cause skin sensitization and allergy. May affect the liver and kidneys.

p-DCB: May be carcinogenic to humans; it causes kidney and liver cancer in animals. There is a suggested association between this chemical and leukemia. There is evidence that *p*-DCB can damage the developing animal fetus. Repeated exposure can damage the nervous system, may cause skin allergy, and damage the lungs, liver, and kidneys. *p*-DCG may affect the blood and cause hemolytic anemia.

Points of Attack: *o*-DCB and *m*-DCB: liver, kidneys, skin, eyes. *p*-DCB: liver, respiratory system, eyes, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: liver, kidney, and lung function tests. Complete blood count. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests: (*o*-isomer) urine (chemical/metabolite), (*p*-isomer) expired air, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Viton™ gloves, suits; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (*o*-DCB or *o*-DCB) or dust-proof (*p*-DCB) chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *For o-DCB: 2000 ppm:* CcrFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

p-DCB: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red (*o*-DCB): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Color Code—Blue (*m*-DCB): Health Hazard/Poison: Store in a secure poison location.

Color Code—Green (*p-DCB*): General storage may be used. Prior to working with any DCB you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dichlorobenzene must be stored to avoid contact with strong oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, hot aluminum or aluminum alloys since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and direct light. Sources of ignition, such as smoking and open flames, are prohibited where dichlorobenzene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where *p*-DCB is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: *o*-DCB: Requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

m-DCB: Toxic, liquids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1 and Packing Group III.

Based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. Under this classification, it requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

p-DCB: May be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: *p-DCB:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

o-DCB and m-DCB: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *p-DCB:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

o-DCB and p-DCB: These chemicals are combustible liquids. Poisonous gases are produced in fire, including hydrogen chloride and chlorine. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Dichlorobenzene: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *1,2-Dichlorobenzene: Health and Environmental Effects Profile No. 64.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *1,3-Dichlorobenzene: Health and Environmental Effects Profile No. 65.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *1,4-Dichlorobenzene: Health and Environmental Effects Profile No. 66.* Washington, DC; Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Dichlorobenzenes: Health and Environmental Effects Profile No. 67.* Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 45−48 (1984) (1,3-Dichlorobenzene); 4, No. 2, 49−52, and 6, No. 2, 50−57 (1986) (Mixed isomers)

US Public Health Service. (December 1987). *Toxicological Profile for 1,4-Dichlorobenzene*. Atlanta, Georgia: Agency for Toxic Substances & Disease Registry

New York State Department of Health. (March 1986). *Chemical Fact Sheet: ortho-Dichlorobenzene.* Albany, NY: Bureau of Toxic Substance Assessment

New York State Department of Health. (April 1986). *Chemical Fact Sheet: para-Dichlorobenzene*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: 1,3-Dichlorobenzene*. Trenton, NJ

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: 1,4-Dichlorobenzene.* Trenton, NJ

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: 1,2-Dichlorobenzene*. Trenton, NJ

3,3′-Dichlorobenzidine (and its salts)

D:0470

Molecular Formula: $C_{12}H_{10}Cl_2N_2$

Common Formula: $C_6H_3ClNH_2C_6H_3ClNH_2$

Synonyms: Benzidine, 3,3′-dichloro-; (1,1′-biphenyl)-4,4′-diamine, 3,3′-dichloro-; C.I. 23060; Curithane C 126; DCB; 4,4′-Diamino-3,3′-dichlorobiphenyl; 4,4′-Diamino-3,3′-dichlorodiphenyl; *o,o′*-Dichlorobenzidine; Dichlorobenzidine; 3,3′-Dichloro-4,4′-biphenyldiamine; 3,3′-Dichlorobiphenyl-4,4′-diamine; 3,3′-Dichloro-4,4′-diamino(1,1-biphenyl); 3,3′-Dichloro-4,4′-diaminobiphenyl; 3,3-Diclorobencidina (Spanish)

Dihydrochloride: A13-22046; Benzidine, 3,3′-dichloro-, dihydrochloride; (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dichloro-, dihydrochloride; 3,3′-Dichlorobenzidine hydrochloride; 3,3′-Dichloro-(1,1′-biphenyl)-4,4′-diamine dihydrochloride

Sulfate: (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dichloro-, sulfate (1:2); 3,3′-Dichlorobenzidine dihydrogen bis(sulfate); 3,3′-Dichlorobenzidine sulphate; Sulfato de 3,3-diclorobenzidina (Spanish)

CAS Registry Number: 91-94-1; 612-83-9 (dihydrochloride); 64969-34-2 (sulfate)

RTECS® Number: DD0525000; DD0550000 (dihydrochloride)

UN/NA & ERG Number: UN1885/153

EC Number: 202-109-0 [*Annex I Index No.:* 612-068-00-4]; 210-323-0 [*Annex I Index No.:* 612-069-00-X] (dihydrochloride); 265-293-1 [*Annex I Index No.:* 612-069-00-X] (sulfate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC[9]: Human Inadequate Evidence, Animal Sufficient Evidence, 1982*, possibly carcinogenic to humans*, Group B2, 1987; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NTP: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

612-83-9

Carcinogenicity: NTP: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; Histidine reversion—Ames test; Inconclusive: *In vitro* UDS—human fibroblast.

Banned or Severely Restricted (several countries) (UN).[13,35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1007).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U073.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (20).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations (*91-94-1*): Hazard Symbol: T, N; Risk phrases: R45; R21; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*91-94-1*): 3—Highly water polluting.

Dyhydrochloride and sulfate:

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1007).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations (*3,3′-dichlorobenzidine salts*): Hazard Symbol: T, N; Risk phrases: R45; R21; R43; R50/53; Safety phrases: S53; S45; S60; S61.

Description: 3,3′-Dichlorobenzidine is a gray or purple crystalline solid. Molecular weight = 253.14; Boiling point = 368°C; Freezing/Melting point = 132.8°C; Autoignition temperature = 350°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.07% at 15°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. The major uses of dichlorobenzidine are in the manufacture of pigments for printing ink, textiles, plastics, and crayons and as a curing agent for solid urethane plastics. There are no substitutes for many of its uses. Additional groups that may be at risk include workers in the printing or graphic arts professions handling the 3,3′-DCB-based azo pigments. 3,3′-DCB may be present as an impurity in the pigments, and there is some evidence that 3,3′-DCB may be metabolically liberated from the azo pigment.

Incompatibilities: Keep away from strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical are to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements. See Appendix B of the *NIOSH Pocket Guide*.

NIOSH REL (*3,3′-Dichlorobenzidine and its salts*): A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

Note: OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine (and dyes based on them) may present a cancer risk to workers and should be handled with caution and exposure minimized.

ACGIH TLV®[1]: [skin] confirmed animal carcinogen with unknown relevance to humans; exposure to carcinogens must be kept to a minimum.

Protective Action Criteria (PAC)

91-94-1

TEEL-0: 0.2 ppm

PAC-1: 0.6 ppm

PAC-2: 4 ppm

PAC-3: 150 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, [skin], Carcinogen 1993; 0.1 mg/m^3, carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for dichlorobenzidine in ambient air[60] ranging from zero (North Dakota, Pennsylvania, Virginia) to 0.002 μg/m^3 (Rhode Island) to 0.10 μg/m^3 (New York) to 0.15 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #5509,[18] OSHA Analytical Method ID-65.

Permissible Concentration in Water: *To protect freshwater and saltwater aquatic life*: no criteria developed due to insufficient data. *To protect human health:* preferably zero. An additional life-time cancer risk of 1 in 100,000 results at a level of 0.103 μg/L.[6] States which have set guidelines for dichlorobenzidine in drinking water[61] include Kansas and Minnesota: both at 0.21 μg/L.

Determination in Water: Chloroform extraction followed by concentration and high-performance liquid chromatography (EPA Method 605) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin allergic sensitization, dermatitis, headache, dizziness, caustic burns, frequent urination, dysuria, hematuria (blood in the urine); gastrointestinal upset, upper respiratory infection.

Long Term Exposure: 3,3′-Dichlorobenzidine was shown to be a potent carcinogen in rats and mice in feeding and injection experiments, but no bladder tumors were produced. LD_{50} = (oral-rat) 5250 mg/kg (insignificantly toxic).

Points of Attack: Bladder, liver, lung, skin, gastrointestinal tract.

Medical Surveillance: Preplacement and periodic examinations should include history of exposure to other carcinogens, smoking, alcohol, medication, and family history. The skin, lung, kidney, bladder, and liver should be evaluated; sputum or urinary cytology may be helpful. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Full body protective clothing and gloves should be used by those employed in handling operations. Full-face supplied-air respirators of continuous-flow or pressure-demand type should also be used. On exit from a regulated area, employees should shower and change into street clothes, leaving their protective clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: 3,3′-Dichlorobenzidine is an animal carcinogen and Suspected Human Carcinogen. It requires a shipping label of "POISONOUS/TOXIC MATERIALS". 3,3′-Dichlorobenzidine falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s for primary combustion; 1204°C, 1.0 s for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. Nitrogen oxides may be abated through the use of thermal or catalytic devices.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *3,3′-Dichlorobenzidine*: *Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *3,3′-Dichlorobenzidine: Health and Environmental Effects Profile No. 68.* Washington, DC: Office o Solid Waste

Sax N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 45−49 (1982) and 3, No. 2, 79−82 (1983)

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: 3,3′-Dichlorobenzidine*. Trenton, NJ

1,4-Dichloro-2-butene D:0480

Molecular Formula: $C_4H_6Cl_2$

Synonyms: *cis-isomer:* 2-Butene, 1,4-dichloro-; 1,4-DCB; DCB; 1,4-Dichloro-2-butene; 1,4-Dichlorobutene-2; 1,4-

Dicloro-2-butano (Spanish) *trans-isomer:* AI3-52332; 2-Butene, 1,4-dichloro-, (*E*)-; 2-Butene, 1,4-dichloro-, *trans*-; 2-Butylene dichloride; (*E*)-1,4-Dichloro-2-butene; (*E*)-1,4-Dichlorobutene; *trans*-1,4-Dichloro-2-butene; *trans*-1,4-Dichlorobutene; *trans*-2,3-Dichlorobut-2-ene; 1,4-Dichloro-*trans*-2-butene; 1,4-Dichlorobutene-2, (*E*)-; 1,4-Dichlorobutene-2, *trans*-

CAS Registry Number: 764-41-0 (*cis*-); 110-57-6 (*trans*-); 11069-19-5 (mixed isomers)

RTECS® Number: EM4900000 (*cis*-)/132; EM4903000 (*trans*-); EM4730000 (mixed isomers)

UN/NA & ERG Number: UN2920/132

EC Number: 212-121-8 [*Annex I Index No.:* 602-073-00-X]; 203-779-7 (*trans*-)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*1,4-isomer*): Animal Inadequate Evidence; Human No Data*, not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U074.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (1,4-Dichloro-2-butene and Dichlorobutene).

trans-isomer:

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): EHS, 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations (*cis*-): Hazard Symbol: T + , N; Risk phrases: R45; R24/25; R26; R34; R50/53; Safety phrases: S53; S45; S60; S61.

European/International Regulations (*trans*-): not listed in Annex 1.

WGK (German Aquatic Hazard Class) (*cis*-): 3—Highly water polluting.

Description: The 1,4-dichloro-2-butenes are colorless liquids. Some have a distinct odor.

(*cis*-isomer): Molecular weight = 125; Boiling point = 153°C; Freezing/Melting point = −48°C. Explosive limits: LEL = 1.5%; UEL = 4.0%. Reacts slowly with water.

(*trans*-isomer): This material has a sweet, pungent odor. Boiling point = 155.5°C; Freezing/Melting point = 1−3°C; Flash point = 53°C. The explosive limits for the *trans*-isomer are LEL = 1.5%; UEL = 4%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water. The *trans-isomer*, only, appears on the EHS list.

Potential Exposure: DC occurs as a by-product in chloroprene manufacture and may be used as a chemical intermediate.

Incompatibilities: (*cis*-isomer): Reacts slowly with water forming hydrogen chloride. Attacks metals and may form other, more dangerous materials; attacks some plastics.

Permissible Exposure Limits in Air

764-41-0

ACGIH TLV®[1]: 0.005 ppm/0.025 mg/m^3 TWA [skin] Suspected Human Carcinogen.

Protective Action Criteria (PAC)

cis-isomer (Dichloro-2-butene, 1,4-)

TEEL-0: 0.005 ppm

PAC-1: 0.6 ppm

PAC-2: 4 ppm

PAC-3: 50 ppm

trans-isomer

TEEL-0: 0.04 ppm

PAC-1: 0.125 ppm

PAC-2: 0.861 ppm

PAC-3: 7.5 ppm

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutagen Category 3A.

Russia[43] set a MAC of 1.0 mg/m^3 in work-place air for 1,3-dichloro-2-butene but set no value for 1,4-dichloro-2-butene.

Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/L for 1,3-dichloro-2-butene in water bodies used for domestic purposes but has no value for 1,4-dichloro-2-butene.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include respiratory distress and burns to skin and eyes. Inhalation of vapor irritates nose and throat. Contact with eyes causes intense irritation and tears. Contact of liquid with skin causes severe blistering. Ingestion causes severe irritation of mouth and stomach. Liquid and vapors from the material are highly corrosive and may damage skin, eyes, lungs, and internal organs.

Long Term Exposure: The material is a carcinogen according to DFG[3] and ACGIH. Corrosive substances may affect the lungs.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and Saranex™ are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red (*cis*-isomer): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Corrosive liquids, flammable, n.o.s. must be labeled: "CORROSIVE, FLAMMABLE LIQUID." It falls in Hazard Class 8.

The code "D" identifies proper shipping names [Dichlorobutene] which are appropriate for describing materials for domestic transportation but may be inappropriate for international transportation under the provisions of international regulations (e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stay upwind; keep out of low areas. Shut off ignition sources. Do not touch spilled material. Use water spray to reduce vapors, but do not get water inside containers. For *small spills*, absorb with sand or other noncombustible absorbent material. For *large spills*, dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The material will burn, though it may require some effort to ignite. Fire produces irritating and poisonous gases. When heated to decomposition, it emits toxic fumes of chlorine-containing compounds. For small fires, use dry chemical, carbon dioxide, spray, or foam. For large fires, use water spray, fog, or foam. Wear positive-pressure breathing apparatus and full protective clothing. Move containers from fire area if you can do so without risk. Spray containers with cooling water until well after fire is out. Isolate for one-half mile in all directions if tank car or truck is involved in a fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with hydrochloric acid scrubbing. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 1,4-Dichlorobutene*, *trans-*. Washington, DC: Chemical Emergency Preparedness Program

Sax N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 41–44

New Jersey Department of Health and Senior Services. (December 2006). *Hazardous Substances Fact Sheet: trans-1,4-Dichlorobutene*. Trenton, NJ

Dichlorodifluoroethylene D:0490

Molecular Formula: $C_2Cl_2F_2$

Common Formula: CFCl=CFCl

Synonyms: Dichlorodifluoroethene; Ethene, dichlorofluoro-; Diclorodifluoroetileno (Spanish) to index

CAS Registry Number: 27156-03-2

RTECS® Number: KV9460000

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichlorodifluoroethylene is a colorless gas or liquid. Molecular weight = 132.93; Boiling point = 21.1°C. ₩ Reacts with water.

Potential Exposure: Those involved in the manufacture of this compound or its use in the synthesis of fluorochemicals. Used for chemical research and development purposes.

Incompatibilities: Reacts with moisture, water, steam, forming corrosive and toxic fumes.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Dichlorodifluoroethylene can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. High levels can cause you to become dizzy, light-headed, and pass out. Similar compounds can cause the heart to beat irregularly, or stop, which can cause death.

Long Term Exposure: May cause liver and kidney damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following tests may be useful: liver function tests. Kidney function tests. Holter monitor (a special 24-h EKG to look for irregular heart beat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Dichlorodifluoroethylene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. On contact with water or steam, dichlorodifluoroethylene produces highly toxic and corrosive fumes. Store in tightly closed containers in a cool, dry area.

Shipping: In its Performance-Oriented Packaging Standards,[19] this material is not specifically cited.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. If dichlorodifluoroethylene gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they

must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichlorodifluoroethylene may burn but does not readily ignite. Poisonous gases are produced in the fire, including highly toxic fumes of fluorides and chlorides. Containers may explode in fire. Use dry chemical or CO_2 extinguishers. Use water spray to keep fire-exposed containers cool. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Dichlorodifluoro-Ethylene*. Trenton, NJ

Dichlorodifluoromethane D:0500

Molecular Formula: CCl_2F_2

Synonyms: Algofrene type 2; Arcton 6; Arcton 12; CFC-12; Diclorodifluometano (Spanish); Difluorodichloromethane; Electro-CF 12; Eskimon 12; F 12; FC 12; Fluorocarbon 12; Freon 12; Freon F-12; Frigen 12; Genetron 12; Halocarbon 12/Ucon 12; Halon; Halon 122; Isceon 122; Isotron 2; Isotron 12; Ledon 12; Methane, Dichlorodifluoro-; Propellant 12; R 12; Refrigerant 12; Ucon 12; Ucon 12/Halocarbon 12

CAS Registry Number: 75-71-8

RTECS® Number: PA8200000

UN/NA & ERG Number: UN1028/126

EC Number: 200-893-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 1.0.

US EPA Hazardous Waste Number (RCRA No.): U075.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.23; Nonwastewater (mg/kg), 7.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5).

Safe Drinking Water Act: Priority List (55 FR 1470) (Removed January 1981).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichlorodifluoromethane is a colorless, nonflammable gas with a characteristic ether-like odor at >20% by volume. Shipped as a compressed gas. Molecular weight = 120.91; Boiling point = −30°C; Freezing/Melting point = −158°C; Vapor pressure = 5.7 atm. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water; solubility = 0.03% at 25°C.

Potential Exposure: Compound Description: Human Data; Hormone. Dichlorodifluoromethane is used as an aerosol propellant, refrigerant, and foaming agent.

Incompatibilities: Chemically active metals: sodium, potassium, calcium, powdered aluminum, zinc, magnesium. Attacks magnesium and its alloys.

Permissible Exposure Limits in Air

OSHA PEL: 1000 ppm/4950 mg/m^3 TWA.

NIOSH REL: 1000 ppm/4950 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/4950 mg/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 15,000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 10,000 ppm

PAC-3: 15,000 ppm

DFG MAK: 1000 ppm/5000 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Australia: TWA 1000 ppm (4950 mg/m^3), 1993; Austria: MAK 1000 ppm (5000 mg/m^3), 1999; Belgium: TWA 1000 ppm (4950 mg/m^3), 1993; Finland: TWA 1000 ppm (4950 mg/m^3); STEL 1250 ppm (6200 mg/m^3), 1999; France: VME 1000 ppm (4950 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; Japan: 500 ppm (2500 mg/m^3), 1999; the Netherlands: MAC-TGG 5040 mg/m^3, 2003; Norway: TWA 500 ppm (2475 mg/m^3), 1999; the Philippines: TWA 1000 ppm (4950 mg/m^3), 1993; Poland: MAC (TWA) 4000 mg/m^3, MAC (STEL) 6200 mg/m^3, 1999; Russia: TWA 500 ppm; STEL 3000 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (5000 mg/m^3), 1999; Turkey: TWA 1000 ppm (4950 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (5030 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for R-12 in ambient air[60] ranging from 49.5 mg/m^3 (North Dakota) to 82.5 mg/m^3 (Virginia) to 99.0 mg/m^3 (Connecticut) to 118.0 mg/m^3 (Nevada) to 247.0 mg/m^3 (North Carolina). Those values may well be modified in the future because of concern over the effect of chlorofluorocarbons on the depletion of the ozone layer in the atmosphere.

Determination in Air: Use NIOSH Analytical Method (IV) #1018.

Permissible Concentration in Water: Human health protection: preferably zero. Additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L. In January 1981 EPA (46FR2266) removed F-12 from the priority toxic pollutant list.[6] Russia[35,43] set a MAC of 10 mg/L in water used for domestic purposes. Several states have set guidelines for R-12 in drinking water[61] ranging from 1.0 μg/L in Arizona to 160 μg/L (Maine) to 5600 μg/L (Kansas).

Determination in Water: Use EPA Method 601.

Routes of Entry: Inhalation, eye and/or skin contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Exposure can cause you to become dizzy and lightheaded, and to have trouble concentrating. Exposure can cause the heart to beat irregularly (cardiac arrhythmia) or cause heart arrest. This can cause death. Contact with the liquid can cause severe eye and skin burns from frostbite. Breathing the gas can irritate the mouth, nose, and throat. High levels can cause asphyxiation.

Points of Attack: Cardiovascular system, peripheral nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Where cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends Neoprene™ rubber as a good to excellent protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10,000 ppm:* Sa (APF = 10) (any supplied-air respirator). *15,000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Dichlorodifluoromethane must be stored to avoid contact with chemically active metals (such as sodium, potassium, calcium, powdered aluminum, zinc, and magnesium), since violent reactions occur. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: R-12 must be labeled "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. The material itself does not burn. Poisonous gases, including hydrogen chloride, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Because of potential ozone decomposition in the stratosphere, R-12 should be released to the atmosphere only as a last resort.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Trichlorofluoromethane and Dichlorodifluoromethane: Health and Environmental Effects Profile No. 167.* Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (May 1998). *Hazardous Substances Fact Sheet: Dichlorodifluoromethane*. Trenton, NJ

New York State Department of Health. (January 1999). *Chemical Fact Sheet: Dichlorodifluoromethane*. Albany, NY: Bureau of Toxic Substance Assessment

1,3-Dichloro-5,5-dimethyl-hydantoin D:0510

Molecular Formula: $C_5H_6Cl_2N_2O_2$

Synonyms: Dactin®; Dantion; DCDMH; DDH; 1,3-Dicloro-5,5-dimehyl-2,4-imidazolinedione; Halane®; 2,4-Imidazolidinedione, 1,3-dichloro-5,5-dimethyl

CAS Registry Number: 118-52-5

RTECS® Number: MU0700000

UN/NA & ERG Number: UN3085 (Oxidizing solid, corrosive, n.o.s.)/140

EC Number: 204-258-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: DCDMH is a combustible, white powder with a chlorine-like odor. Molecular weight = 197.03; Freezing/Melting point = 130°C; Flash point = 175°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0 Oxidizer, ₩. Water reactive; slightly soluble; solubility = 0.2%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Primary Irritant. It is used as a chlorinating agent, disinfectant, biocide, and laundry bleach. It is also used as a polymerization catalyst in making vinyl chloride and in drug and pesticide synthesis.

Incompatibilities: A strong oxidizer. Contact with water forms poisonous and corrosive gases. Mixtures with xylene may explode. Not compatible with moisture (especially hot water, steam), strong acids, easily oxidized materials (such as ammonia salts, sulfides, etc.), reducing agents, strong bases, ammonium salts, sulfides.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA.

NIOSH REL: 0.2 mg/m^3 TWA; 0.4 mg/m^3 STEL.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA; 0.4 mg/m^3 STEL.

NIOSH IDLH: 5 mg/m^3.

No TEEL available.

Australia: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, 1993; Belgium: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, 1993; Finland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, 1999; France: VME 0.2 mg/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; the Philippines: TWA 0.2 mg/m^3, 1993; Switzerland: MAK-W 0.2 mg/m^3, 1999; United Kingdom: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.4 mg/m^3. Several states have set guidelines or standards for this material in ambient air[60] ranging from 2.0−4.0 μg/m^3 (North Dakota) to 3.2 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: No method established.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of skin, eyes, mucous membrane, and respiratory system. LD$_{50}$ = (oral-rat) 542 mg/kg (slightly toxic). Higher levels can irritate the lungs, causing a buildup of fluid (pulmonary edema). This can cause death.

Long Term Exposure: Can irritate the lungs, causing bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2 mg/m^3*: Sa (APF = 10) (any supplied-air respirator). *Up to 5 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. 1,3-Dichloro-5,5-dimethyl-hydantoin must be stored to avoid contact with strong acids (such as sulfuric acid, nitric acid, or hydrochloric acid) and easily oxidized materials (such as ammonium salts and sulfides) since violent reactions occur and poisonous gases can be produced. Store in tightly closed containers in a cool, well-ventilated area away from water or steam. 1,3-Dichloro-5,5-dimethyl-hydantoin decomposes with formation of poisonous gases at 201−210°C. If 1,3-dichloro-5,5-dimethyl-hydantoin contacts water or steam, it decomposes at lower temperatures and produces poisonous gases, including chlorine. Sources of ignition, such as smoking and open flames, are prohibited where 1,3-dichloro-5,5-dimethyl-hydantoin is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical or carbon dioxide. *Do not use water*. Poisonous gases are produced in fire, including chlorine, phosgene, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (815.5°C/816°C, 0.5 s for primary combustion; 104.4°C/220°F, 1.0 s for secondary combustion). The formation of elemental chlorine can be prevented by injection of steam or methane into the combustion process. Any nitrogen oxides may be abated by the use of thermal or catalytic devices.

Reference

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: 1,3-Dichloro-5,5-Dimethyl Hydantoin*. Trenton, NJ

1,1-Dichloroethane D:0520

Molecular Formula: $C_2H_4Cl_2$

Common Formula: CH_3CHCl_2

Synonyms: Aethylidenchlorid (German); *asym*-Dichloroethane; Chlorinated hydrochloric ether; Chlorure d'ethylidene (French); 1,1-Dichloraethan (German); Dichloromethylethane; 1,1-Dicloroetano (Spanish); Ethane, 1,1-dichloro-; 1,1-Ethylidene chloride; Ethylidene chloride; Ethylidene dichloride; NCI-C04535

CAS Registry Number: 75-34-3

RTECS® Number: KI0175000

UN/NA & ERG Number: UN2362/130

EC Number: 200-863-5 [*Annex I Index No.:* 602-011-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); equivocal evidence: mouse, rat; EPA: Possible Human Carcinogen; NIOSH recommends this material be treated in the workplace with caution because of its structural similarity to other chloroethanes shown to be carcinogenic in animals. (See Chloroethanes, *NIOSH Pocket Guide, Appendix C*).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U076.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; B2 Flammable liquid.

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; R22; R36/37; R52/53; Safety phrases: S2; S16; S23; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,1-Didichloroethane is a colorless, oily liquid with a chloroform-like odor. Odor threshold = 50−1350 ppm. Molecular weight = 98.96; Specific gravity (H_2O:1) = 1.2; Boiling point = 57.2°C; Freezing/Melting point = −96.6°C; Vapor pressure = 182 mmHg at 20°C; Flash point = −16.6°C (cc); Autoignition temperature = 458°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Explosive limits: LEL = 5.4%; UEL = 11.4%. Slightly soluble in water; solubility = 0.6%.

Potential Exposure: It is used as a solvent, cleaning and degreasing agent, as well as in organic synthesis as an intermediate.

Incompatibilities: Forms explosive mixture with air. Reacts violently with strong oxidizers, alkali metals, earth-alkali metals, powdered metals, causing fire and explosion hazard. Contact with strong caustic will produce flammable and toxic acetaldehyde gas. Attacks aluminum, iron. Attacks some plastics (including polyethylene) and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.05 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/400 mg/m^3 TWA.

NIOSH REL: 100 ppm/400 mg/m^3 TWA, potential animal carcinogen, as chloroethanes; See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 100 ppm/405 mg/m^3 TWA, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 750 ppm

PAC-2: 3000 ppm

PAC-3: 3000 ppm

DFG MAK: 100 ppm/410 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

NIOSH IDLH: 3000 ppm.

Australia: TWA 200 ppm (810 mg/m^3); STEL 250 ppm, 1993; Austria: MAK 100 ppm (400 mg/m^3), 1999; Belgium: TWA 200 ppm (810 mg/m^3); STEL 250 ppm (1010 mg/m^3), 1993; Finland: TWA 100 ppm (400 mg/m^3); STEL 250 ppm (1000 mg/m^3), 1999; France: VME 200 ppm (810 mg/m^3), 1999; Japan: 100 ppm (400 mg/m^3), 1999; the Netherlands: MAC-TGG 400 mg/m^3, 2003; the Philippines: TWA 100 ppm (400 mg/m^3), 1993; Poland: TWA 50 mg/m^3, 1999; Russia: TWA 100 ppm, 1993; Switzerland: MAK-W 100 ppm (400 mg/m^3), KZG-W 200 ppm (800 mg/m^3), 1999; Thailand: TWA 50 ppm; STEL 100 ppm, 1993; Turkey: TWA 100 ppm (400 mg/m^3), 1993; United Kingdom: TWA 200 ppm (823 mg/m^3); STEL 400 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for ethylidene chloride in ambient air[60] ranging from 8.0 mg/m^3 (Connecticut) to 8.1−10.1 mg/m^3 (North Dakota) to 13.5 mg/m^3 (Virginia) to 19.3 mg/m^3 (Nevada).

Determination in Air: Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV)#1003, Halogenated hydrocarbons or OSHA Analytical Method 7.

Permissible Concentration in Water: No criteria set for aquatic life or human health due to insufficient data.[6] Several states have set guidelines or standards for ethylidene chloride in drinking water[61] ranging from 1.0 μg/L (Illinois) to 20.0 μg/L (California) to 25 μg/L (New Mexico) to 70.0 μg/L (Vermont) to 850 μg/L (Wisconsin).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 1.79$.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical may affect the central nervous system. Exposure can cause drowsiness, unconsciousness, and death. High exposures may damage the liver or kidneys. Contact can cause eye and skin irritation with eye burns. Long-term exposure can cause thickening and cracking of skin. 1,1-Dichloroethane is a highly flammable liquid and a dangerous fire hazard. Never use near combustion sources. Do not use 1,1-dichloroethane where welding is being done because deadly phosgene gas can be formed.

Long Term Exposure: It may damage the developing fetus. The liquid destroys the skin's natural oils. May affect the kidneys and liver. A chloroethane, this chemical may be a potential occupational carcinogen. Prolonged skin contact can cause thickening and cracking of the skin and mild burns. Although not adequately evaluated, similar petroleum-based chemicals can cause brain or other nerve damage.

Points of Attack: Skin, liver, kidneys, lungs, central nervous system.

Medical Surveillance: If overexposure or illness is suspected, consider liver and kidney function tests. Interview for brain effects, including recent memory, mood, concentration, headaches, malaise, altered sleep patterns. Consider autonomic and peripheral nervous system evaluation. Positive and borderline cases should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Tychem 10000® suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* Sa (APF = 10) (any supplied-air respirator). *2500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *3000 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,1-Dichloroethane must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and fluorine, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where 1,1-dichloroethane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gallons or more of 1,1-dichloroethane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,1-dichloroethane.

Shipping: This material requires a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous and corrosive fumes, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Chloroethanes: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *1,1-Dichloroethane: Health and Environmental Effects Profile No. 69.* Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 44−47

New York State Department of Health. (May 1986). *Chemical Fact Sheet: 1,1-Dichloroethane*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: 1,1-Dichloroethane*. Trenton, NJ

Dichloroethyl acetate D:0530

Molecular Formula: $C_4H_6Cl_2O_2$

Common Formula: $CH_3COOCHClCH_2Cl$

Synonyms: Aceto de 1,2-dicloroetilo (Spanish); 1,2-Dichloroethanol acetate; 1,2-Dichloroethyl acetate; Ethanol, 1,2-dichloro-, acetate

CAS Registry Number: 10140-87-1

RTECS® Number: KK4200000

EC Number: 233-398-1

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichloroethyl acetate is a water-white liquid. Molecular weight = 155.32; Boiling point = 58−65°C at 13 mmHg; Flash point = 152°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Contact with strong oxidizing acids may cause an exothermic reaction strong enough to ignite reaction products. May explode on contact with nitrates and heat. Reacts with caustic solutions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.35 ppm

PAC-1: 1 ppm

PAC-2: 1.71 ppm

PAC-3: 6 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: EPA states that the material is toxic by inhalation.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and nitrates. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: There is no label requirement, Hazard category, or Packing group.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Ventilate area of spill or leak. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethanol, 1,2-Dichloro, Acetate*. Washington, DC: Chemical Emergency Preparedness Program

1,2-Dichloroethylene D:0540

Molecular Formula: $C_2H_2Cl_2$

Common Formula: $ClCH{=}CHCl$

Synonyms: *sym-*: Acetylene dichloride; 1,2-Dichloraethen (German); 1,2-Dichloroethene; *sym*-Dichloroethylene; Dichloroethylene, *sym*; Dichloro-1,2-ethylene; 1,2-Dicloroeteno (Spanish); Dioform; Ethene, 1,2-dichloro-; Ethylene, 1,2-dichloro-; NCI-C56031

cis-isomer: Acetyalyne-dichloride; *cis*-1,2-Dichlorethylene; *cis*-1,2-Dichloroethene; (Z)-1,2-Dichloroethylene; *cis*-Dichloroethylene; 1,2-*cis*-Dichloroethylene; Ethene, 1,2-dichloro-, (Z)-ethene; Ethylene, 1,2-dichloro-, (Z) *trans-isomer:* *trans*-Acetylene dichloride; *trans*-1,2-Dichloroethylene; *trans*-Dichloroethylene; *trans*-1,2-Dicloroeteno (Spanish); Dioform; Ethene, *trans*-1,2-dichloro-; Ethene, 1,2-dichloro-, (*E*)-

CAS Registry Number: 540-59-0 (1,2-); 156-59-2 (*cis*-); 156-60-5 (*trans*-)

RTECS® Number: KV9360000; KV9420000 (*cis*-); RV9400000 (*trans*-)

UN/NA & ERG Number: UN1150/130

EC Number: 208-750-2 [*Annex I Index No.:* 602-026-00-3] (1,2-); 205-859-7 [*Annex I Index No.:* 602-026-00-3] (*cis*-); 205-860-2 [*Annex I Index No.:* 602-026-00-3] (*trans*-)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (*CAS: 156-59-2*): Not Classifiable as to human carcinogenicity.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*sym*-Dichloroethylene).

European/International Regulations *(1,2-, cis- and trans-isomers*): Hazard Symbol: F, Xn, N; Risk phrases: R11; R20; R52/53; Safety phrases: S2; S7; S16; S29; S61.

trans-isomer:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U079.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

cis-isomer:

Safe Drinking Water Act: MCL, 0.07 mg/L; MCLG, 0.07 mg/L; Regulated chemical (47 FR 9352).

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; R20; R52/53; Safety phrases: S2; S7; S16; S29; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*all isomers*).

Description: 1,2-Dichloroethylene exists as three isomers: *sym*-, *cis*- 60%, and *trans*- 40%. There are variations in toxicity between these three forms. At room temperature, these chemicals are colorless liquids with a slightly acrid, ethereal odor. The odor threshold in air is 17 ppm.

sym-isomer: Molecular weight = 96.94; Boiling point = 48−55°C. Specific gravity (H_2O:1) = 1.27 at 25°C; Flash point = 2°C (cc); Autoignition temperature = 460°C. Explosive Limits: LEL = 9.7%; UEL = 12.8%. Poor solubility in water; solubility = 0.4%.

cis-isomer*:* Boiling point = 60.3°C; Freezing/Melting point = −82°C; Flash point = 6°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2.

trans-isomer*:* Boiling point = 47.5°C; Freezing/Melting point = −49°C; Flash point = 2−4°C. The explosive limits are LEL = 5.6% or 9.7%[52]; UEL = 12.8%. Slightly soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2.

Potential Exposure: Compound Description: Mutagen. Primary Irritant. 1,2-Dichloroethylene is used as a solvent for waxes, resins, and acetylcellulose. It is also used in the extraction of rubber, as a refrigerant, in the manufacture of pharmaceuticals and artificial pearls, and in the extraction of oils and fats from fish and meat.

Incompatibilities: Forms explosive mixture with air. Keep away from strong oxidizers. Gradual decomposition results in hydrochloric acid formation in the presence of ultraviolet light or upon contact with hot metal or other hot surfaces. Reacts with strong oxidizers, strong bases, potassium hydroxide, difluoromethylene, dihypofluoride, nitrogen tetroxide (explosive), or copper (and its alloys) producing toxic chloroacetylene which is spontaneously flammable on contact with air. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.97 mg/m^3 (*sym*-dichloroethylene) at 25°C & 1 atm.

OSHA PEL: 200 ppm/790 mg/m^3 TWA.

NIOSH REL: 200 ppm/790 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm/793 mg/m^3 TWA, all isomers.

NIOSH IDLH: 1000 ppm *(sym*-dichloroethylene).

Protective Action Criteria (PAC)*

sym-isomer (540-59-0)

TEEL-0: 200 ppm

PAC-1: 200 ppm

PAC-2: 200 ppm

PAC-3: 1000 ppm

cis-isomer

TEEL-0: 140 ppm

PAC-1: **140** ppm

PAC-2: **500** ppm

PAC-3: **850** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

trans-isomer

TEEL-0: 200 ppm

PAC-1: **280** ppm

PAC-2: **1000** ppm

PAC-3: **1700** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 200 ppm/800 mg/m^3; Peal Limitation Category II(2) (*sym-*).

Australia: TWA 200 ppm (790 mg/m^3), 1993; Austria: MAK 200 ppm (790 mg/m^3), 1999; Belgium: TWA 200 ppm (793 mg/m^3), 1993; Denmark: TWA 200 ppm (790 mg/m^3), 1999; Finland: TWA 200 ppm (790 mg/m^3); STEL 250 ppm (990 mg/m^3), 1999; Hungary: TWA 80 mg/m^3; STEL 160 mg/m^3, 1993; Japan: 150 ppm (590 mg/m^3), 1999; the Netherlands: MAC-TGG 790 mg/m^3, 2003; Norway: TWA 100 ppm (395 mg/m^3), 1999; the Philippines: TWA 200 ppm (790 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, 1999; Russia: TWA 150 ppm, 1993; Switzerland: MAK-W 200 ppm (790 mg/m^3), KZG-W 400 ppm (1580 mg/m^3), 1999; Turkey: TWA 200 ppm (790 mg/m^3), 1993; United Kingdom: TWA 200 ppm (806 mg/m^3); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 200 ppm. Several States have set guidelines or standards for *sym*-dichloroethylene in ambient air[60] ranging from 0.110 mg/m^3 (Massachusetts) to 13.0 mg/m^3 (Virginia) to 15.8 mg/m^3 (Connecticut) to 18.8 mg/m^3 (Nevada).

Determination in Air: Charcoal absorption workup with CS_2, analysis by gas chromatography. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated or OSHA Analytical Method 7.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 11,600 μg/L on an acute toxicity basis for dichloroethylenes in general. *To protect saltwater aquatic life:* 224,000 μg/L on an acute toxicity basis for dichloroethylenes as a class. To protect human health—no criteria developed due to insufficient data.[6] A long-term health advisory for *cis*-1,2-DCE has been determined by EPA[48] as 3.5 mg/L and a lifetime health advisory as 0.07 mg/L. Maximum levels in drinking water have been set by EPA[62] at 0.07 mg/L for the *cis*-isomer and 0.10 mg/L for the *trans*-isomer. Several states have set guidelines or standards for the dichloroethylenes in drinking water[61] as follows:

State	***cis-* (μg/L)**	***trans-* (μg/L)**	***sym-* (μg/L)**
Arizona	–	–	70
California	16	16	–
Kansas	70	70	–
Maine	400	270	–
Minnesota	70	70	–
New Jersey	–	–	10
Vermont	–	–	70
Wisconsin	100	100	–

Determination in Water: *trans*-1,2-dichloroethylene may be determined by inert gas purge followed by gas chromatography with halide-specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol–water coefficient: Log $K_{ow} = 1.96$.

Routes of Entry: Inhalation of the vapor, ingestion, skin and eye contact.

Short Term Exposure: This liquid can act as a primary irritant producing dermatitis and irritation of mucous membranes. 1,2-DCE irritates the eyes, skin, and respiratory tract. Skin contact can cause a burning sensation and rash. 1,2-Dichloroethylene acts principally as a narcotic, causing central nervous system depression. Symptoms of acute exposure include dizziness, nausea, frequent vomiting, and central nervous system intoxication, similar to that caused by alcohol. High levels can cause unconsciousness. LD_{50} = (oral-rat) 770 mg/kg (slightly toxic).

Long Term Exposure: Destroys skin's natural oils. Repeated exposure may damage the liver and kidneys. Renal effects, when they do occur, are transient.

Points of Attack: Respiratory system, eyes, central nervous system.

Medical Surveillance: Consider possible irritant effects on skin or respiratory tract as well as liver, and renal function as preplacement or periodic examinations. Expired air analysis may be useful in detecting exposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade® coated suits; CPF3® suits; Responder™ suits; Trychem 10000® suits. **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials for the *cis-* and *trans-*isomers. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,2-DCE you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2-Dichloroethylene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 1,2-dichloroethylene is used, handled, or stored. Metal containers involving the transfer of 5 gallons or more of 1,2-dichloroethylene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of 1,2-dichloroethylene. Wherever 1,2-dichloroethylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dichloroethylene must carry a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,2-DCE is a flammable liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Dichloroethylenes: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Trans-1,2-Dichloroethylenes: Health and Environmental Effects Profile No. 72.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Dichloroethylenes: Health and Environmental Effects Profile No. 73.* Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 48−53

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: 1,2-Dichloroethylene*. Trenton, NJ

Dichloroethyl ether D:0550

Molecular Formula: $C_4H_8Cl_2O$
Common Formula: $ClCH_2CH_2OCH_2CH_2Cl$
Synonyms: BCEE; Bis(β-chloroethyl) ether; Bis(2-chloroethyl) ether; Bis(2-cloroetil)eter (Spanish); Chlorex; 1-Chloro-2-(β-chloroethoxy)ethane; Chloroethyl ether (DOT); Clorex; DCEE; 2,2′-Dichlor-diaethylaether (German); 2,2′-Dichlorethyl ether; β,β′-Dichlorodiethyl ether; 2,2′-Dichlorodiethyl ether; Dichloroether; β,β′-Dichloroethyl ether; *sym*-Dichloroethyl ether; 2,2′-Dichloroethyl ether; Di(β-chloroethyl) ether; Di(2-chloroethyl) ether; Dichloroethyl ether; Dichloroethyl oxide; ENT 4,504; Ethane, 1,1′-oxybis 2-chloro-; Ether dichlore (French); 1,1′-Oxybis(2-chloro)ethane; Oxyde de chlorethyle (French)
CAS Registry Number: 111-44-4
RTECS® Number: KN0875000
UN/NA & ERG Number: UN1916 (2,2′-Dichlorodiethyl ether)/152
EC Number: 203-870-1 [*Annex I Index No.:* 603-029-00-2]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, Limited Evidence; Human, Inadequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH treats this chemical as a suspected human carcinogen, See *NIOSH Pocket Guide*, Appendix A.
Banned or Severely Restricted (Finland, Sweden) (UN).[13]
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U025.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.033; Nonwastewater (mg/kg), 6.0.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).
Reportable Quantity (RQ): 10 lb (4.54 kg).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4550 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Mexico, drinking water criteria = 0.0003 mg/L.
California Proposition 65 Chemical: Cancer 4/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T + ; Risk phrases: R26/27/28; R40; Safety phrases: S1/2; S7/9; S27; S36/37; S45. (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Dichloroethyl ether is a clear, colorless liquid with a pungent, fruity odor. It is also described as having a chlorinated solvent-like odor. Molecular weight = 143.02; Boiling point = 176−178°C; Flash point = 55°C[17]; Autoignition temperature = 369°C; Explosive limits: LEL = 2.7%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Insoluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. Dichloroethyl ether is used as a soil fumigant, an insecticide, and an acaricide, and in the manufacture of paint, varnish, lacquer, soap, and finish removers. It is also used as a solvent for cellulose esters, naphthalenes, oils, fats, waxes, greases, pectin, tar, and gum, in dry cleaning and in textile scouring.
Incompatibilities: Contact with moisture caused decomposition producing hydrochloric acid. Can form peroxides. Forms explosive mixture with air. Contact with strong oxidizers may cause fire and explosion hazard. Attacks some plastics, rubber, and coatings. Attacks metals in the presence of moisture.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 5.85 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 15 ppm/90 mg/m^3 Ceiling Concentration [skin].
NIOSH REL: 5 ppm/30 mg/m^3 TWA; 10 ppm/60 mg/m^3 STEL [skin]; See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 5 ppm/29 mg/m^3 TWA; 10 ppm/58 mg/m^3 STEL [skin], not classifiable as a human carcinogen.
NIOSH IDLH: 100 ppm.
Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 10 ppm
PAC-2: 2.5 ppm
PAC-3: 100 ppm
DFG MAK: 10 ppm/59 mg/m^3 TWA; Peak Limitation Category I(1) [skin].
Australia: TWA 5 ppm (30 mg/m^3); STEL 10 ppm, [skin], 1993; Austria: MAK 5 ppm (30 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (29 mg/m^3); STEL 10 ppm (58 mg/m^3), [skin], 1993; Finland: TWA 5 ppm (30 mg/m^3); STEL 10 ppm (60 mg/m^3), [skin], 1999; France: VME 5 ppm (30 mg/m^3), [skin], 1999; Japan: 15 ppm (88 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 30 mg/m^3, 2003; the Philippines: TWA 15 ppm (90 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 60 mg/m^3,

1999; Russia: STEL 0.6 mg/m^3, [skin]; TWA 15 ppm; STEL 2 mg/m^3, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 5 ppm (30 mg/m^3), KZG-W 25 ppm (50 mg/m^3), [skin], 1999; Thailand: TWA 15 ppm (90 mg/m^3), 1993; Turkey: TWA 15 ppm (90 mg/m^3), [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm [skin]. Several states have set guidelines or standards for BCEE in ambient air[60] ranging from 0.0714 mg/m^3 (Kansas) to 0.3−0.6 mg/m^3 (North Dakota) to 0.5 mg/m^3 (Virginia) to 0.6 mg/m^3 (Connecticut) to 0.714 mg/m^3 (Nevada) to 0.72 mg/m^3 (Pennsylvania).

Determination in Air: Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1004 or OSHA Analytical Method 7.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 238,000 μg/L for chloroalkyl ethers in general. No criteria developed for protection of saltwater aquatic life due to insufficient data. For the protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.3 μg/L.[6] Several states have set guidelines for BCEE in drinking water[61] ranging from 0.31 μg/L (Minnesota) to 4.2 μg/L (Kansas) to 8.3 μg/L (Maine) to 10.0 μg/L (Arizona).

Determination in Water: CH_2Cl_2 extraction followed by gas chromatography with halogen; specific detector (EPA Method 611) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: BCEE can be absorbed through the skin, thereby increasing exposure. Exposure irritates the eyes, skin, and respiratory tract. Skin and eye contact may cause burns. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. At concentrations above 500 ppm, coughing, retching, and vomiting may occur; as well as profuse tearing. There can be irritation at lower concentrations. This material is very toxic; the probable oral lethal dose is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb person. It can be a central nervous system depressant in high concentrations. It is extremely irritating to the eyes, nose, and respiratory passages. It can penetrate the skin to cause serious and even fatal poisoning. Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin.

Long Term Exposure: BCEE may damage the liver and kidneys. Can irritate the lungs; repeated exposures may cause bronchitis.

Points of Attack: Respiratory system, skin, eyes, liver and kidneys. This chemical causes liver cancer in animals and may be a potential human carcinogen.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: liver, kidney, and lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Tychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with BCEE you should be trained on its proper handling and storage.

Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Bis (2-chloroethyl) ether must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and chlorine dioxide, since violent reactions occur, and moisture. Store in tightly closed containers in a cool, dry, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where bis (2-chloroethyl) ether is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dichloroethyl ether must carry a "POISONOUS/ TOXIC MATERIALS, FLAMMABLE LIQUID" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb spills in vermiculite, dry sand, earth, or similar material. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock down vapors. *Spill or leak:* shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Chloroalkyl Ethers*: *Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bis (2-Chloroethyl) Ether: Health and Environmental Effects Profile No. 24*. Washington, DC: Office of Solid Waste

International Agency for Research on Cancer. (1975). *IARC: Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France 9, 117

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dichloroethyl Ether*. Washington, DC; Chemical Emergency Preparedness Program

Sax N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 62−76

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Bis (2-Chloroethyl) Ether.* Trenton, NJ

Dichloromethylphenyl-silane D:0560

Molecular Formula: $C_7H_8Cl_2Si$

Common Formula: $C_6H_5SiCl_2CH_3$

Synonyms: Dichloromethylphenylsilane; Methylphenyldichlorosilane; Phenylmethyldichlorosilane; Silane, dichloromethylphenyl-

CAS Registry Number: 149-74-6

RTECS$^{®}$ Number: VV3530000

UN/NA & ERG Number: UN2437/156

EC Number: 205-746-2

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dichloromethylphenyl-silane is a flammable, colorless liquid. Molecular weight = 191.14; Boiling point = 205°C; Freezing/Melting point: −52.7°C; Flash point = 82°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: Used in the manufacture of silicones and as a chemical intermediate for silicone fluids, resins, and elastomers.

Incompatibilities: Forms explosive mixture with air. Contact with moisture causes decomposition, forming HCl, and explosive hydrogen. Contact with ammonia may form a self-igniting material. Reacts strongly with oxidizing materials. Attacks some metals in the presence of moisture.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: The chemical is toxic and a corrosive irritant. Contact with the skin or eyes causes burns and permanent damage. Inhalation may cause irritation. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause lung irritation and bronchitis.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with methylphenyldichlorosilane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, oxidizers, and ammonia. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Methylphenyldichlorosilane requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Fire Extinguishing: Dichloromethylphenyl-silane is a combustible liquid. Poisonous gases, including silicon oxides and hydrogen chloride, are produced in fire. *Do not use water*. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dichloromethylphenylsilane.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methylphenyldichlorosilane*. Trenton, NJ

Dichloromonofluoro-methane D:0570

Molecular Formula: $CHCl_2F$

Synonyms: Algofrene type 5; Dichloromonofluorometha NE; F 21; FC 21; Fluorodichloromethane; Freon F 21; Genetron 21; Halon 112; HCFC-21; Methane, dichlorofluoro-; Monofluorodichlorometha NE; R 21 (refrigerant); Refrigerant 21

CAS Registry Number: 75-43-4

RTECS® Number: PA8400000

UN/NA & ERG Number: UN1029/126

EC Number: 200-869-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dichlorofluoro-methane is a heavy, colorless gas or liquid (below 9°C) with a slight ether-like odor. Molecular weight = 102.92; Boiling point = 9°C; Freezing/Melting point = −135°C; Relative vapor density (air = 1) = 3.57; Vapor pressure = 1.6 atm at 25°C; Autoignition temperature = 522°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Poor solubility in water; solubility = 0.7% at 30°C.

Potential Exposure: Compound Description: Reproductive Effector. This material is used as a refrigerant and a propellant gas.

Incompatibilities: Reacts violently with chemically active metals: sodium, potassium, calcium, powdered aluminum, zinc, magnesium, alkali, alkaline earth. Reacts with acids or acid fumes producing highly toxic chlorine and fluorine fumes. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 1000 ppm/4200 mg/m^3 TWA.
NIOSH REL: 10 ppm/40 mg/m^3 TWA.
ACGIH TLV®[1]: 10 ppm/42 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 10 ppm
PAC-1: 1500 ppm
PAC-2: 5000 ppm
PAC-3: 5000 ppm
DFG MAK: 10 ppm/43 mg/m^3 TWA; Peak Limitation Category II(2).
NIOSH IDLH: 5000 ppm.

Australia: TWA 10 ppm (40 mg/m^3), 1993; Austria: MAK 10 ppm (45 mg/m^3), 1999; Belgium: TWA 10 ppm (42 mg/m^3), 1993; Denmark: TWA 10 ppm (40 mg/m^3), 1999; Finland: TWA 10 ppm (40 mg/m^3); STEL 20 ppm (80 mg/m^3), 1999; France: VME 10 ppm (40 mg/m^3), 1999; Hungary: STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 43 mg/m^3, 2003; Norway: TWA 10 ppm (42 mg/m^3), 1999; the Philippines: TWA 1000 ppm (4200 mg/m^3), 1993; Poland: MAC (TWA) 40 mg/m^3, MAC (STEL) 200 mg/m^3, 1999; Switzerland: MAK-W 10 ppm (40 mg/m^3), KZG-W 20 ppm (80 mg/m^3), 1999; Turkey: TWA 1000 ppm (4200 mg/m^3), 1993; United Kingdom: TWA 10 ppm (43 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm. Several states have set guidelines or standards for R-21 in ambient air[60] ranging from 0.4 mg/m^3 (North Dakota) to 0.5 mg/m^3 (North Carolina) to 0.65 mg/m^3 (Virginia) to 0.8 mg/m^3 (Connecticut) to 0.952 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2516.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 1.55.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact with the liquid may cause frostbite. This chemical affects the central nervous system at high concentrations. High exposure could cause asphyxia and/or cardiac arrhythmia (irregular heartbeat). This might lead to cardiac arrest.

Long Term Exposure: May damage the developing fetus. May damage the liver. May cause irregular heartbeat.

Points of Attack: Respiratory system, lungs, cardiovascular system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. EKG, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm*: Sa (APF = 10) (any supplied-air respirator). *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *500 ppm*: SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *5000 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with dichloromonofluoro-methane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chemically active metals, acids, acid fumes, alkali and alkaline earth metals, since violent reaction occur. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Dichloromonofluoro-methane must be labeled "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine, fluorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition

sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Because of recent discovery of potential ozone decomposition in the stratosphere, this material should be released to the atmosphere only as a last resort.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Dichlorofluoromethane*. Trenton, NJ

1,1-Dichloro-1-nitroethane D:0580

Molecular Formula: $C_2H_3Cl_2NO_2$

Common Formula: $CH_3CCl_2NO_2$

Synonyms: Dichloronitroethane; Ethide®

CAS Registry Number: 594-72-9

RTECS® Number: KI1050000

UN/NA & ERG Number: UN2650/153

EC Number: 209-854-0 [*Annex I Index No.:* 610-002-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1,1-Dichloro-1-nitroethane is a colorless liquid with an unpleasant odor; causes tears. Molecular weight = 143.96; Boiling point = 124°C; Vapor pressure = 15 mmHg at 20°C; Flash point = 58°C; 76°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 3. Poor solubility in water; solubility = 0.3%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. This material is used as a fumigant insecticide. Therefore, those engaged in the manufacture, formulation, and application of this material may be exposed.

Incompatibilities: Strong oxidizers. Corrosive to iron in the presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.89 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/60 mg/m^3 Ceiling Concentration.

NIOSH REL: 2 ppm/10 mg/m^3 TWA.

ACGIH TLV®[1]: 2 ppm/12 mg/m^3 TWA.

No TEEL available.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 2 ppm (10 mg/m^3), 1993; Austria: MAK 2 ppm (12 mg/m^3), 1999; Belgium: TWA 2 ppm (12 mg/m^3), 1993; Finland: TWA 10 ppm (60 mg/m^3), STEL 20 ppm (120 mg/m^3), 1999; France: VME 2 ppm (10 mg/m^3), 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; the Philippines: TWA 10 ppm (60 mg/m^3), 1993; Poland: MAC (TWA) 30 mg/m^3, MAC (STEL) 60 mg/m^3, 1999; Switzerland: MAK-W 2 ppm (12 mg/m^3), 1999; Thailand: TWA 10 ppm (60 mg/m^3), 1993; Turkey: TWA 10 ppm (60 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm. Several states have set guidelines or standards for dichloronitroehtane in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1601 or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: In animals: lung, skin, eye irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 410 mg/kg (moderately toxic).

Long Term Exposure: This chemical causes liver, heart, kidney, and blood vessel damage in animals.

Points of Attack: Lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 20 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 25 ppm:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: 1,1-Dichloro-1-nitroethane requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Water may be used to blanket fire since liquid is heavier than water (sp. gr. = 1.4). Apply water gently to the surface of the liquid.[17] Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s for primary combustion; 1204°C, 1.0 s for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. Nitrogen oxides may be abated through the use of thermal or catalytic devices.

2,4-Dichlorophenol D:0590

Molecular Formula: $C_6H_4Cl_2O$

Common Formula: $Cl_2C_6H_3OH$

Synonyms: 2,4-DCP; 1,3-Dichloro-4-hydroxybenzene; 4,6-Dichlorophenol; 2,4-Diclorofenol (Spanish); Phenol, 2,4-dichloro-

CAS Registry Number: 120-83-2

RTECS® Number: SK8575000

UN/NA & ERG Number: UN2020/153

EC Number: 204-429-6 [*Annex I Index No.:* 604-011-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (feed); no evidence: mouse, rat.

US EPA Gene-Tox Program, Inconclusive: Histidine reversion—Ames test.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U081.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.044; Nonwastewater (mg/kg), 14.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, Drinking Water, ≤0.0003 mg/L MAC, National Pollutant Release Inventory (NPRI).

Mexico Drinking water, 0.03 mg/L.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R22; R24; R34; R51/53; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 2,4-DCP is a colorless crystalline solid with a characteristic odor. Molecular weight = 163.00; Boiling point = 210°C; Freezing/Melting point = 45.0°C; Flash point = 113°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. 2,4-Dichlorophenol is a commercially produced substituted phenol used in the manufacture of industrial and agricultural products and in synthesis of pharmaceuticals. As an intermediate in the chemical industry, 2,4-DCP is utilized as the feedstock for the manufacture of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4-D derivatives (germicides, soil sterilants, etc.); certain methyl compounds are used in mothproofing, antiseptics, and seed disinfectants. 2,4-DCP is also reacted with benzene sulfonyl chloride to produce miticides or further chlorinated to pentachlorophenol, a wood preservative. It is thus a widely used pesticide intermediate. The only group expected to be at risk for high exposure to 2,4-DCP is industrial workers involved in the manufacturing or handling of 2,4-DCP and 2,4-D.

Incompatibilities: Violent reaction with strong oxidizers. Contact with acids or acid fumes causes decomposition releasing poisonous chlorine gas. Incompatible with caustics, acid anhydrides, acid chlorides. Quickly corrodes aluminum, slowly corrodes zinc, tin, brass, bronze, copper, and its alloys. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

AIHA WEEL: 1 ppm TWA [skin]; Absorbed rapidly through the skin in molten or heated liquid form in amounts that have caused rapid death in humans.

Protective Action Criteria (PAC)
TEEL-0: 0.2 ppm
PAC-1: 0.2 ppm
PAC-2: 2 ppm
PAC-3: 20 ppm

Michigan[60] has set a guideline for 2,4-dichlorophenol in ambient air of 77.0 μg/m^3.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 2020 μg/L on an acute toxicity basis and 365 μg/L on a chronic toxicity basis. *To protect saltwater aquatic life:* no criteria because of insufficient data. *To protect human health:* 0.3 μg/L based on organoleptic effects and 3090 μg/L based on toxicity data.[6] Canada, Drinking Water, ≤0.0003 mg/L MAC. Mexico Drinking Water, 0.03 mg/L. Russia[35,43] set a MAC of 2 μg/L in water bodies used for domestic purposes. This applies to all dichlorophenols isomers. Two states have set guidelines for 2,4-dichlophenol in drinking water: Maine at 200 μg/L and Kansas at 700 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion, through the skin.

Harmful Effects and Symptoms

Although a paucity of aquatic toxicity data exists, 2,4-DCP appears to be less toxic than the higher chlorinated phenols. 2,4-DCP's toxicity to certain microorganisms and plant life has been demonstrated and its tumor-promoting potential in mice has been reported. In addition, it has been demonstrated that 2,4-DCP can produce objectionable odors when present in water at extremely low levels. These findings, in conjunction with potential 2,4-DCP pollution by waste sources from commercial processes or the inadvertent production of 2,4-DCP due to chlorination of waters containing phenol, led to the conclusion that 2,4-DCP represents a potential threat to aquatic and terrestrial life, including humans. 2,4-DCP can irritate tissue and mucous membranes. LD_{50} = (oral-rat) 580 mg/kg (slightly toxic).

Short Term Exposure: 2,4-DCP can be absorbed through the skin, thereby increasing exposure. Skin or eye contact can cause irritation and burns. Inhalation can cause respiratory irritation, coughing, and wheezing. A suspected carcinogen.

Long Term Exposure: May cause liver and kidney damage. May affect the nervous system causing headache, dizziness, nausea, vomiting, weakness, and possible coma. Several other chlorophenols are carcinogenic, although 2,4-DCP has not been identified specifically as a carcinogen.

Points of Attack: Nervous system, liver, and kidneys.

Medical Surveillance: Examination of the nervous system. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DCP you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers, acid, acid fumes, acid chlorides, acid anhydrides, caustics. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorophenols, solid require a "POISONOUS/TOXIC MATERIALS" label. 2,4-DCP falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Dry chemical or CO_2 are preferred extinguishers. Water or foam may cause frothing. Poisonous gases are produced in fire, including corrosive hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent and incinerate in a furnace equipped with afterburner and scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *2,4-Dichlorophenol: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Mono/Dichlorophenols.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *2,4-Dichlorophenol: Health and Environmental Effects Profile No. 75.* Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 50−52 (1981), & 7, No. 3, 70−86 (1987)

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: 2,4-Dichlorophenol*. Trenton, NJ

2,6-Dichlorophenol D:0600

Molecular Formula: $C_6H_4Cl_2O$
Common Formula: $Cl_2C_6H_3OH$
Synonyms: 2,6-DCP; 2,6-Diclorofenol (Spanish)
CAS Registry Number: 87-65-0
RTECS® Number: SK8750000
UN/NA & ERG Number: UN2020/153
EC Number: 201-761-3
Regulatory Authority and Advisory Bodies
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U082.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.044; Nonwastewater (mg/kg), 14.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: 2,6-Dichlorophenol is a white crystalline solid having a strong odor similar to *o*-chlorophenol; Molecular weight = 163.00; Boiling point = 219.5°C; Freezing/Melting point = 68−69°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.
Potential Exposure: 2,6-Dichlorophenol is produced as a by-product from the direct chlorination of phenol. It is used primarily as a starting material for the manufacture of trichlorophenols, tetrachlorophenols, and pentachlorophenols. It also acts as a sex pheromone for lone star tick.
Incompatibilities: Incompatible with strong oxidizers, acids, acid fumes, acid anhydrides, acid chlorides.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 12.5 mg/m^3
PAC-1: 35 mg/m^3
PAC-2: 250 mg/m^3
PAC-3: 500 mg/m^3
Permissible Concentration in Water: Russia[35,43] set a MAC of 2.0 μg/L in water bodies used for domestic purposes (applies to all chlorophenol isomers). Kansas[61] has set a guideline of 0.2 μg/L of 2,6-dichlorophenol in drinking water.
Routes of Entry: Inhalation, through the skin.
Harmful Effects and Symptoms
Short Term Exposure: 2,6 DCP can be absorbed through the skin, thereby increasing exposure. Causes severe local irritation of eyes, skin, and mucous membranes and also burns. Other symptoms are tremors, convulsions, and respiratory inhibition. LD_{50} = (oral-rat) 2,940 mg/kg (slightly toxic).
Long Term Exposure: May cause liver and kidney damage. May affect the nervous system causing headache, dizziness, nausea, vomiting, weakness, and possible coma. Several other chlorophenols are carcinogenic, although 2,6-DCP has not been identified specifically as a carcinogen.
Points of Attack: Nervous system, liver, and kidneys.
Medical Surveillance: Examination of the nervous system. Liver and kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a

pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,6-DCP you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers and other incompatible materials listed above.

Shipping: Chlorophenols, solid require a “POISONOUS/TOXIC MATERIALS” label. 2,6-DCP falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent and incinerate in a furnace equipped with afterburner and scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *2,6-Dichlorophenol: Health and Environmental Effects Profile No. 76.* Washington, DC: Office of Solid Waste

Sax N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 5, 35−38

2-(2,4-Dichlorophenoxy)propionic acid D:0610

Molecular Formula: $C_9H_8C_{12}O_3$

Synonyms: Acide-2-(2,4-dichloro-phenoxy)propionique (French); Acido 2-(2,4-diclorofenoxi)propionico (Spanish); BH 2,4-DP; Celatox-DP; Cornox RD; Cornox RK; Desormone; α-(2,4-Dichlorophenoxy)propionic acid; (+−)-2-(2,4-Dichlorophenoxy)propionic acid; 2-(2,4-Dichlorophenoxy)propionic acid; 2,4-Dichlorophenoxy-α-propionic acid; 2,4-Dichlorophenoxypropionic acid; Dichloroprop; 2-(2,4-Dichlor-phenoxy)-propionsaeure (German); Dichlorprop; 2-(2,4-DP); 2,4-DP (EPA); Embutox; Graminon-plus; Hedonal; Hedonal DP; Herbizid DP; Hormatox; Kildip; NSC 39624; Polyclene; Polymone; Polytox; Propanoic acid, 2-(2,4-dichlorophenoxy)-; Propionic acid, 2-(2,4-dichlorophenoxy)-; RD 406; Seritox 50; U 46; U46 DP-Fluid; Visko-Rhap; Weedone 170; Weedone DP

CAS Registry Number: 120-36-5

RTECS® Number: UF1050000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152; UN 2588 (Pesticide, solid, toxic, n.o.s.)/151

EC Number: 204-390-5 [*Annex I Index No.:* 607-045-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence, Animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1987.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Developmental/Reproductive toxin 4/27/99.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; R38; R41; Safety phrases: S2; S26; 36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 2,4-DP is a combustible, colorless to yellowish to tan crystalline solid with a faint phenolic odor; Molecular weight = 235.07; Freezing/Melting point = 117−118°C. Soluble in water; solubility = 350 mg/L at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. May be applied as a liquid formulated with a flammable carrier, which can alter the physical properties listed here.

Potential Exposure: A phenoxy herbicide.

Incompatibilities: Contact with oxidizers may cause a fire and explosion hazard. The aqueous solution is a weak acid. Attacks many metals in presence of moisture.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Water: No method listed. Octanol−water coefficient: Log $K_{ow} = 5.9$

Routes of Entry: Inhalation and passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause headache, fatigue, muscle twitching, fever, nausea, vomiting, diarrhea, stomach pain, poor appetite, and convulsions.

Long Term Exposure: There is limited evidence that related phenoxy herbicide compounds cause cancer. May cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DP you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and bases. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phenoxy pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: *Solid material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid formulations containing organic solvents: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Solid material:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including phosgene, hydrogen chloride, and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid formulations containing organic solvents: This chemical is a combustible liquid. Poisonous gases, including phosgene, hydrogen chloride, and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (October 2006). *Hazardous Substances Fact Sheet: 2-(2,4-Dichlorophenoxy) Propionic Acid.* Trenton NJ

Dichlorophenyl isocyanates D:0620

Molecular Formula: $C_7H_3C_{12}NO$ (102-36-3)

Synonyms: *102-36-3:* Benzene, 1,2-dichloro-4-isocyanato-; 3,4-Dichlorfenylisokyanat; 1,2-Dichloro-4-phenyl isocyanate; 3,4-Dichlorophenyl isocyanate; Dichlorophenyl isocyanate

Other dichlorophenyl isocyanates: Benzene, 2,4-dichloro-1-isocyanato-; 1,2-Dichloro-3-phenyl isocyanate; 1,3-Dichloro-2-phenyl isocyanate; 1,4-Dichloro-2-phenyl isocyanate; 2,4-Dichloro-1-phenyl isocyanate; Dichlorophenyl isocyanate

CAS Registry Number: *General group:* 102-36-3; 41195-90-8; 39920-37-1; 5392-82-5; 2612-57-9; 34893-92-0

RTECS® Number: NQ8755000 (General group); NQ8760000 (102-36-3)

UN/NA & ERG Number: UN2250/156

EC Number: 203-026-2 (CAS: 102-36-3); 255-253-1 (CAS: 41195-90-8); 254-699-4 (CAS: 39920-37-1); 226-396-7 (CAS: 5392-82-5); 220-040-4 (CAS: 2612-57-9); 252-276-9 (CAS: 34893-92-0)

Regulatory Authority and Advisory Bodies

Isocyanic Acid, 3,4-Dichlorophenyl Ester (102-36-3).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%, all isomers.

WGK (German Aquatic Hazard Class): 2—Water polluting (CAS: 102-36-3).

Description: The dichlorophenyl isocyanates are combustible, crystalline (sugar- or sand-like) solids. In general, they are white to yellow in color, but the 1,4-dichloro-2-phenyl isomer is white to light green. Their flash points are generally >113°C but that of the 1,3-dichloro-2-phenyl isomer is reported as 77°C. These chemicals are insoluble in water, and some may be reactive. *1,2-dichloro-4-isomer* (CAS 102-36-3) is the isomer of regulatory focus: Freezing/Melting point = 42−43°C. Molecular weight = 188.01; Boiling point = 243°C; Freezing/Melting point = 42°C. Reacts with water.

Potential Exposure: Those materials used as chemical intermediates.

Incompatibilities: Water (forms carbon dioxide), alcohols and glycols, acids, ammonia, strong bases, carboxylic acids, amines, caprolactum solution, and metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 14 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: Impinger; Reagent; High-pressure liquid chromatography/Fluorescence/Electrochemical detection; NIOSH Analytical Method (IV) #5522, Isocyanates. See also Method #5521.

Permissible Concentration in Water: No criteria set. Reacts with water, forming carbon dioxide.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, nose, throat, air passages, and lungs, causing coughing, shortness of breath, and tightness in the chest.

Long Term Exposure: Dichlorophenyl isocyanates may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dichlorophenyl isocyanates, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with these chemicals you should be trained on its proper handling and storage. Store to avoid contact with alcohols, strong bases (such as potassium hydroxide and sodium hydroxide), carboxylic acids, amines, and metals since violent reactions occur. Store in tightly closed containers in a dry, cool, well-ventilated area away from moisture and temperatures above 40°C.

Shipping: Dichlorophenyl isocyanates must carry a "POISONOUS/TOXIC MATERIALS" label. They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are combustible solids. Use dry chemical, carbon dioxide, or water spray extinguishers. Poisonous gases are produced in fire, including hydrogen cyanide, oxides of nitrogen, and hydrogen chloride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Combustion in an incinerator equipped with afterburner and fume scrubber.

References

New Jersey Department of Health and Senior Services. (April 1986). *Hazardous Substance Fact Sheets: 1,2-Dichloro-4-Phenyl Isocyanate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substance Fact Sheets: 1,3-Dichloro-2-Phenyl Isocyanate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substance Fact Sheets: 1,4-Dichloro-2-Phenyl Isocyanate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substance Fact Sheets: 2,4-Dichloro-1-Phenyl Isocyanate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substance Fact Sheets: 1,2-Dichloro-3-Phenyl Isocyanate.* Trenton, NJ

Dichlorophenyl trichloro-silane D:0630

Molecular Formula: $C_6H_3Cl_5Si$
Common Formula: $Cl_2C_6H_3SiCl_3$
Synonyms: Silane, trichloro(dichlorophenyl)-; Trichloro (dichlorophenyl)silane
CAS Registry Number: 27137-85-5
RTECS® Number: VV3540000
UN/NA & ERG Number: UN1766/156
EC Number: 248-254-3
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Dichlorophenyl trichloro-silane is a straw-colored liquid. Molecular weight = 280.43; Boiling point = 258.6°C; Vapor pressure = <1 mmHg at 18°C; Flash point = 141°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Decomposes in water.
Potential Exposure: This material is used in silicone polymer manufacture.
Incompatibilities: Water, combustible materials.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.2 ppm
PAC-1: **0.6** ppm
PAC-2: **7.3** ppm
PAC-3: **33** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Russia[43] set a MAC of 1.0 mg/m^3 in work-place air.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. This substance is a corrosive chemical and contact can cause severe skin and eye burns. Exposure can irritate the eyes, nose, and throat.
Long Term Exposure: Repeated exposure may affect the lungs.
Points of Attack: Lungs.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to Dichlorophenyl trichloro-silane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure demand or other positive-pressure mode.
Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Dichlorophenyl trichloro-silane should be stored to avoid contact with moisture or with combustible materials, such as wood, paper, and oil.
Shipping: This chemical requires a shipping label of "CORROSIVE". It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Fire Extinguishing: Dichlorophenyl trichloro-silane may burn but does not readily ignite. Poisonous gas is produced in fire. Use dry chemical, CO_2, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Dichloro Phenyl Trichlorosilane.* Trenton, NJ

1,2-Dichloropropane D:0640

Molecular Formula: $C_3H_6Cl_2$

Common Formula: $ClCH_2CHClCH_3$

Synonyms: Bichlorure de propylene (French); α,β-Dichloropropane; 1,2-Dicloropropano (Spanish); ENT 15,406; NCI-C55141; Propane, 1,2-dichloro-; Propylene chloride; α,β-Propylene dichloride; Propylene dichloride

CAS Registry Number: 78-87-5; 26638-19-7 (dichloropropane)

RTECS® Number: TX9625000

UN/NA & ERG Number: UN1279/130

EC Number: 201-152-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U083.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.85; Nonwastewater (mg/kg), 18.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352); Priority List (55 FR 1470).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, National Pollution Release Inventory (NPRI).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Dichloropropane is a colorless stable liquid. Sweet, chloroform-like odor. The odor threshold in air is 0.25 ppm. Molecular weight = 112.99; Specific gravity (H_2O:1) = 1.16; Boiling point = 96°C; Freezing/Melting point = − 100°C; Vapor pressure = 40 mmHg at 20°C; Flash point = 16°C (cc); Autoignition temperature = 557°C. Explosive limits: LEL = 3.4%; UEL = 14.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Very slightly soluble in water; solubility = 0.3% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Dichloropropane is used as a chemical intermediate in perchloroethylene and carbon tetrachloride synthesis, and as a lead scavenger for antiknock fluids. It is also used as a solvent for fats, oils, waxes, gums, and resins, and in solvent mixtures for cellulose esters and ethers. Other applications include the use of dichloropropane; as a fumigant, alone and in combination with dichloropropane, as a scouring compound; and a metal degreasing agent. It is also used as an insecticidal fumigant.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges and may cause ignition of its vapors. Contact with strong oxidizers, powdered aluminum may cause fire and explosion hazard. Strong acids can cause decomposition and the formation of hydrogen chloride vapors. Reacts with strong bases, *o*-dichlorobenzene, 1,2-dichloroethane. Corrosive to aluminum and its alloys. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 75 ppm/350 mg/m^3 TWA.

NIOSH REL: Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/46 mg/m^3 TWA, sensitizer, not classifiable as a human carcinogen.

78-87-5

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 200 ppm

PAC-2: 400 ppm

PAC-3: 400 ppm

DFG MAK: Carcinogen Category 3B.

NIOSH IDLH: [Ca] 400 ppm.

Australia: TWA 75 ppm (350 mg/m^3); STEL 110 ppm, 1993; Austria: MAK 75 ppm (350 mg/m^3), 1999; Belgium: TWA 75 ppm (347 mg/m^3); STEL 110 ppm (509 mg/m^3), 1993; Denmark: TWA 75 ppm (350 mg/m^3), 1999; Finland: TWA 75 ppm (350 mg/m^3); STEL 115 ppm (530 mg/m^3), 1999; France: VME 75 ppm (350 mg/m^3), 1999; Hungary: TWA 50 mg/m^3; STEL 100 mg/m^3 [skin] 1993; the Netherlands: MAC-TGG 350 mg/m^3, 2003; Norway: TWA 40 ppm (185 mg/m^3), 1999; the Philippines: TWA 75 ppm (350 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, MAC (STEL) 400 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Switzerland: MAK-W 75 ppm (350 mg/m^3), KZG-W 375 ppm (1750 mg/m^3), 1999; Turkey: TWA 74 ppm (350 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 110 ppm. Russia[35, 43] set a MAC of 0.18 mg/m^3 in ambient air in residential areas on a daily average basis. Several states have set guidelines or standards for propylene dichloride in ambient air[60] ranging from 5.1 μg/m^3 (Massachusetts) to 13.89 μg/m^3 (Kansas) to 3500−5100 μg/m^3 (North Dakota) to 5800 μg/m^3 (Virginia) to 7000 μg/m^3 (Connecticut) to 8330 μg/m^3 (Nevada).

26638-19-7

TEEL-0: 5 ppm

PAC-1: 15 ppm

PAC-2: 100 ppm

PAC-3: 350 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1013 or OSHA Analytical Method 7.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 23,000 μg/L on an acute toxicity basis and 5700 μg/L on a chronic basis. *To protect saltwater aquatic life:* 10,300 μg/L on an acute toxicity basis and 3040 μg/L on a chronic basis. *To protect human health:* no value set because of insufficient data.[6] EPA[62] has recently proposed a limit of 0.005 mg/L (5 μg/L) in drinking water. Several states have set guidelines for propylene dichloride in drinking water[61] ranging from 1 μg/L (Arizona, Massachusetts) to 6 μg/L (Kansas and Minnesota) to 10 μg/L (California and Connecticut). Russia[35,43] set a MAC of 0.4 mg/L in water bodies used for domestic purposes. The US EPA[47] has derived a no-observed-adverse-effects-level (NOAEL) of 8.8 mg/kg/day which gives a 10-day health advisory of 0.09 mg/L for a 10-kg child.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = about 2.

Routes of Entry: Inhalation of vapor, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: 1,2-Dichloropropane irritates the eyes, skin, and respiratory tract. It may affect the nervous system. High concentration exposure can result in lightheadedness, dizziness, and unconsciousness. Propylene dichloride may cause dermatitis and defatting of the skin. More severe irritation may occur if it is confined against the skin by clothing. Undiluted, it is moderately irritating to the eyes, but does not cause permanent injury. The vapor can irritate the nose, throat, eyes, and air passages. Repeated or prolonged skin contact can cause rash.

Long Term Exposure: Repeated exposure can cause skin drying and dermatitis. There is limited evidence that this chemical causes cancer in animals. It may cause liver cancer. In animal experiments, acute exposure to propylene dichloride produced central nervous system narcosis, fatty degeneration of the liver and kidneys. High or repeated exposure can damage the liver, kidneys, and brain. Early symptoms include headaches, nausea, personality changes. Based on animal tests this chemical may affect reproduction and may cause malformations in the human fetus.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, central nervous system. *Cancer site:* (in animals) liver and mammary gland.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Evaluate the skin condition.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ is among the recommended protective materials for all dichloropropane isomers. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At *any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,2-dichloropropane you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2-dichloropropane must be stored to avoid contact with aluminum since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), *o*-dichlorobenzene, and 1,2-dichloroethane. Sources of ignition, such as smoking and open flames, are prohibited where 1,2-dichloropropane, is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of 1,2-dichloropropane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,2-dichloropropane. Wherever 1,2-dichloropropane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Propylene dichloride must be labeled: "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, CO_2, or foam extinguishers. Water may be ineffective, except to blanket fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Dichloropropanes/Dichloropopenes: Ambient Water Quality Criteria.* Washington, DC

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Dichloropropane,* Report PB-274-73. Cincinnati, OH, pp. 292−294

US Environmental Protection Agency. (April 30, 1980). *1,2-Dichloropopane: Health and Environmental Effects Profile No. 78.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April, 30, 1980). *Dichloropropanes/Dichloropropenes: Health and Environmental Effects Profile No. 79.* Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: 1,2-Dichloropropane.* Trenton, NJ

Dichloropropanols D:0650

Molecular Formula: $C_3H_6Cl_2O$

Common Formula: $C_3H_6OCl_2$

Synonyms: *26545-73-3:* Dichloropropanol; 1,3-Dichloropropanol-2; Glycerin dichlorohydrin

96-23-1: α-Dichlorohydrin; Dichlorohydrin; *sym*-Dichloroisopropyl alcohol; 1,3-Dichloropropanol-2; Dichloro-2-propanol, 1,3-; *sym*-Glycerol dichlorohydrin; Glycerol α,β-dichlorohydrin; U 25,354

616-23-9: 1,2-Dichloro-3-propanol; 1,2-Dichloropropanol-3; 1,3-Dichloro-2-propanol; 2,3-Dichloro-1-propanol; 2,3-Dichloropropanol; Glycerol-α,β-dichlorohydrin

CAS Registry Number: 26545-73-3 (Dichloropropanol); 96-23-1 (Dichloro-2-propanol, 1,3-); 616-23-9 (2,3-Dichloropropanol)

RTECS® Number: UB1400000 (96-23-1); UB1225000 (616-23-9) (2,3-dichloropropan-1-ol)

UN/NA & ERG Number: UN2750 (1,3-Dichloropropanol-2)/153

EC Number: 247-787-9 (dichloropropanol); 202-491-9 [*Annex I Index No.:* 602-064-00-0] (dichloro-2-propanol, 1,3-); 210-470-0 (2,3-dichloropropan-1-ol)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (chlorophenols) Human Limited Evidence, Animal Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1973; DFG: (96-23-1) Category 2 Hazardous Constituent Waste (EPA-RCRA), as dichloropropanols.

California Proposition 65 Chemical (*96-23-1*): Cancer: 10/8/10.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, 1,3-Dichloro-2-propanol.

WGK (German Aquatic Hazard Class): No value assigned.

Description: There are 4 isomers of dichloropropanols 1,3-dichloro-2-propanol (96-23-1), and "dichloropropanols" (26545-73-3) are citations in environmental regulations: $C_3H_6OCl_2$ is a colorless viscous liquid with a chloroform-like odor. Slightly soluble in water. *1,3-Dichloro-2-propanol*: Boiling point = 174°C; Flash point = 74°C; Freezing/Melting point = −4°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water. *2,3-Dichloro-1-propanol*: Boiling point = 182°C. *3,3-Dichloro-1-propanol*: Boiling point = 82−83°C. *1,1-Dichloro-2-propanol*: Boiling point = 146−148°C.

Potential Exposure: It is used as a solvent for hard resins and nitrocellulose, in the manufacture of photographic chemicals and lacquer, as a cement for celluloid, and as a binder of water colors. It occurs in effluents from glycerol and halohydrin production plants.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Dichloro-2-propanol, 1,3-

TEEL-0: 6 ppm

PAC-1: 0.2 ppm

PAC-2: 50 ppm

PAC-3: 50 ppm

DFG MAK: [skin] Carcinogen Category 2.

Harmful Effects and Symptoms

Short Term Exposure: *2,3-dichloro-1-propanol*[52]: Irritation of the eyes, skin, and mucous membranes; dyspnea, coughing, nausea, vomiting, diarrhea, abdominal pain; gastrointestinal hemorrhage; toxic hepatitis; jaundice, hemolytic anemia; decreased urinary output from nephritis and renal failure; somnolence, cerebral hemorrhage; central nervous system depression, and coma. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *1,3-dichloro-2-propanol*[52]*:* Irritation of skin, eyes, and respiratory system; inhalation may cause headache, vertigo, nausea, vomiting; may also cause coma and liver damage.

Long Term Exposure: Causes cancer in animals; may be a potential human carcinogen. May cause liver, kidney, and/or lung damage.

Points of Attack: Central nervous system, liver, kidneys, lungs.

Medical Surveillance: Kidney function tests. Liver function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 1,3-dichloro-2-propanol you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a refrigerator under inert atmosphere away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: 1,3-Dichloropropanol-2 requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine and phosgene, are produced in fire. Use alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling

streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (April 30, 1980). *Dichloropropanol: Health and Environmental Effects Profile No. 80.* Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 1,3-Dichloropropanol*. Trenton, NJ

Dichloropropenes D:0660

Molecular Formula: $C_3H_4Cl_2$

Common Formula: $CHCl{=}CHCH_2Cl$

Synonyms: β-Chloroallyl chloride; 3-Chloroallyl chloride; 3-Chloropropenyl chloride; 1,3-D; 1,3-Dichloro-1-propene; 1,3-Dichloro-2-propene; α,β-Dichloropropylene; 1,3-Dichloropropylene; 1,3-Dicloropropeno (Spanish); 1-Propene, 1,3-dichloro-; Propene, 1,3-dichloro-; Telone; Telone II

CAS Registry Number: 563-58-6 (1,1-); 542-75-6; (*alt*) 8022-76-2 (1,3-); 78-88-6 (2,3-); 26952-23-8 (dichloropropenes); 10061-01-5 (*cis-; Z*); 10061-02-6 (*trans-*)

RTECS® Number: UC8310000

UN/NA & ERG Number: UN2047/129

EC Number: 248-134-0 (dichloropropene); 208-826-5 [*Annex I Index No.:* 602-030-00-5] (*1,3-; 8022-76-2*); 201-153-8 [*Annex I Index No.:* 602-079-00-2] (*2,3-; 78-88-6*); 233-195-8 [*Annex I Index No.:* 602-030-00-5] (*cis-; Z; 10061-01-5*)

Regulatory Authority and Advisory Bodies

Carcinogenicity (542-75-6): IARC (*technical grade*): Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NTP (*technical grade*): 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U084.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (CAS: 542-75-6).

Mexico, drinking water, 0.09 mg/L.

European/International Regulations:

(*1,3-; 542-75-6*): Hazard Symbol: T, N; Risk phrases: R10; R20; R24/25; R36/37/38; R43; R65; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61.

(2,3- 78-88-6): Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; R37/38; R41; R50/53 ; Safety phrases: S2; S9; S16; S23; 226; S36/37/39; S61 (see Appendix 4).

(*cis-isomer; 10061-01-5*) European/International Regulations: Hazard Symbol: T, N; Risk phrases: R10; R20; R24/25; R36/37/38; R43; R65; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61.

(*trans-isomer; 10061-02-6*) Not listed.

WGK (German Aquatic Hazard Class) (*1,3-; 78-88-6*): 3—Highly water polluting.

trans-isomer*:*

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 18.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations (*Z; 10061-01-5*): Hazard Symbol: T, N; Risk phrases: R10; R20; R24/25; R36/37/38; R43; R65; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61.

Description: 1,3-Dichloropropene is a colorless to straw-colored liquid with a sharp, sweet, irritating, chloroform-like odor. Molecular weight = 110.97; Specific gravity (H_2O:1) = 1.21; Boiling point = 107.7°C; 103−110°C (mixed *cis-* and *trans*-isomers); Freezing/Melting point = −83.8°C; Vapor pressure = 29 mmHg at 20°C; Flash point = 35°C. The explosive limits are LEL = 5.3%; UEL = 14.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.2%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. Used as a soil fumigant prior to planting crops, such as cotton, sugar beet, potatoes; used in combinations with dichloropropanes as a soil fumigant. Workers engaged in manufacture, formulation, and application of this soil fumigant and nematocide.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers. May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with strong acids, oxidizers, aluminum or magnesium compounds, aliphatic amines, alkanolamines, alkaline materials, halogens, or corrosives.

Note: Epichlorohydrin may be added as a stabilizer.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 ppm/5 mg/m^3 TWA [skin]; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 1 ppm/4.5 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans (2003).

Protective Action Criteria (PAC)

dichloropropene, 2,3-

TEEL-0: 0.2 ppm

PAC-1: 0.6 ppm

PAC-2: 4 ppm

PAC-3: 75 ppm

DFG MAK (*cis- and trans-isomers*): [skin] danger of skin sensitization; Carcinogen Category 2

Australia: TWA 1 ppm (5 mg/m^3), [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (4.5 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (5 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Norway: TWA 1 ppm (5 mg/m^3), 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: 1 ppm (5 mg/m^3), [skin], carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for 1,3-dichloropropene in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No method listed.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 6060 μg/L on an acute toxicity basis and 244 μg/L on a chronic basis. *To protect saltwater aquatic life:* 790 μg/L on an acute toxicity basis. *To protect human health:* 87.0 μg/L.[6] Russia[35,43] set a MAC of 0.4 mg/L in water bodies used for domestic purposes. Mexico's drinking water criteria is 0.09 mg/L. A no-observed-adverse-effects level (NOAEL) of 3.0 mg/kg/day has been determined by the EPA (see Health Advisory reference below). This results in a drinking water level on a lifetime basis of 0.011 mg/L (11.0 μg/L). Several states have set guidelines for 1,3-dichloropopene in drinking water[61] ranging from 10 μg/L (Connecticut) to 87 μg/L (Arizona and Kansas) to 89 μg/L (Vermont).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Fish Tox = 137.01437000 ppb MATC (LOW).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Exposure can cause headaches, chest pain, and dizziness. High levels can cause you to pass out. Contact can severely burn the eyes and skin, with permanent damage. High exposures can damage the kidneys, liver, and lungs.

Long Term Exposure: There is evidence that 1,3-dichloropropene causes cancer in animals and humans. May damage the kidneys, liver, and lungs. May cause chronic headache and personality changes. Human Tox = 2.86885 ppb CHCL (Chronic Human Carcinogen Level) (HIGH).

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys. *Cancer site:* (in animals) bladder, liver, lung, and stomach.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver function tests, lung function tests, and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton™ gloves, suits; Responder™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,3-dichloropropene you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,3-Dichloropropene must be stored to avoid contact with aluminum or magnesium compounds, substances containing fluorine, chlorine, bromine or iodine, and alkaline or corrosive materials, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Separate outside storage is preferred. Sources of ignition, such as smoking and open flames are prohibited where 1,3-dichloropropene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of 1,3-dichloropropene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,3-dichloropropene. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dichloropropene must be labeled "FLAMMABLE LIQUID." They fall in DOT Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Dichloropropanes/Dichloropropenes: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *1,3-Dichloropropene: Health and Environmental Effects Profile No. 81.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Dichloropropanes/Dichloropropenes: Health and Environmental Effects Profile No. 79*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (August 1987). *Health Advisory: 1,3-Dichloropropene*. Washington, DC: Office of Drinking Water

Sax N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 5, 88−93

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration,*

Reregistration, and Special Review (Rainbow Report). Washington, DC
New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: 1,3-Dichloropropene*. Trenton, NJ

2,2-Dichloropropionic acid D:0670

Molecular Formula: $C_3H_4Cl_2O_2$
Common Formula: CH_3CCl_2COOH
Synonyms: Acido 2,2-dicloropropionico (Spanish); Atlas Lignum (formulation); Basapon; Basapon B; Basapon/Basapon N; Basinex; BH Dalapon; BH Rasinox R (formulation); BH Total (formulation); Crisapon; Dalapon; Dalapon 85; Dalapon aliphatic acid herbicide; Ded-Weed; Destral; Devipon; α,α-Dichloropropionic acid; α-Dichloropropionic acid; Dowpon, Dowpon M; Fydulan (Formulation); Gramevin; Kenapon; Liropon; Proprop (South Africa); Radapon; Revenge; Synchemicals couch and grass killer; Unipon; Volunteered
CAS Registry Number: 75-99-0
RTECS® Number: UF0690000
UN/NA & ERG Number: UN1760/154
EC Number: 200-923-0 [*Annex I Index No.*: 607-162-00-7]
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Safe Drinking Water Act: MCL, 0.2 mg/L; MCLG, 0.2 mg/L.
Reportable Quantity (RQ): 5000 lb (2270 kg).
European/International Regulations: Hazard Symbol: Xi,N; Risk phrases: R38-R41; R52/53; Safety phrases: S2; S26; S39; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: 2,2-Dichloropropionic acid is a colorless liquid with an acrid odor or a white to tan powder below 8°C. The sodium salt, a white powder, is often used. Molecular weight = 142.97; Boiling point = 190°C; Freezing/Melting point = 7.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Highly soluble in water (slowly reactive); solubility = 50%.
Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Those involved in the manufacture, formulation, and application of the herbicide. Used against quack grass, bermuda grass, johnson grass, cattails, rushes, etc.
Incompatibilities: *Metals:* Highly corrosive to aluminum and copper alloys. Reacts slowly in water to form hydrochloric and pyruvic acids.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 1 ppm/6 mg/m^3 TWA.
ACGIH TLV®[1]: 5 mg/m^3 TWA intermittent; not classifiable as a human carcinogen.
No TEEL available.
DFG MAK: No numerical value established. Data may be available; suspended 2004.
Austria: MAK 1 ppm (6 mg/m^3), 1999; Denmark: TWA 1 ppm (6 mg/m^3), 1999; France: VME 1 ppm (6 mg/m^3), 1999; the Netherlands: MAC-TGG 6 mg/m^3, 2003; Switzerland: MAK-W 1 ppm (5 mg/m^3), 1999. Russia[35,43] set a MAC of 10 mg/m^3 in work-place air and a value of 0.03 mg/m^3 for ambient air in residential areas.[35]
Determination in Air: No method available.
Permissible Concentration in Water: The no-observed-adverse-effects-level (NOAEL) for the acid is 8 mg/kg/day according to the EPA Health Advisory. This gives a lifetime drinking water equivalent level of 2.8 mg/L.
Determination in Water: By gas chromatography. See Health Advisory referenced below for details.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: 2,2-Dichloropropionic acid is a corrosive chemical and can cause irritation and burn the skin and eyes, causing permanent damage. Exposure may cause symptoms of throat pain, loss of appetite, nausea and sweating, lassitude (weakness, exhaustion), diarrhea, vomiting, slowing of pulse, central nervous system depressant/depression. 2,2-Dichloropropionic acid can affect you when breathed in. Exposure can irritate the upper respiratory tract. 2,2-Dichloropropionic acid may cause a skin allergy. If allergy develops, very low future exposures can cause itching and a skin rash.
Long Term Exposure: May cause liver and kidney damage. May cause skin allergy.
Points of Attack: Eyes, skin, respiratory system, gastrointestinal tract, central nervous system.
Medical Surveillance: If overexposure or illness is suspected, consider lung function tests. Kidney and liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.
Personal Protective Methods: Wear acid-resistant protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquids or dust-proof goggles and face shield when working with powders or dusts unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals and moisture.

Shipping: Acids, liquid, n.o.s. must carry a "CORROSIVE" label. They fall in DOT Hazard Class 8 and Packing Group II.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Powder: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit with efficient gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 2, 74−77

US Environmental Protection Agency. (August 1987). *Health Advisory: Dalapon*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: 2,2-Dichloropropionic Acid*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC.

Dichlorotetrafluoro-ethane D:0680

Molecular Formula: $C_2Cl_2F_4$
Common Formula: $F_2ClCCClF_2$
Synonyms: Arcton 114; Arcton 33; CFC-114; Cryofluoran; Cryofluorane; *sym*-Dichlorotetrafluoroethane; 1,2-Dichloro-1,1,2,2-tetrafluoroethane; *sim*-Diclorotetrafluoetano (Spanish); Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-; Ethane, 1,2-dichlorotetrafluoro-; F 114; FC 114; Fluorane 114;

Fluorocarbon 114; Freon 114; Frigen 114; Frigiderm; Genetron 114; Genetron 316; Halocarbon 114; Halon 242; Ledon 114; Propellant 114; R 114; 1,1,2,2-Tetrafluoro-1,2-dichloroethane; Ucon 114

CAS Registry Number: 76-14-2; 1320-37-2 (1,2-dichlorotetrafluoroethane)

RTECS® Number: KI1101000

UN/NA & ERG Number: UN1958/126

EC Number: 200-937-7 (CAS: 76-14-2); 215-300-9 (CAS: 1320-37-2)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 1.0.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (CAS: 76-14-2).

Description: CFC 114 is a colorless gas with a faint, ether-like odor at high concentrations. A liquid below 3.3°C/38°F. Shipped as a liquefied compressed gas. Molecular weight = 170.92; Boiling point = 3°C; Freezing/Melting point = −94°C; Vapor pressure = 1.9 atm at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.1%.

Potential Exposure: This material is used as a refrigerant and also as a propellant gas.

Incompatibilities: Keep away from welding and hot metals; decomposes, forming hydrogen chloride and hydrogen fluoride. Reacts with acids and acid fumes forming highly toxic chloride gases. Keep away from chemically active metals: sodium, potassium, calcium, powdered aluminum, zinc, and magnesium. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.99 mg/m^3 at 25°C & 1 atm.

OSHA PEL 1000 ppm/7000 mg/m^3 TWA.

NIOSH REL: 1000 ppm/7000 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/6990 mg/m^3 TWA, not classifiable as a human carcinogen.

76-14-2

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 1500 ppm

PAC-2: 10,000 ppm

PAC-3: 15,000 ppm

DFG MAK: 1000 ppm/7100 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group D.

NIOSH IDLH: 15,000 ppm.

Australia: TWA 1000 ppm (7000 mg/m^3), 1993; Austria: MAK 1000 ppm (7000 mg/m^3), 1999; Belgium: TWA 1000 ppm (6990 mg/m^3), 1993; Denmark: TWA 500 ppm (3500 mg/m^3), 1999; Finland: TWA 1000 ppm (7000 mg/m^3); STEL 1250 ppm (8750 mg/m^3), 1999; France: VME 1000 ppm (7000 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; the Netherlands: MAC-TGG 7130 mg/m^3, 2003; Norway: TWA 500 ppm (3500 mg/m^3), 1999; the Philippines: TWA 1000 ppm (7000 mg/m^3), 1993; Poland: MAC (TWA) 5000 mg/m^3, MAC (STEL) 8750 mg/m^3, 1999; Russia: STEL 3000 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (7000 mg/m^3), 1999; Turkey: TWA 1000 ppm (7000 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (7110 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for R-114 in ambient air[60] ranging from 70 mg/m^3 (North Dakota) to 115 mg/m^3 (Virginia) to 140 mg/m^3 (Connecticut) to 167 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1018.

Determination in Water: No method cited. Octanol−water coefficient: Log K_{ow} = 2.8.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Dichlorotetrafluoro-ethane can affect you when breathed in. Irritates the eyes and upper respiratory tract. Inhalation of vapors can cause you to become dizzy and lightheaded, drowsy, and pass out. It can cause the heart to beat irregularly or stop, which can cause death. Contact with the liquid can cause frostbite, burning of eyes and skin.

Long Term Exposure: Can irritate the lungs and cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Respiratory system, cardiovascular system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24 h EKG to look for irregular heart rhythms).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid, wear gas-proof goggles and face shield when working with the gas unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10,000 ppm:* Sa (APF = 10) (any supplied-air respirator). *15,000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with CFC 114 you should be trained on its proper handling and storage. Dichlorotetrafluoro-ethane must be stored to avoid contact with acids, acid fumes, chemically active metals, such as sodium, potassium, calcium, powdered aluminum, zinc, and magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This chemical requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2; there is no Packing Group.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If the liquid is spilled or leaked, allow it to vaporize. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichlorotetrafluoro-ethane is a nonflammable liquid or gas. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire, including hydrogen chloride, phosgene, and hydrogen fluoride. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with combustible fuel. Use flue gas scrubber.[22]

Reference

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: Dichlorotetrafluoroethane*. Trenton, NJ

Dichlorvos D:0690

Molecular Formula: $C_4H_7Cl_2O_4P$

Synonyms: Apavap; Astrobot; Atgard; Atgard V; Bay 19149; Bayer 19149; Benfos; Bibesol; Brevinyl; Brevinyl E 50; Canogard; Cekusan; Chlorvinphos; Cyanophos; Cypona; DDVF; DDVP (Insecticide); Dedevap; Deriban; Derribante; DES; Devikol; Dichlofos; Dichlorman; 2,2-Dichloroethenol dimethyl phosphate; 2,2-Dichloroethenyl dimethyl phosphate; 2,2-Dichlorovinyl dimethyl phosphate; Dichlorovos; (2,2-Dichlorvinyl)-dimethyl-phosphat (German); *O*-(2,2-Dichlorvinyl)*O,O*-dimethylphosphat (German); Dimethyl 2,2-dichloroethenyl phosphate; *O,O*-Dimethyl 2,2-dichlorovinyl phosphate; Dimethyl 2,2-dichlorovinyl phosphate; Dimethyl dichlorovinyl phosphate; Divipan; Dquigard; Duo-Kill; Duravos; ENT 20,738; Equigard; Equigel; Estrosel; Estrosol; Ethenol, 2,2-dichloro-, dimethyl phosphate; Fecama; Fekama; Fly-Die; Fly fighter; Herkal; Insectigas D; Krecalvin; Lindan; Mafu; Marvex; Mopari; NCI-C00113; Nefrafos; Nerkol; Nogos; Nogos 50; Nogos G; No-Pest; No-Pest Strip; Novotox; NSC-6738; Nuva; Nuvan; Nuvan 100EC; Nuvan 7; OKO; OMS 14; Panaplate; Phosphate de dimethyle et de 2,2-dichlorovinyle (French); Phosphoric acid, 2,2-dichloroethenyl dimethyl ester; Phosphoric acid, 2-dichloroethenyl dimethyl ester; Phosphoric acid, 2,2-dichlorovinyl dimethyl ester; Phosvit; SD 1750; Szklarniak; Tap 9VP; Task; Task Tabs; Tenac; Tetravos; Unifos (Pesticide); Unitox; Vapona; Vapona, insecticide; Vaponite; Verdican; Verdipor; Vinylofos; Vinylophos; Winylophos

CAS Registry Number: 62-73-7; *(alt.)* 8023-22-1; *(alt.)* 8072-21-7; *(alt.)* 8072-39-7; *(alt.)* 11095-17-3; *(alt.)* 11096-21-2; *(alt.)* 12772-40-6; *(alt.)* 55819-32-4; *(alt.)* 62139-95-1; *(alt.)* 95828-55-0; *(alt.)* 116788-91-1

RTECS® Number: TC0350000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-547-7 [*Annex I Index No.:* 015-019-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1991 NTP: Carcinogenesis Studies (gavage); some evidence: rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat.

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; *E. coli* polA without S9; Positive: Histidine reversion—Ames test; TRP reversion; Positive: *S. cerevisiae* gene conversion; Negative: *In vivo* cytogenetics—nonhuman bone marrow; Negative: Cytogenetics—male germ cell; Host-mediated assay; Negative: Mammalian micronucleus; *In vitro* SCE—human lymphocytes; Negative: *In vitro* SCE—human; *D. melanogaster* sex-linked lethal; Inconclusive: Carcinogenicity—mouse/rat; Rodent dominant lethal; Inconclusive: Sperm morphology—mouse.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

California Proposition 65 Chemical: Cancer 1/1/89.

European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R 24/25; R26; R43; R50; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Dichlorvos is a colorless to amber liquid with a mild aromatic odor. Molecular weight = 220.98; Boiling point = 140°C under 20 mmHg at 20°C; Flash point ≥ 79°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Organometallic, Mutagen; Reproductive Effector. Those involved in manufacture, formulation, and application of this fumigant insecticide in household, public health, and agricultural uses. Used as an insecticide and as an anthelmintic for swine and dogs.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Corrosive to iron, mild steel, some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.04 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 mg/m^3 TWA [skin].

NIOSH REL: 1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.9 mg/m^3 TWA measured as inhalable fraction and vapor; [skin, sensitization]; not classifiable as a human carcinogen; BEI$_A$ issued; Acetylcholinesterase inhibiting pesticides.

NIOSH IDLH: 100 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: 0.11 ppm/1 mg/m^3 TWA; Peak Limitation Category II(2) [skin], Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 ppm (1 mg/m^3), 1993; Australia: TWA 0.1 ppm (1 mg/m^3), [skin], 1993; Austria: MAK 0.1 ppm (1 mg/m^3), [skin], 1999; Belgium: TWA 01 ppm (0.9 mg/m^3), [skin], 1993; Denmark: TWA 0.1 ppm (1 mg/m^3), [skin], 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3, [skin], 1999; France: VME 0.1 ppm (1 mg/m^3), [skin], 1999; India: TWA 0.1 ppm (1 mg/m^3), [skin], 1993; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003;

Norway: TWA 0.1 ppm (1 mg/m^3), 1999; the Philippines: TWA 1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3; STEL 3 mg/m^3, 1999; Russia: STEL 0.2 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.1 ppm (1 mg/m^3), [skin], 1999; United Kingdom: TWA 0.1 ppm (0.92 mg/m^3); STEL 0.3 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH P&CAM Method #295 (II-5) or OSHA Analytical Method 62.

Permissible Concentration in Water: Russia set a MAC of 1.0 mg/L in water bodies used for domestic purposes and in water for fishing of zero.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 1.47.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Symptoms of exposure include sweating, twitching, contracted pupils, respiratory distress (tightness in the chest and wheezing), salivation (drooling), lacrimation (tearing), nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation and urination, slurred speech, coma, apnea (cessation of breathing), and death. Dichlorvos is a very toxic compound with a probable lethal oral dose in humans between 50 and 500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150-lb) person. However, brief exposure (30−60 min) to vapor concentrations as high as 6.9 mg/L did not result in clinical signs or depressed serum cholinesterase levels. Toxic changes are typical of organophosphate insecticide poisoning with progression to respiratory distress, respiratory paralysis, and death if there is no clinical intervention.

Short Term Exposure: Dichlorvos irritates the eyes and skin. Symptoms include miosis, aching eyes, rhinorrhea (discharge of thin nasal mucous), headache, chest tightness, wheezing, laryngeal spasm, salivation, cyanosis, anorexia, nausea, vomiting, diarrhea, sweating, muscle fasiculation, paralysis, giddiness, ataxia, convulsions, low blood pressure, cardiac irregular/irregularities. The substance may cause effects on the central nervous system. Cholinesterase inhibitor. High levels of exposure may result in death.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and dermatitis. Cholinesterase inhibitor; cumulative effect is possible: see "Short Term Exposure." This substance may be carcinogenic to humans; it has been shown to cause cancer of the pancreas in animals. There is limited evidence that Dichlorvos is a teratogen in animals, and may cause birth defects or damage the fetus in humans.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, central nervous system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. NIOSH lists the following tests: blood serum; cholinesterase: whole blood (chemical/metabolite); cholinesterase: blood plasma, red blood cells/count; cholinesterase: blood serum, red blood cells/count; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h following overexposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 10 mg/*m*^{3}: Sa (APF = 10) (any supplied-air respirator). *25 mg/m*^{3}: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 mg/m*^{3}: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m*^{3}: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dichlorvos you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; strong alkalis. Dichlorvos will attack some forms of mild iron, plastics, rubber, and coatings.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a "POISON, FLAMMABLE LIQUID" label. Dichlorvos falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leaks if you can do it without risk. Reduce vapors with water spray. Take up *small spills* with sand or other noncombustible absorbent material for later disposal in canisters. Dike *large spills* far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen chloride and phosphoric acid, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Use self-contained breathing apparatus with a full face-piece operated on pressure-demand or other positive-pressure mode. Prevent skin contact with protective clothing. Isolate area and deny entry. Fight fire from maximum distance. Dike fire control water for future disposal. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Fifty percent hydrolysis is obtained in pure water in 25 min at 70°C and in 61.5 days at 20°C. A buffered solution yields 50% hydrolysis (37.5°C) in 301 min at pH 8, 462 min at pH 7, 620 min at pH 5.4. Hydrolysis yields no toxic residues. Incineration in a furnace equipped with an afterburner and alkaline scrubber is recommended as is alkaline hydrolysis followed by soil burial.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (August 1976). *Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates*, Report EPA-560/2076-007. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 57−59

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dichlorvos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Dichlorvos*. Trenton, NJ

Dicofol D:0700

Molecular Formula: $C_{14}H_9Cl_5$

Synonyms: Acarin; Benzenemethanol, 4-chloro-a(-4-chlorophenyl)-α-(trichloromethyl)-; Benzhydrol, 4,4′-dichloro-α-(trichloromethyl)-; 1,1-Bis(*p*-chlorophenyl)-2,2,2-trichloroethanol; 1,1-Bis(4-chlorophenyl)-2,2,2-trichloroethanol; 4-Chloro-α-(4-chlorophenyl)-α-(trichloromethyl) benzene methanol; CPCA; Decofol; Dichlorokelthane; Di(*p*-chlorophenyl) trichloromethyl carbinol; 4,4′-Dichloro-α-(trichloromethyl)benzhydrol; DTMC; ENT 23,648; Ethanol, 2,2,2-trichloro-1,1-bis(4-chlorophenyl)-; Fumite dicofol; FW 293; Keltane; *p,p*′-Kelthane; Kelthane; Kelthane A; Kelthanethanol; Milbol; Mitigan; NCI-C00486; 2,2,2-Trichloro-1,1-bis(*p*-chlorophenyl)ethanol; 2,2,2-Trichloro-1,1-bis(4-chlorophenyl)ethanol; 2,2,2-Trichloro-1,1-di (4-chlorophenyl)ethanol

CAS Registry Number: 115-32-2

RTECS® Number: DC8400000

UN/NA & ERG Number: UN2761/151

EC Number: 204-082-0 [*Annex I Index No.:* 603-044-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat; IARC: Human, No Adequate Data, 1983; Animal, Limited Evidence, 1983, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R21/22; R38; R43; R50/53; Safety phrases: S2; S36/37; 60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dicofol is a white or brown waxy solid. Molecular weight = 370.48; Flash point = 120°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those involved in manufacture, formulation and application of this organochlorine pesticide. Used as acaricide (miticide) in agricultural and nonagricultural applications.

Incompatibilities: Incompatible with alkaline pesticides, strong acids, acid fumes, aliphatic amines, isocyanates, and steel.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Dicofol can be absorbed through the skin, thereby increasing exposure. It irritates the skin and the respiratory tract. Exposure can cause headache, nausea, vomiting, and poor appetite. Dicofol may affect the central nervous system causing numbness and weakness in the hands and feet, muscle twitching, seizures, unconsciousness, and death.

Long Term Exposure: May affect the liver and kidneys. May cause personality changes with depression, anxiety, and irritability. May decrease fertility in females. Prolonged or repeated skin contact may cause dermatitis. There is limited evidence that Dicofol causes liver cancer in animals.

Points of Attack: Skin, nervous system, liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Dermatological examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. For liquid solutions containing Dicofol wear indirect-vent, impact, and splash-resistant goggles. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dicofol you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline pesticides, strong acids, acid fumes, and steel. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Organochlorine pesticides, solid, toxic, n.o.s. require a “POISONOUS/TOXIC MATERIALS” label.

They fall in DOT Hazard Class 6.1 and Dicofol in Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Dicofol*. Trenton NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Dicrotophos D:0710

Molecular Formula: $C_8H_{16}NO_5P$

Synonyms: Bidirl; Bidrin; Bidrin (Shell); Bidrin-R; C-709; C-709 (Ciba-Geigy); Carbicrin; Carbicron; Carbomicron; Ciba 709; Crotonamide, 3-hydroxy-*N*,*N*-dimethyl-, *cis*-, dimethyl phosphate; Crotonamide, 3-hydroxy-*N*,*N*-dimethyl-, dimethylphosphate, (*E*)-; Crotonamide, 3-hydroxy-*N*,*N*-dimethyl-, dimethylphosphate, *cis*-; Diapadrin; Dicroptophos; Didrin; 3-(Dimethoxyphosphinyloxy)-*N*,*N*-dimethyl[e]crotonamide; 3-(Dimethoxyphosphinyloxy)-*N*,*N*-dimethyl-*cis*-crotonamide; 3-(Dimethoxyphosphinyloxy)-*N*,*N*-dimethylisocrotonamide; 3-(Dimethylamino)-1-methyl-3-oxo-1-propenyl dimethyl phosphate; (*E*)-2-Dimethylcarbamoyl-1-methylvinyl dimethylphosphate; *cis*-2-Dimethylcarbamoyl-1-methylvinyl dimethylphosphate; *O,O*-Dimethyl-*O*-(2-dimethyl-carbamoyl-1-methylvinyl)phosphat (German); *O,O*-Dimethyl *O*-(1,4-dimethyl-3-oxo-4-azapent-1-enyl) phosphate; *O,O*-Dimethyl *O*-(*N*,*N*-dimethylcarbamoyl-1-methylvinyl) phosphate; Dimethyl phosphate ester with 3-hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide; Dimethyl phosphate of 3-hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide; Ektafos; Ektofos; ENT 24,482; 3-Hydroxy-*N*,*N*-dimethyl-(*E*)-crotonamide dimethyl phosphate; 3-Hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide dimethyl phosphate; 3-Hydroxydimethyl crotonamide dimethyl phosphate; Karbicron; Phosphatede dimethyle et de 2-dimethylcarbamoyl 1-methyl vinyle (French); Phosphoric acid, 3-(dimethylamino)-1-methyl-3-oxo-1-propenyl dimethyl ester, (*E*)-; Phosphoric acid, dimethyl ester, ester with (*E*)-3-hydroxy-*N*,*N*-dimethylcrotonamide; Phosphoric acid, dimethyl ester, ester with *cis*-3-hydroxy-*N*,*N*-dimethylcrotonamide; SD 3562; Shell SD-3562

CAS Registry Number: 141-66-2

RTECS® Number: TC3850000

UN/NA & ERG Number: UN3018 (organophosphorus pesticides, liquid, toxic)/152

EC Number:205-494-3 [*Annex I Index No.:* 015-073-00-4]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Supported.

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion.

Banned or Severely Restricted (Germany and Malaysia) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dicrotophos is an amber liquid with a mild ester odor. Molecular weight = 237.22; Boiling point = 400°C (Decomposes below boiling point at 75°C after storage for 31 days); Flash point ≥94°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. Those involved in the manufacture, formulation and application of this organophosphate. Used to control the coffee borer and certain economically important pests of cotton.

Incompatibilities: Attacks some metals: Corrosive to cast iron, mild steel; brass, and stainless steel. Decomposes after prolonged storage but is stable when stored in glass or polyethylene containers with temperatures up to 40°C. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.70 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.25 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI: methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.9 mg/m^3

PAC-3: 40 mg/m^3

Australia: TWA 0.25 mg/m^3, [skin], 1993; Belgium: TWA 0.25 mg/m^3, [skin], 1993; Denmark: TWA 0.25 mg/m^3, [skin], 1999; Finland: TWA 0.25 mg/m^3, 1999; France: VME 0.25 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.25 mg/m^3, [skin], 2003; Switzerland: MAK-W 0.25 mg/m^3, [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for dicrotophos in ambient air[60] ranging from 2.5 μg/m^3 (North Dakota) to 4.0 μg/m^3 (Virginia) to 5.0 μg/m^3 (Connecticut) to 6.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Dicrotophos may affect the nervous system, causing convulsions, respiratory failure. Dicrotophos is a cholinesterase inhibitor which can penetrate the skin. Effects may be cumulative. It is extremely toxic. Probable human oral lethal dose is 5−50 mg/kg, 7 drops to 1 teaspoonful for a 70-kg (150-lb) person. Closely related in toxicity to azodrin. Acute exposure to dicrotophos may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. The effects may be delayed.

Long Term Exposure: Dicrotophos is a cholinesterase inhibitor; cumulative effect is possible. May damage the nervous system causing numbness, "pins and needles" sensation, and/or weakness of the hands and feet. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended; effect may be delayed.

Note to physician: 1,1′-Trimethylenebis(4-formylpyridinium bromide) dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof

chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, metals, strong bases, and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove all ignition sources. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Poisonous gases, including nitrogen oxides, phosphorus oxides, carbon monoxide, are produced in fire. Fire and runoff from fire control water may produce irritating or poisonous gases. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dicrotophos decomposes after 7 days at 90°C and 31 days at 75°C. Hydrolysis is 50% complete in aqueous solutions at 38°C after 50 days at pH 9.1 (100 days are required at pH 1.1). Alkaline hydrolysis (NaOH) yields $(CH_3)_2NH$. Incineration is also recommended as a disposal method.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 49−54

US Environmental Protection Agency. (October 1998). *Chemical Hazard Information Profile: Dicrotophos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Dicyclohexylamine D:0720

Molecular Formula: $C_{12}H_{23}N$

Common Formula: $C_6H_{11}{-}NH{-}C_6H_{11}$

Synonyms: *n*-Cyclohexylcyclohexanamine; DCHA; Dicha; Di-Cha; Dodecahydrodiphenylamine

CAS Registry Number: 101-83-7

RTECS® Number: HY4025000

UN/NA & ERG Number: UN2565/153

EC Number: 202-980-7 [*Annex I Index No.:* 612-066-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, No Adequate Data, 1980; Animal, Limited Evidence, 1980, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R22; R34; R50/53; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dicyclohexylamine is a combustible, colorless liquid with a faint amine odor. Molecular weight = 181.36; Boiling point = 256°C; Flash point ≥99°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Dicyclohexylamine salts of fatty acids and sulfuric acid have soap and detergent properties useful to the printing and textile industries. Metal complexes of Di-Cha are used as catalysts in the paint, varnish, and ink industries. Several vapor-phase corrosion inhibitors are solid Di-Cha derivatives. These compounds are slightly volatile at normal temperatures and are used to protect packaged or stored ferrous metals from atmospheric corrosion. Dicyclohexylamine is also used for a number of other purposes: plasticizers, insecticidal formulations; antioxidant in lubricating oils, fuels, and rubber; and as an extractant.

Incompatibilities: Contact with strong oxidizers can cause fire and explosion hazard.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] No numerical value established.

Russia: STEL1 mg/m^3, [skin], 1993. Russia[43] set a MAC of 0.008 mg/m^3 for ambient air in residential areas on a momentary basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the skin and eyes; may cause burns and permanent damage. Dicyclohexylamine is somewhat more toxic that cyclohexylamine. Poisoning symptoms and death appear earlier in rabbits injected with 0.5 g/kg Di-Cha (as opposed to Cha). Doses of 0.25 g/kg are just sublethal, causing convulsions and reversible paralysis. Dicyclohexylamine is a skin irritant. LD_{50} = (oral-rat) 373 mg/kg (moderately toxic). Symptoms of exposure include severe irritation of the eyes, skin, and mucous membranes. Also, nausea, vomiting, weakness, and irritation of the gastrointestinal tract.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at lest 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Di-Cha you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Protection from air is recommended for long-term storage.

Shipping: Dicyclohexylamine requires a "CORROSIVE" label. If falls in DOT Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or

federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

US Environmental Protection Agency. (October 21, 1977). *Chemical Hazard Information Profile: Cyclohexylamine*. Washington, DC

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Dicyclohexylamine*. Trenton, NJ

Dicyclohexylamine nitrite D:0730

Molecular Formula: $C_{12}H_{24}N_2O_2$

Common Formula: $C_6H_{11}-NH-C_6H_{11}HNO_2$

Synonyms: Dechan; Diana; Dichan; Di-Chan; Dicynit; Dicyclohexylaminonitrite; Dicyclohexylammonium nitrite; Dodecahydrophenylamine nitrite; Leukorrosin C

CAS Registry Number: 3129-91-7

RTECS® Number: HY4200000

UN/NA & ERG Number: UN2687/133

EC Number: 221-515-9 [*Annex I Index No.*: 007-009-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xn; Risk phrases R20/22; Safety phrases: S2; S15; S41 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dicyclohexylamine nitrite is a flammable white powder which has some volatility at room temperature and higher. Molecular weight = 228.38; Melting point = 181°C; Flash point = 185°C. Partly soluble in water.

Potential Exposure: It is used as a vapor-phase corrosion inhibitor whereby it vaporizes either from the solid state or from solution, and offers protection against atmospheric rusting. Wrapping paper, plastic wraps, and other materials may be impregnated with dichan to protect metal parts during packaging and storage.

Incompatibilities: Highly flammable and a strong oxidizer. Contact with reducing materials (nitrides, hydrides, sulfides, etc.) or easily oxidized materials may cause fire and explosion hazard.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: No numerical value established. Data may be available.

Russia[43] set a MAC of 0.5 mg/m^3 in work-place air and a MAC of 0.02 mg/m^3 in ambient air in residential areas.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: $LD_{50} =$ (oral-rat) 284 mg/kg (moderately toxic). It decreases blood pressure.

Long Term Exposure: Prolonged exposure to dicyclohexylamine nitrite vapor is reported to lead to changes in the CNS, erythrocytes, and methemoglobinemia; and to disturb the functional state of the liver and kidneys of human workers.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: Blood pressure. Complete blood count. Liver and kidney function tests.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere for long-term storage.

Shipping: Dicyclohexylammonium nitrite requires a "FLAMMABLE SOLID" label. It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and nitrous acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

Reference

US Environmental Protection Agency. (October 21, 1977). *Chemical Hazard Information Profile: Cyclohexylamine*. Washington, DC

N,N′-Dicyclohexylcarbodiimide

D:0735

Molecular Formula: $C_{13}H_{22}N_2$

Synonyms: Bis(cyclohexyl)carbodiimide; Carbodicyclohexylimide; Carbodiimide, 1,3-dicyclohexylcarbodiimide; Cyclohexanamine, *N,N′*-methanetetraylbis-; DCC; DCCD; DCCI; Dicyclocarbodiimide; Dicyclohexylcarbodiimide; *N,N′*-Methanetetraylbiscyclohexanamine

CAS Registry Number: 538-75-0

RTECS Number: FF2160000

UN/NA & ERG Number: UN2928 (toxic solid, corrosive, organic, n.o.s)/154

EC Number: 208-704-1 [*Annex I Index No.:* 615-019-00-5]

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory.

SARA 311/312 codes: Acute.

Canada: WHMIS Classification D1A; D2B; on DSL list.

European/International Regulations: Hazard Symbol: T, Xn, Xi; Risk phrases: R22; R24; R41; R43; Safety phrases: S1/2; S24; S26; S37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *N,N′*-Dicyclohexylcarbodiimide (DCC) is a white crystalline solid. Odor is sweet and heavy. Molecular weight = 206.33; Freezing/Melting point = 34-35°C; Boiling Point = 122−124°C at 6.0 mmHg; Flash point = 110°C to >113°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3; Flammability 1; Reactivity 1₩. Insoluble in water; water reactive.

Potential Exposure: Laboratory reagent.

Incompatibilities: Dust may for explosive mixture with air. Reacts with steam and water. *N,N′*-Dicyclohexylcarbodiimide is an imide: contact with strong oxidizers may cause fire and explosions. Incompatible with acids, strong bases, strong reducing agents (may form flammable gasses), azo and diazo compounds (may form toxic gases), chlorinated hydrocarbons, nitro compounds. Contact with mixture of acetic acid + dinitrogen trioxide may cause explosion. The combustion of amide compounds generates nitrogen oxides (NOx). In the presence of moisture, may attack metals and plastics.

Permissible Exposure Limits in Air:
Protective Action Criteria (PAC)
TEEL-0: 0.0035 mg/m^3
PAC-1: 0.01 mg/m^3
PAC-2: 0.06 mg/m^3
PAC-3: 100 mg/m^3

Determination in Air: No NIOSH or OSHA method available.

Permissible Concentration in Water: No data available.

Determination in Water: Data not available.

Routes of Entry: Ingestion, inhalation, or absorbed through the skin. Causes burns by all exposure routes.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Highly toxic by inhalation. Severe overexposure can result in death. Harmful if inhaled, swallowed, or absorbed through skin. May cause allergic skin reaction and allergic reaction to the respiratory tract. Depending on the intensity and duration of exposure, this chemical can cause severe destruction of tissues of the mucous membranes and upper respiratory tract. Causes burns to any internal or external area of contact. Symptoms of exposure to this compound may include severe skin and eye irritation, irritation of the mucous membranes and upper respiratory tract, burning feeling, laryngitis, coughing and wheezing, shortness of breath, headache, nausea, and vomiting. Inhalation of this chemical can be fatal, resulting from inflammation, bronchial pneumonia, edema of the larynx, bronchi, and pulmonary tract. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. LD_{50} = (oral-rat) 400 mg/kg.

Long Term Exposure: The chronic properties of this material have not been fully investigated. May cause skin and respiratory allergies. Repeated exposure to a highly toxic material may result in general deterioration of health and possible organ damage.

Points of Attack: Skin, respiratory tract.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin or respiratory tract allergy.

First Aid: *Eyes*: Check the victim for contact lenses and remove. Flush victim's eyes with water or normal saline solution for 20−30 min, lifting lower and upper eyelids occasionally. Remove contaminated clothing and shoes. Get medical attention immediately. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water and wash for at least 15 min. Remove and isolate all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician. Transport the victim to a hospital for treatment. *Inhalation*: Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. *Ingestion*: *Do not induce vomiting*. If the victim is conscious and not convulsing, give large amount of water to dilute the chemical. Never give anything by mouth to an unconscious person. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician. In all cases get medical attention immediately. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body.

Personal Protective Methods: Maintain eyewash fountain and quick-drench facilities in work area. Unless full facepiece respiratory protection is worn, wear splash-proof protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Wear Tyvek-type disposable protective clothing or other impervious protective clothing, gloves, lab coat, apron, or coveralls, as appropriate, to prevent skin contact. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA- or European Standard EN 149-approved respirator; or an approved half-face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO_2) with a dust/mist filter. Splash-proof safety goggles should be worn while handling this chemical. Alternatively, a full-face respirator, equipped as above, may be used to provide simultaneous eye and respiratory protection. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Keep DCC in a tightly closed container in a cool, dry, ventilated area away from sources of incompatible materials, heat, direct sunlight, moisture, or ignition; best stored under an inert atmosphere at refrigerated temperatures. Containers of DCC may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product. Shelf life when stored under ideal conditions: >4 years.

Shipping: This material requires a label of "TOXIC SOLID." Hazard Class 6.1, 8. Packing Group II. May be shipped in 100-g packages.

Spill Handling: Wear appropriate personal protective equipment. Remove all sources of ignition. Ventilate area of leak or spill. *Small spills and leakage*: If a spill occurs while you are handling this chemical, *remove all sources of ignition.* Clean up spills in a manner that does not disperse dust into the air. Reduce airborne dust and prevent scattering by moistening the solid spill material with 60−70% ethanol and using nonsparking tools and equipment, transfer the dampened material to a suitable container. Use absorbent paper dampened with 60−70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: In the event of a fire, wear full protective clothing and use a NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus (SCBA) with full face-piece operated in the pressure-demand or other positive-pressure mode. Burning may produce carbon monoxide, carbon dioxide, nitrogen oxides. Fires involving this material can be controlled with a dry chemical, carbon dioxide, or Halon extinguisher. When heated to decomposition it emits toxic fumes of carbon monoxide, carbon dioxide, and Nox.

Disposal Method Suggested: Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use, or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state, and local requirements.

Dicyclopentadiene D:0740

Molecular Formula: $C_{10}H_{12}$

Synonyms: Bicyclopentadiene; Biscyclopentadiene; 1,3-Cyclopentadiene, dimer; DCPD; Diciclopentadieno (Spanish); 4,7-Methano-1H-indene; 4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydro-; 3a,4,7,7a-Tetrahydro-4,7-methanoindene

CAS Registry Number: 77-73-6

RTECS® Number: PC1050000

UN/NA & ERG Number: UN2048/130

EC Number: 201-052-9 [*Annex I Index No.:* 601-044-00-9]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn, N; R11; R20/22; R36/37/38; R51/53; Safety phrases: S2; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Cyclopentadiene is a crystalline solid or a liquid (above 32°C) with a disagreeable, camphor-like odor. The odor threshold is 0.011 (detectable); 0.020 ppm (recognizable). Molecular weight = 132.22; Boiling point = decomposes at 172.2°C; Freezing/Melting point = 32°C; Vapor pressure = 1.4 mmHg at 20°C; Flash point = 32°C; Autoignition temperature = 503°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 1. Explosive limits: LEL = 0.8; UEL = 6.3. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Hormone, Primary Irritant. This compound is used in the manufacture of cyclopentadiene as a pesticide intermediate; in the production of ferrocene compounds; in paints, varnishes, and resin manufacture; in production of elastomers, resin systems, and polymers.

Incompatibilities: Forms explosive mixture with air above flash point. Depolymerizes at boiling point and forms two molecules of cyclopentadiene unless inhibited and maintained under inert atmosphere to prevent polymerization. Violent reaction with strong oxidizers, strong acids, strong bases. Can accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.41 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 5 ppm/30 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/27 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.01 ppm

PAC-1: 0.01 ppm

PAC-2: 5 ppm

PAC-3: 75 ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.5 ppm/2.7 mg/m^3 TWA; Peak Limitation Category II(1); Pregnancy Risk Group D.

Australia: TWA 5 ppm (30 mg/m^3), 1993; Austria: MAK 0.5 ppm (3 mg/m^3), 1999; Belgium: TWA 5 ppm (27 mg/m^3), 1993; Denmark: TWA 5 ppm (30 mg/m^3), 1999; Finland: TWA 5 ppm (30 mg/m^3); STEL 10 ppm (54 mg/m^3) [skin] 1999; France: VME 5 ppm (30 mg/m^3), 1999; Norway: TWA 5 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 3 mg/m^3, 2003; Switzerland: MAK-W 0.5 ppm (3 mg/m^3), KZG-W 1 ppm (6 mg/m^3), 1999; United Kingdom: TWA 5 ppm (27 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm. Several states have set guidelines or standards for dicyclopentadiene in ambient air[60] ranging from 0.3 mg/m^3 (North Dakota) to 0.5 mg/m^3 (Virginia) to 0.6 mg/m^3 (Connecticut) to 0.714 mg/m^3 (Nevada).

Determination in Air: See OSHA Analytical Method PV-2098.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Dicyclopentadiene irritates the skin and eyes. Human subjects reported an odor threshold at 0.003 ppm, slight eye or throat irritation at 1−5 ppm. May cause headache, loss of balance and coordination, and even convulsions. Increased urinary frequency has been reported in exposed workers.

Long Term Exposure: May affect the liver, kidneys, nervous system, and gastrointestinal tract. May cause lung irritation with possible cough and shortness of breath. Animal experiments produced leukocytosis and kidney lesions.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Lung and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles when working with powders or dusts and splash-proof goggles when working with liquids unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator with a combination cartridge offering protection against organic vapors as well as against dust, fume, and mist. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect dicyclopentadiene, or in the case of a full-face-piece respirator if you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing materials, strong acids, and strong bases. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Dicyclopentadiene must carry a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: *Powders and dusts:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Dicyclopentadiene*. Trenton, NJ

Dieldrin D:0750

Molecular Formula: $C_{12}H_8Cl_6O$

Synonyms: Alvit; Compound 497; Dieldrex; Dieldrina (Spanish); Dieldrine (French); Dieldrite; 2,7: 3,6-Dimethanonaphtha(2,3b)oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,-3,6,6a, 7,7a-octahydro-(1a a,2.b,2a.a,3b,6.b,6aa,7b,7aa); ENT 16,225; HEOD; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-di-methanonaphthalene; Hexachloroepoxyoctahydro-endoexo-dimethanonaphthalene; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7: 3,6-dimethano; 3,4,5,6,9,9-Hexachloro-1a, 2, 2a, 3, 6, 6a, 7, 7a-octahydro-2,7:3,6-dimethanonaphth(2,3-b)oxirene; (1r,4s,4as, 5r,6r,7s,8s,8ar)1,2,3,4,10,10-Hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene; Illoxol; Killgerm dethlac insecticidal laquer; NCI-C00124; Octalox; Oxralox; Panoram; Panoram D-31; Quintox

CAS Registry Number: 60-57-1

RTECS® Number: IO1750000

UN/NA & ERG Number: UN2761/151

EC Number: 200-484-5 [*Annex I Index No.:* 602-049-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, Inadequate Data, 1974; Animal, Limited Evidence, 1974*, not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Bioassay (feed); equivocal evidence: mouse, no evidence: rat, 1978; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA Gene-Tox Program, Positive: V79 cell culture—gene mutation; Negative: Rodent dominant lethal; Host-mediated assay; Negative: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis; Inconclusive: *D. melanogaster* sex-linked lethal.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): P037.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 0.13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Mexico, Drinking Water Criteria, 0.0000007 mg/L.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

California Proposition 65 Chemical: Cancer 7/1/88.

List of Stockholm Convention POPs: Annex A (Elimination).

Regulations: Hazard Symbol: T + , N; Risk phrases: R25; R27; R40; R48/25; R50/53; Safety phrases: S1/2; S21; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Dieldrin is a colorless to light tan solid with a mild chemical odor. The odor threshold in water is 0.04 mg/L. Molecular weight = 380.90; Boiling point = (decomposes); Freezing/Melting point = 176.1°C; Vapor pressure = 8×10^{-7} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Aldrin belongs to the group of cyclodiene insecticides. They are a subgroup of the chlorinated cyclic hydrocarbon insecticides which include DDT, BHC, etc. They were manufactured in the United States by Shell Chemical Co. until the US EPA prohibited their manufacture in 1974 under the Federal Insecticide, Fungicide, and Rodenticide Act. The primary use of the chemicals in the past was for control of corn pests although they were also used by the citrus industry.

Dieldrin's persistence in the environment is due to its extremely low volatility (i.e., a vapor pressure of 1.78×10^{-7} mmHg at 20°C) and low solubility in water (186 μg/L at 25−29°C). In addition, dieldrin is extremely apolar, resulting in a high affinity for fat which accounts for its retention in animal fats, plant waxes, and other such organic matter in the environment. The fat solubility of dieldrin results in the progressive accumulation in the food chain which may result in a concentration in an organism which would exceed the lethal limit for a consumer.

Incompatibilities: Incompatible with strong acids: concentrated mineral acids; acid catalysts; phenols; strong oxidizers; active metals like sodium, potassium, magnesium, and zinc. Keep away from copper, iron, and their salts.

Permissible Exposure Limits in Air

OSHA PEL: 0.25 mg/m^3 TWA[skin].

NIOSH REL: 0.25 mg/m^3 TWA[skin]; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.25 mg/m^3 TWA measured as inhalable fraction and vapor [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.25 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK: 0.25 mg/m^3, measured as the, inhalable fraction; [skin] Peak Limitation Category II(8).

Australia: TWA 0.25 mg/m^3, [skin], 1993; Austria: MAK 0.25 mg/m^3, [skin], 1999; Belgium: TWA 0.25 mg/m^3, [skin], 1993; Denmark 0.25 mg/m^3, [skin], 1999; Finland: TWA 0.25 mg/m^3; STEL 0.75 mg/m^3, [skin], carcinogen, 1999; France: VME 0.25 mg/m^3, [skin], continuous carcinogen, 1999; India: TWA 0.25 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.25 mg/m^3, [skin], 2003; Norway: TWA 0.25 mg/m^3, 1999; the Philippines: TWA 0.25 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3; STEL 1.5 mg/m^3, 1999; Russia: STEL 0.01 mg/m^3, 1993; Switzerland: MAK-W 0.25 mg/m^3, [skin], 1999; Thailand: TWA 0.25 mg/m^3, 1993; Turkey: TWA 0.25 mg/m^3, [skin], 1993; United Kingdom: TWA 0.25 mg/m^3; STEL 0.75 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for dieldrin in ambient air[60] ranging from 0.035 μg/m^3 (Pennsylvania) to 0.595 μg/m^3 (Kansas) to 2.5 μg/m^3 (North Dakota) to 4.0 μg/m^3 (Virginia) to 5.0 μg/m^3 (Connecticut) to 6.0 μg/m^3 (Nevada).

Determination in Air: Filter; Isooctane; Gas chromatography/Electrochemical detection; NIOSH II(3), Method #S283.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0019 μg/L as a 24-h average, never to exceed 2.5 μg/L. *To protect saltwater aquatic life:* 0.0019 μg/L as a 24-h average never to exceed 0.71 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 0.71 ng/L (0.00071 μg/L).[6]

Mexico[35] has set a MAC value of 0.0000007 mg/L for dieldrin in water used for drinking water supply; of 0.003 mg/L in estuaries and 0.03 μg/L in estuaries. WHO[35] has set a limit of 0.03 μg/L in drinking water. A NOAEL (no-observed-adverse-effects-level) of 0.005 mg/kg/day has been calculated by EPA which results in the calculation of a drinking water equivalent of 1.75 μg/L. No lifetime health advisory could be calculated in view of the cancer risk. Several states have set standards or guidelines for dieldrin in drinking water[61] ranging from 0.01 μg/L (Minnesota) to 0.019 μg/L (Kansas) to 0.05 μg/L (California) to 1.0 μg/L (Illinois).

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{\text{ow}} = 6.2$.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

During the past decade, considerable information has been generated concerning the toxicity and potential carcinogenicity of the two organochlorine pesticides, aldrin and dieldrin. These two pesticides are usually considered together since Aldrin is readily epoxidized to dieldrin in the environment. Both are acutely toxic to most forms of life including arthropods, mollusks, invertebrates, amphibians, reptiles, fish, birds, and mammals. Dieldrin is extremely persistent in the environment. By means of bioaccumulation it is concentrated many times as it moves up the food chain.

Short Term Exposure: *Inhalation:* May cause nausea, drowsiness, loss of appetite, visual disturbances, and insomnia. Sprays of 1−2.5% have caused giddiness, headache, muscle twitching, convulsions, and loss of consciousness. *Skin:* Can be absorbed to cause or increase the severity of symptoms as listed under ingestion. Contact may cause skin rash. *Eyes:* May cause irritation, redness, and affect vision. *Ingestion:* Can cause headache, nausea, irritability, insomnia, high blood pressure, vision problems, loss of coordination, profuse sweating, dizziness, frothing at the mouth, convulsions, and loss of consciousness. Death may occur from as little as 1/20 oz (1.4 g). Some symptoms may be delayed up to 12 h. Exposure to dieldrin may affect the central nervous system, resulting in convulsions.

Long Term Exposure: May cause liver damage. Dieldrin accumulates in the human body. Dieldrin has caused cancer in laboratory animals. It is considered a suspect occupational carcinogen. May damage the developing fetus. May reduce fertility in males and females. Dieldrin concentrates in breast milk, and therefore, may be transferred to breast-feeding infants. Repeated higher exposure can cause tremors, muscle twitching and seizures (convulsions), and may lead to coma and death. Convulsions are somewhat delayed and may occur weeks or months following exposure. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Central nervous system, liver, kidneys, skin. *Cancer site* (in animals): lung, liver, thyroid, and adrenal gland.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Blood dieldrin level. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. EEG. Blood dieldrin levels (normal = less than 1 mg/100 mL; level should not exceed 15 mg/100 mL). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 12 h after overexposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At *any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dieldrin you should be trained on its proper handling and storage. Dieldrin must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); strong acids (such as hydrochloric, sulfuric, and nitric); chemically active metals (such as potassium, sodium, magnesium, and zinc) since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dieldrin, an organochlorine pesticide, solid toxic, must carry a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dieldrin is a noncombustible solid. Commercial solutions may contain flammable or combustible liquids. Use dry chemical, carbon dioxide, water spray, alcohol or polymer foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s minimum for primary combustion; 1760°C, 1.0 s for secondary combustion) with adequate scrubbing and ash disposal facilities.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Aldrin/Dieldrin: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Dieldrin: Health and Environmental Effects Profile No. 82*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 52−55 (1981) and 6, No. 1, 9−16

US Environmental Protection Agency. (August 1987). *Health Advisory: Dieldrin*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: Dieldrin*. Trenton, NJ

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Dieldrin*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Public Health Service. (November 1987). *Toxicological Profile for Aldrin/Dieldrin*. Atlanta, GA: Agency for Toxic Substances & Disease Registry

Diepoxybutane D:0760

Molecular Formula: $C_4H_6O_2$

Synonyms: 1,1′-Bi(Ethylene Oxide); Bioxirane; 2,2′-Bioxirane; Butadiendioxyd (German); Butadiene Diepoxide; 1,3-Butadiene Diepoxide; Butadiene Dioxide; Butane Diepoxide; Butane, 1,2: 3,4-Diepoxy-; DEB; Dioxybutadiene; ENT 26,592; Erythritol anhydride

CAS Registry Number: 1464-53-5

RTECS® Number: EJ8225000

UN/NA & ERG Number: UN2929 (Toxic liquids, flammable, organic, n.o.s.)/131

EC Number: 215-979-1 [*Annex I Index No.:* 603-060-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U085.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R46; R25/26; R34; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diepoxybutane is a flammable, colorless liquid. Molecular weight = 86.09; Boiling point = 57°C at 25°C; Freezing/Melting point = 19°C; also reported at 2−4°C; Flash point = 44.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Mixes with water.

Potential Exposure: DEB is primarily used in research and experimental work; as a curing agent for polymers; as a crosskicking agent for textile fabrics; and in preventing microbial spoilage in substances. DEB is also used commercially as mixed stereoisomers and as individual isomers in the preparation of erythritol and other pharmaceuticals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.04 ppm

PAC-1: 0.125 ppm

PAC-2: 0.995 ppm

PAC-3: 10 ppm

DFG MAK: Germ Cell Mutation Category 2.

North Dakota[60] has set a guideline of zero in ambient air.

Routes of Entry: Human exposure to DEB is principally through inhalation and skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Eye and skin contact can cause severe irritation. Accidental minor exposure caused swelling of the eyelids, upper respiratory tract irritation, and painful eye irritation 6 h after exposure. Contact may cause skin sensitization. Inhalation may cause respiratory tract irritation. Poison if ingested or inhaled.

Long Term Exposure: May cause skin allergies. There is sufficient evidence for the carcinogenicity of diepoxybutane in experimental animals. Two forms of 1,2:3,4-diepoxybutane (DL- and *meso*-) were carcinogenic in mice by skin application. Both compounds produced squamous-cell skin carcinomas. The DL-racemate also produced local sarcomas in mice and rats by subcutaneous injection.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diepoxybutane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic liquids, flammable, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb the material on carbon, clay, bentonite, or sawdust. For spills on water bodies, isolate the contaminated water and add dilute HCl or acetic acid to detoxify, then treat the water by biological treatment. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling

streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Detoxify by HCl or acetic acid treatment followed by secure landfill disposal, landfarming, or biological treatment. Incineration is another alternative. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 56−60

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diepoxybutane*. Washington, DC: Chemical Emergency Preparedness Program

Diethanolamine D:0770

Molecular Formula: $C_4H_{11}NO_2$

Synonyms: *N,N*-Bis(2-hydroxyethyl)amine; Bis(2-hydroxyethyl)amine; Bis(hydroxyethyl)amine; DEA; Diaethanolamin (German); Dietanolamina (Spanish); *N,N*-Diethanolamine; Diethylolamine; 2,2′-Dihydroxydiethylamine; Di(2-hydroxyethyl)amine; Diolamine; Ethanol, 2,2′-iminobis-; Ethanol, 2,2′-iminodi-; 2-[(2-Hydroxyethyl)amino]ethanol; 2,2′-Iminobis(ethanol); 2,2′-Iminodi-1-ethanol; 2,2′-Iminodiethanol; Iminodiethanol; NCI: C55174

CAS Registry Number: 111-42-2

RTECS® Number: KL2975000

UN/NA & ERG Number: UN3082/171

EC Number: 203-868-0 [*Annex I Index No.:* 603-071-00-]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, Inadequate Data; Animal, Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 2000 NCI: Carcinogenesis Studies (dermal); clear evidence: mouse; no evidence: rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R38; R41; R48/22; Safety phrases: S2; S26; S36/37/39; R46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diethanolamine is a colorless crystalline solid or a syrupy, white liquid (above 28°C) with a mild, ammonia-like odor. Odor threshold = 0.27 ppm. Molecular weight = 105.16; Boiling point = 269°C (decomposes); Freezing/Melting point = 28°C; Vapor pressure = very low; below 0.01 mmHg at 20°C; Flash point = 137.4°C (oc); Autoignition temperature = 662°C. Explosive limits: LEL = 1.6%; UEL = 9.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Highly soluble in water; solubility = 95%.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Primary Irritant. Used as a detergent; and as an intermediate for making fatty alkanolamides; morpholine, plasticizers, and resins; as an absorbent for acid gases.

Incompatibilities: The aqueous solution is a medium strong base. Violent reaction with strong acids; oxidizers, acid anhydrides; halides. Incompatible with isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, aldehydes. Reacts with CO_2 in the air. Hygroscopic (i.e., absorbs moisture from the air). Corrosive to copper, zinc, aluminum and their alloy; and galvanized iron.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.30 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 3 ppm/15 mg/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg/m^3/1 mg/m^3 TWA measured as inhalable fraction and vapor [skin].

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 300 mg/m^3

DFG MAK: 1 mg/m^3; measured as the inhalable fraction TWA; Peak Limitation Category I(1) [skin] danger of skin sensitization; Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 3 ppm (15 mg/m^3), 1993; Austria: MAK 3 ppm (13 mg/m^3), 1999; Belgium: TWA 3 ppm (13 mg/m^3), 1993; Denmark: TWA 3 ppm (15 mg/m^3), 1999; France: VME 3 ppm (15 mg/m^3), 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 3 ppm (15 mg/m^3), 1999; Russia: STEL 5 mg/m^3 [skin] 1993; Switzerland: MAK-W 0.1 mg/m^3, 1999; Switzerland: TWA 3 ppm (13 mg/m^3), 1993; United Kingdom: TWA 3 ppm (13 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value: TWA 2 mg/m^3 (skin).

Determination in Air: Use NIOSH Analytical Method (IV) #3509, aminoethanol Compounds II or OSHA Analytical Method PV-2018.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = below -1.0.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator. Irritates the eyes, skin, nose, and throat. Contact can cause severe irritation and burns of the skin and eyes. Inhalation can cause headache, nausea and vomiting, coughing, wheezing, and/or shortness of breath.

Long Term Exposure: Diethanolamine may affect the kidneys and liver. Prolonged or repeated skin exposure may cause a skin allergy and rash.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Liver and kidney function tests. Lung function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Viton™ gloves, suits; CPF3, Responder™ suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): natural rubber gloves; Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield when working with the liquid or solid material unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with diethanolamine you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Ethanolamine or Ethanolamine solutions require a shipping label of "CORROSIVE." They fall in Hazard Class 8 and Packing Group III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Dry material:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. *Liquid:* This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Diethanolamine*. Trenton NJ

Diethoxypropene D:0780

Molecular Formula: $C_7H_{14}O_2$

Common Formula: $(C_2H_5O)_2CHCH{=}CH_2$

Synonyms: Acrolein acetal; Acrylaldehyde diethyl; 3,3-Diethoxy-1-propene; 3,3-Diethoxypropene; Propenal diethyl acetal; 1-Propene, 3,3-diethoxy-

CAS Registry Number: 3054-95-3

RTECS® Number: AS1370000

UN/NA & ERG Number: UN1993/128

EC Number: 221-276-0

Regulatory Authority and Advisory Bodies

US EPA, TSCA, use is restricted to research and development only.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 3,3-Diethoxypropene is a colorless flammable liquid; Molecular weight = 130.21; Boiling point = 123.5°C; Flash point = 4.4°C. Hazard Identification (based on HMIS Rating System scale: 0−4): Health 1, Flammability 3, Reactivity 1. Water solubility = not determined.

Potential Exposure: Used by technically qualified individuals only; in organic synthesis. US EPA under TSCA restricts use of this chemical to R&D only.

Incompatibilities: Forms explosive mixture with air. Contact with acids and strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Irritating to the eyes, skin, and respiratory tract.

Long Term Exposure: There is little information about the long-term health effects of diethoxypropene known at this time. It may be a mutagen based on tests with bacteria.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids and strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where diethoxypropene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of diethoxypropene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of diethoxypropene. Wherever diethoxypropene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: 3,3-Diethoxypropene must bear a “FLAMMABLE LIQUID” label. It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: 3,3-Diethoxypropene*. Trenton, NJ

Diethylamine D:0790

Molecular Formula: $C_4H_{11}N$

Common Formula: $(C_2H_5)_2NH$

Synonyms: 2-Aminopentane; DEN; Diaethyamin (German); Diethamine; *N*,*N*-Diethylamine; Dietilamina (Spanish); *n*-Ethyl ethanamine

CAS Registry Number: 109-89-7

RTECS*® *Number: HZ8750000

UN/NA & ERG Number: UN1154/132

EC Number: 203-716-3 [*Annex I Index No.:* 612-003-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 100 lb (45.4 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R20/21/22; R35; Safety phrases: S1/2; S3; S16; S26; S29; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DEA, a secondary aliphatic amines compound, is a colorless, flammable liquid with a fishy ammonia-like odor. The odor threshold is 0.14 ppm. Molecular weight = 73.16; Boiling point = 55.6°C; Freezing/Melting point = −50°C; Vapor pressure = 192 mmHg at 20°C; Flash point = −23°C; Autoignition temperature = 312°C. Explosive limits: LEL = 1.8%; UEL = 10.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Diethylamine (DEA) is used in the manufacture of the following chemicals: diethyldithiocarbamate and thiurams (rubber processing accelerators); diethylaminoethanol (medicinal intermediate); diethylaminopropylamine (epoxy curing agent); *N*,*N*-diethyl-*m*-toluamide and other pesticides; and 2-diethylaminoethylmethacrylate. It is used in the manufacture of several drugs.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Violent reaction with strong oxidizers, strong acids, cellulose nitrate. Incompatible with organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, mercury, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc, and alloys.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.99 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/75 mg/m^3 TWA.

NIOSH REL: 10 ppm/30 mg/m^3 TWA; 25 ppm/75 mg/m^3 STEL.

ACGIH TLV®[1]: 5 ppm TWA; 15 ppmSTEL; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 15 ppm

PAC-2: 75 ppm

PAC-3: 200 ppm

DFG MAK: 5 ppm/15 mg/m^3 TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/30 mg/m^3 should not be exceeded; Pregnancy Risk Group D.

NIOSH IDLH: 200 ppm.

Australia: TWA 10 ppm (30 mg/m^3); STEL 25 ppm, 1993; Austria: MAK 10 ppm (30 mg/m^3), 1999; Belgium: TWA 10 ppm (30 mg/m^3); STEL 25 ppm, 1993; Finland: STEL 10 ppm (30 mg/m^3), [skin], 1999; France: VLE 10 ppm (30 mg/m^3), 1999; Hungary: TWA 30 mg/m^3; STEL 60 mg/m^3, 1993; Japan: 10 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 15 mg/m^3, [skin], 2003; Norway: TWA 10 ppm (30 mg/m^3), 1999; the Philippines: TWA 25 ppm (75 mg/m^3), 1993; Russia: TWA 10 ppm; STEL 30 mg/m^3, [skin], 1993; Sweden: NGV 10 ppm (30 mg/m^3), KTV 15 ppm (45 mg/m^3), [skin], 1999; Switzerland: MAK-W 10 ppm (30 mg/m^3), KZG-W 20 ppm (60 mg/m^3), 1999; Turkey: TWA 25 ppm (75 mg/m^3), 1993; United Kingdom: TWA 10 ppm (30 mg/m^3); STEL 25 ppm (76 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm [skin]. Several states have set guidelines or standards for Diethylamine in ambient air[60] ranging from 4.1 μg/m^3 (Massachusetts) to 300−750 μg/m^3 (North Dakota) to 500 μg/m^3 (Virginia) to 600 μg/m^3 (Connecticut) to 715 μ/m^3 (Nevada).

Determination in Air: Adsorption on silica, workup with H_2SO_4 in CH_3OH (Methanol); Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #2010 or OSHA Analytical Method 41.

Permissible Concentration in Water: Russia[43] set a MAC of 2 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: It is irritant and corrosive to eyes, skin, mucous membranes, and the respiratory tract. Dyspnea (difficult breathing) results in inhalation and it may be fatal.[24] Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. DEA can be absorbed through the skin, thereby increasing exposure. LD_{50} = (oral-rat) 540 mg/kg (slightly toxic).

Long Term Exposure: Repeated exposure may affect the liver and kidneys and result in swelling of the eyes, impaired vision, and the appearance of "circles" or halos around lights. Repeated exposures may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. In animals; myocardial degeneration.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Consider chest X-ray following acute overexposure. Consider vision tests, especially if symptoms have been noted. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Use butyl rubber gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *200 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] orCcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern organic vapor and acid gas cartridge(s)] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with DEA you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Keep containers well closed. Protect against direct sunlight. Store in a cool place. Protect containers against physical damage. Outdoors or detached storage is preferred. In case of indoor storage, store in a standard combustible liquid storage room or cabinet. Good ventilation. Separate from oxidizing materials, strong acids, cellulose nitrate, and other incompatible materials listed above.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Spread sodium bisulfate and sprinkle water upon a spill,[24] then flush to sewer. Alternatively, absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, foam, or carbon dioxide fire extinguishing agent. Water may be ineffective, but use water spray to keep fire-exposed containers cool; to disperse the vapor; to flush spills away from exposures; to dilute spills to nonflammable mixtures and thus to prevent the spread of fires. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Primary Aliphatic Amines*, Report PB-274,073. Cincinnati, OH, pp. 154−166

US Environmental Protection Agency. (April 1, 1978). *Chemical Hazard Information Profile: Ethylamines*. Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Diethylamine*. Trenton, NJ

Diethylaminoethanol D:0800

Molecular Formula: $C_6H_{15}NO$

Common Formula: $(C_2H_5)_2NCH_2CH_2OH$

Synonyms: DEAE; Diaethylaminoaethanol (German); 2-Diethylamino-; β-Diethylaminoethanol; *n*-Diethylaminoethanol; 2-(Diethylamino)ethanol; 2-*N*-Diethylaminoethanol;

β-Diethylaminoethyl alcohol; 2-(Diethylamino) ethyl alcohol; *N*,*N*-Diethylethanolamine; *N*,*N*-Diethyl-*N*-(β-hydroxyethyl) amine; *N*,*N*-Diethyl-2-hydroxyethylamine*;* *n*-1,1-Diethyl-*N*-(2-hydroxyethyl)amine; Ethanol, 2-(diethylamino)-; 2-Hydroxytriethylamine

CAS Registry Number: 100-37-8

RTECS® Number: KK5075000

UN/NA & ERG Number: UN2686/132

EC Number: 202-845-2 [*Annex I Index No.:* 603-048-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R20/21/22; R34; Safety phrases: S1/2; S25; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DEAE, an aminoethanol compound, is a colorless liquid with a weak ammoniacal odor. The odor perception limit in air is 0.011 ppm; the odor recognition level is 0.04 ppm.[41] Molecular weight = 117.22; Specific gravity (H_2O:1) = 0.89; Boiling point = 162.8°C; Freezing/Melting point = −70°C; Vapor pressure = 1 mmHg at 20°C; Flash point = 52.2°C; Autoignition temperature = 250°C. Explosive limits: LEL = 6.7; UEL = 11.7. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. This compound is used as an anticorrosive additive; as a chemical intermediate for the production of emulsifiers, detergents, solubilizers, cosmetics, and textile finishing agents. It is also used in drug manufacture.

Incompatibilities: Forms explosive mixture with air. Violent reaction with oxidizers, strong acids, acid chlorides, and isocyanates. Attacks light metals and copper. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

OSHA PEL/NIOSH REL: 10 ppm/50 mg/m^3 TWA [skin].

NIOSH REL: 10 ppm/50 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/9.6 mg/m^3 TWA [skin].

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 3 ppm

PAC-2: 20 ppm

PAC-3: 100 ppm

DFG MAK: 5 ppm/24 mg/m^3 TWA; Peak Limitation Category I(1) [skin]; Pregnancy Risk Group C.

Australia: TWA 10 ppm (50 mg/m^3), [skin], 1993; Austria: MAK 10 ppm (50 mg/m^3), [skin], 1999; Belgium: TWA 10 ppm (48 mg/m^3), [skin], 1993; Denmark: TWA 10 ppm (50 mg/m^3), [skin], 1999; Finland: STEL 10 ppm (50 mg/m^3), [skin], 1999; France: VME 10 ppm (50 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 9.6 mg/m^3, [skin], 2003; the Philippines: TWA 10 ppm (50 mg/m^3), [skin], 1993; Poland: TWA 50 mg/m^3, 1999; Russia: STEL 5 mg/m^3, [skin], 1993; Switzerland: MAK-W 10 ppm (50 mg/m^3), [skin], 1999; United Kingdom: TWA 10 ppm (49 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin]. Several states have set guidelines or standards for diethylaminoethanol in ambient air[60] ranging from 0.5 mg/m^3 (North Dakota) to 0.8 mg/m^3 (Virginia) to 1.0 mg/m^3 (Connecticut) to 1.19 mg/m^3 (Nevada).

Determination in Air: Adsorption on silica gel; Methanol/Water; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #2007, aminoethanol Compounds I.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = <0.5.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Diethylaminoethanol can affect you when breathed in by passing through your skin. Contact can cause very severe burns of the eyes, leading to permanent damage. It can also irritate the skin, causing a rash and burning sensation upon contact. Breathing the vapor may irritate the lungs, causing coughing and/or shortness of breath. Inhalation of vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms include nausea, vomiting; eye, skin, and respiratory irritation. LD_{50} = (oral-rat) 1300 mg/kg (slightly toxic).

Long Term Exposure: Diethylaminoethanol can cause a skin allergy to develop and may affect the nervous system. May cause lung irritation.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with DEAE you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diethylaminoethanol must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where diethylaminoethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Diethylaminoethanol must carry a "CORROSIVE, FLAMMABLE LIQUID" label. It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Diethylaminoethanol*. Trenton, NJ

***N,N*-Diethylaniline D:0810**

Molecular Formula: $C_{10}H_{15}N$

Common Formula: $C_6H_5N(C_2H_5)_2$

Synonyms: Benzenamine, *N,N*-diethyl-; DEA; Diaethyanilin (German); *N,N*-Diethylaminobenzene; Diethylaniline; *N,N*-Diethylbenzenamine; Diethylphenylamine; *N,N*-Dietilanilina (Spanish)

CAS Registry Number: 91-66-7

RTECS® Number: BX3400000

UN/NA & ERG Number: UN2432/153

EC Number: 202-088-8 [*Annex I Index No.:* 612-054-00-8]

Regulatory Authority and Advisory Bodies

Reportable Quantity (RQ): 1 lb (0.454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R51/53; Safety phrases: S1/2; S28; S37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diethyl aniline is a colorless to yellow liquid. Molecular weight = 149.26; Boiling point = 216°C; Flash point = 85°C; Autoignition temperature = 630°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Diethyl aniline is used in organic synthesis and as a diestuff intermediate.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers, halogens. Incompatible with acids, organic anhydrides, isocyanates, aldehydes.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

DEA can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure by skin contact or breathing can interfere with the ability of the blood to carry oxygen (a condition called methemoglobinemia). This can cause headaches, dizziness, a bluish color to the skin and lips, trouble breathing, and even collapse and death. Repeated exposures can cause a low red blood count (anemia). Very high single or repeated high exposures to diethyl aniline can damage the liver.

Long Term Exposure: May cause anemia and liver damage.

Points of Attack: Blood, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: liver function tests. Complete blood count (CBC). If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to diethyl aniline, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DEA you should be trained on its proper handling and storage. Diethyl aniline must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric) and direct sunlight.

Shipping: *N,N*-Diethylaniline must be labeled: "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of

spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Diethyl aniline*. Trenton, NJ

Diethylcarbamazine citrate D:0820

Molecular Formula: $C_{10}H_{21}N_3O{-}C_6H_8O_7$

Synonyms: Banocide; Caricide; Caritrol; Dicarocide; Diethylcarbamazane citrate; Diethylcarbamazine citrate; Diethylcarbamazine hydrogen citrate; 1-Diethylcarbamoyl-4-methylpiperazine dihydrogen citrate; *N,N*-Diethyl-4-methyl-1-piperazine carboxamide citrate; *N,N*-diethyl-4-methyl-1-piperazinecarboxamide dihydrogen citrate; *N,N*-Diethyl-4-methyl-1-piperazinecarboxamide 2-hydroxy-1,2,3-propanetricarboxylate; Ditrazin; Ditrazin citrate; Ditrazine; Ditrazine citrate; Ethodryl citrate; Franocide; Franozan; Hetrazan; Loxuran; 1-Methyl-4-diethylcarbamoylpiperazine citrate

CAS Registry Number: 1642-54-2

RTECS® Number: TL1225000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 216-696-6

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diethylcarbamazine citrate is an odorless, white crystalline powder; Molecular weight = 391.48; Freezing/Melting point = 135−143°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used against filariasis in humans and animals. Especially popular in veterinary medicine (anthelmintic).

Routes of Entry: Inhalation, ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if inhaled. Symptoms of exposure include nausea, vomiting, headache, weakness, and (as seen in dogs) muscle tremors and convulsions. May be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. The average adult man may tolerate a single dose of 1.5 g without ill effects.

Long Term Exposure: May have reproductive effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: For emergency situations, wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash, or a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Medicine, solid, toxic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diethylcarbamazine Citrate*. Washington, DC: Chemical Emergency Preparedness Program.

Diethylcarbamoyl chloride D:0830

Molecular Formula: $C_5H_{10}ClNO$
Common Formula: $(C_2H_5)_2NCOCl$

Synonyms: Caricide®; Diethylcarbamic chloride; Diethylcarbamidoyl chloride; *N*,*N*-Diethylcarbamoyl chloride; Diethylcarbamyl chloride; Hetrazan®
CAS Registry Number: 88-10-8
RTECS® Number: FD4025000
UN/NA & ERG Number: UN3123 (Toxic liquids, water-reactive, n.o.s.)/139
EC Number: 201-798-5 [*Annex I Index No.*: 607-229-00-0]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: Xn; Risk phrases R20/22; R36/37/38; R40; Safety phrases: S2; S26-36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diethylcarbamoyl chloride is a colorless liquid. Molecular weight = 135.61; Boiling point = 186−190°C; Melting point = −44; Flash point = 163−172°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 2. Soluble in water (reactive).

Potential Exposure: Diethylcarbamazine citrate, a carbamate anthelmintic (working agent), used in the synthesis of pharmaceuticals.

Incompatibilities: Will react with water or steam to produce toxic and corrosive fumes.

Permissible Exposure Limits in Air

No standards or TEEL available.

DFG MAK: Carcinogen Category 3B.

Harmful Effects and Symptoms

Long Term Exposure: A study has shown DECC to be mutagenic in two *E. coli* strains (WP2 and WP2S from Witkin). However, DECC was not as mutagenic as its close analog, dimethylcarbamoyl chloride (DMCC). A suspected carcinogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic liquids, water-reactive, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS, DANGEROUS WHEN WET." They fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and chlorides, are produced in fire. Use dry chemical, carbon dioxide extinguishers. Reacts with water, forming corrosive and toxic fumes. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Diethylcarbamoyl Chloride*. Trenton, NJ

Diethyl chlorophosphate D:0840

Molecular Formula: $C_4H_{10}ClO_3P$

Common Formula: $P(OC_2H_5)_2OCl$

Synonyms: Chlorophosphoric acid diethyl ester; Clorofosfato de dietilo (Spanish); Diethoxyphosphorous oxychloride; Phosphorochloridic acid, diethyl ester

CAS Registry Number: 814-49-3

RTECS® Number: TD1400000

UN/NA & ERG Number: UN3278 (organophosphorus compound, toxic n.o.s.)/151

EC Number: 212-396-4

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diethyl chlorophosphate is a combustible, clear liquid with an unpleasant odor. Molecular weight = 172.76; Boiling point = 60°C at 2.0 mmHg; 81°C at 6.0 mmHg. Freezing/Melting point = 0°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 2₩. Reacts with water.

Potential Exposure: This material may be used as an intermediate in the manufacture of pesticides and chemical warfare agents.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Strong oxidizers, bases.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 8 mg/m^3

PAC-3: 8 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Poison; can be absorbed through the skin. Diethyl chlorophosphate may severely irritate or burn the skin, eyes, or mucous membranes. This material is a cholinesterase inhibitor. It has high oral and very high dermal toxicity. It is a skin irritant. It is also toxic by inhalation. Acute exposure to diethyl chlorophosphate may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may either decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may be observed although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Diethyl chlorophosphate may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give conscious victims water or milk. Promote excretion by administering saline cathartic or sorbitol. Do not make an unconscious person vomit.

Personal Protective Methods: For emergency situations, wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape (SCBA) and a fully encapsulating, chemical-resistant suit.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus compound, toxic n.o.s. requires a label of “POISONOUS/TOXIC MATERIALS.” These materials fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.4
Night	0.8/1.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200

Then: Protect persons downwind (miles/kilometers)

Day	1.6/2.6
Night	2.8/4.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides and chlorides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Stay upwind; keep out of low areas. Wear self-contained (positive-pressure if available) breathing apparatus and full protective clothing. Isolate for 1/2 mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diethyl Chlorophosphate*. Washington, DC: Chemical Emergency Preparedness Program

Diethylene triamine D:0850

Molecular Formula: $C_4H_{13}N_3$

Common Formula: $(NH_2CH_2CH_2)_2NH$

Synonyms: Aminoethandiamine; *n*-(2-Aminoethyl); Aminoethylethandiamine; 3-Azapentane-1,5-diamine; Bis (2-aminoethyl)amine; Bis(β-aminoethyl)amine; Bis(2-aminoethyl)amine; DETA; 2,2′-Diaminodiethylamine; Diethylenetriamine; 1,2-Ethanediamine, *n*-(2-aminoethyl)-; Ethylenediamine; 2,2′-Iminobisethylamine; 3-a2a pentane-1, 5-diamine; 1,4,7-Triazaheptane

CAS Registry Number: 111-40-0

RTECS® Number: IE1225000

UN/NA & ERG Number: UN2079/154

EC Number: 203-865-4 [*Annex I Index No.:* 612-058-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R21/22; R34-43; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diethylene triamine is a flammable, thick yellow liquid with an ammoniacal odor. The odor threshold is 100 ppm.[41] Molecular weight = 103.20; Specific gravity = (H_2O:1) = 0.96; Boiling point = 207°C; Freezing/Melting point = −38.9°C; Vapor pressure = 0.4 mmHg at 20°C; Flash point = 97.8°C; Autoignition temperature = 358°C. Explosive limits: LEL = 2%; UEL = 6.7%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. This material is used in textile finishes, fungicides, corrosion inhibitors, adhesives, asphalt additives, as a solvent for sulfur, acid gases, resins, and dyes.

Incompatibilities: Forms explosive mixture with air. Ignites spontaneously on contact with cellulose nitrate. Contact with silver, cobalt, or chromium compounds may cause explosions. Incompatible with acids, halogenated organics, organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, mercury, phenols, cresols, caprolactum solution, strong oxidizers. Attacks aluminum, copper, copper alloys, lead, tin, zinc and alloys.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.22 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 1 ppm/4 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 1 ppm/4.2 mg/m^3 TWA [skin].
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 1 ppm
PAC-2: 1.25 ppm
PAC-3: 1.5 ppm
DFG MAK: [skin] Danger of skin sensitization.

Australia: TWA 1 ppm (4 mg/m^3), [skin], 1993; Austria: MAK 1 ppm (4 mg/m^3), 1999; Belgium: TWA 1 ppm (4.2 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (4 mg/m^3), [skin], 1999; France: VME 1 ppm (4 mg/m^3), 1999; Hungary: STEL 4 mg/m^3, [skin], 1993; Netherlands: MAC-TGG 4 mg/m^3, 2003; Norway: TWA 1 ppm (4 mg/m^3), 1999; the Switzerland: MAK-W 1 ppm (4 mg/m^3), [skin], 1999; United Kingdom: TWA 1 ppm (4.3 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm [skin]. Several states have set guidelines or standards for diethylene triamine in ambient air[60] ranging from 40.0 μg/m^3 (North Dakota) to 65 μg/m^3 (Virginia) to 80.0 μg/m^3 (Connecticut) to 95 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2540, OSHA Analytical Method 60.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes.

Determination in Water: No tests listed. Octanol–water coefficient: Log $K_{ow} = -1.27$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Diethylene triamine can affect you when breathed in and by passing through your skin. Exposure can severely irritate the eyes, skin, and respiratory system. Diethylene triamine is a corrosive liquid and contact can irritate the skin and may irritate and burn the eyes. Skin sensitization, dermatitis, and pulmonary sensitization and irritation, possibly leading to bronchial asthma. Also, conjunctivitis, keratitis; nausea, vomiting; eye, skin necrosis; cough, dyspnea (breathing difficulty). LD_{50} = (oral-rat) 1080 mg/kg (slightly toxic).

Long Term Exposure: Diethylene triamine can cause both skin and lung allergies to develop. Once allergy develops, further low exposures can trigger allergic effects.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Skin testing with diluted diethylene triamine may help diagnose allergy if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; neoprene rubber gloves, suits, and boots; Viton™ gloves, suits; Trychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from acids, halogenated organics, and oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates). Protect containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This material requires a "CORROSIVE" label. It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Diethylene triamine may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in admixture with flammable solvent in furnace equipped with afterburner and scrubber.[22]

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Diethylene Triamine*. Trenton, NJ

Di(2-ethylhexyl)phthalate D:0860

Molecular Formula: $C_{24}H_{38}O_4$

Synonyms: BEHP; 1,2-Benzenedicarboxylic acid, bis (2-ethylhexyl) ester; 1,2-Benzenedicarboxylic acid, dioctyl ester; Bis(2-ethylhexyl) 1,2-benzenedicarboxylate; Bis (2-ethylhexyl)phthalate; Bis(2-etilhexil)ftalato (Spanish); Bisoflex 81; Bisoflex 82; Bisoflex DOP; Compound 889; DAF 68; DEHP; Diester of 2-ethylhexyl alcohol and phthalic acid; Di(2-ethylhexyl) *o*-phthalate; Di(2-ethylhexyl) phthalate; Di-*s*-octyl phthalate; Di-*sec*-octyl phthalate; Dioctyl phthalate; DOF; DOP; Ergoplast FDO; Ergoplast FDO-S; 2-Ethylhexyl phthalate; Ethylhexyl phthalate; Eviplast 80; Eviplast 81; Fleximel; Flexol DOP; Flexol plasticizer DOP; Ftalato de(2-etilhexilo) (Spanish); Good-Rite GP 264; Hatcol DOP; Hercoflex 260; Kodaflex DOP; Mitsubishi DOP; Mollano; NCI-C52733; Nuoplaz DOP; Octoil; Octyl phthalate; Octyl phthalate, di-*sec*; Palatinol AH; Phthalic acid dioctyl ester; Pittsburgh PX-138; Plasthall DOP; Plasticizer 28P; Platinol AH; Platinol DOP; Polycizer 162; PX-138; RC Plasticizer DOP; Reomol D 79P; Reomol DOP; Sicol 150; Staflex DOP; Truflex DOP; Vestinol AH; Vinicizer 80; Witcizer 312

CAS Registry Number: 117-81-7

RTECS® Number: TI0350000

UN/NA & ERG Number: UN3082/171

EC Number: 204-211-0 [*Annex I Index No.:* 607-317-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: IARC: Human, Inadequate Data; Animal, Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 2000; Carcinogenesis studies (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; Carcinogenesis studies; on test (prechronic studies), October 2000; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Rodent dominant lethal; Inconclusive: *In vitro* SCE—nonhuman.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U028.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.28; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water.

Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (20); 8270 (10).

Safe Drinking Water Act: MCL, 0.006 mg/L; MCLG, zero.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin (male) 10/24/03.

Canada, WHMIS, Ingredients Disclosure List concentration 0.1%, National Pollutant Release Inventory (NPRI); listed on Canada's DSL List.

European/International Regulations: Hazard Symbol: T; Risk phrases: R61; R60. Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Di(2-ethylhexyl)phthalate is a colorless oily liquid with almost no odor. Molecular weight = 390.56; Specific gravity (H$_2$O:1) = 0.99; Boiling point = 385°C; Freezing/Melting point = −50°C; Vapor pressure = <0.01% mmHg at 20°C; Flash point = 195°C; Autoignition temperature = 348°C. Explosive limits: LEL = 0.1%; UEL − 0.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.00003% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Di (2-ethylhexyl)phthalate (DEHP) is commercially produced by the reaction of 2-ethylhexyl alcohol and phthalic anhydride. It is used as a plasticizer for polyvinyl chloride (PVC), plastic resins, di-electrical fluid component in capacitors; in the manufacture of organic pump fluids. Two groups are at risk in regard to phthalic acid esters. These are workers in the industrial environment in which the phthalates are manufactured or used and patients receiving chronic transfusion of blood and blood products stored in PVC blood bags.

Incompatibilities: Nitrates, strong oxidizers, strong acids, strong alkalis.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA; 10 mg/m^3 STEL, potential carcinogen, reduce to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 5 mg/m^3 TWA, confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 10 mg/m^3 TWA; Peak Limitation Category II (8); Carcinogen Category 4; Pregnancy Risk Group C.

Australia: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; Denmark: TWA 3 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3, [skin], 1999; France: VME 5 mg/m^3, 1999; Hungary: TWA 5 mg/m^3; STEL 10 mg/m^3, [skin], 1993; Japan: 5 mg/m^3, 1999; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 5 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: NGV 3 mg/m^3, KTV 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for bis (2-ethylhexyl)phthalate in ambient air[60] ranging from 0.5 μg/m^3 (Rhode Island) to 0.68 μg/m^3 (Massachusetts) to 16.0 μg/m^3 (New York) to 25.0 μg/m^3 (North Carolina) to 80.0 μg/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μg/m^3 (Nevada) to 120 μg/m^3 (Pennsylvania).

Determination in Air: Collection on a filter, workup with CS$_2$; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #5020, di(2-Ethylhexyl) Phthalate.

Permissible Concentration in Water: *For freshwater and saltwater aquatic life*, no criteria have been set due to lack of data. *For protection of human health*, the ambient water criterion is 15 mg/L (15,000 μg/L).[6] A no-adverse-effect-level in drinking water has been calculated by NAS/NRC to be 4.2 mg/L. An acceptable daily intake (ADI) value of 0.6 μg/kg/day has been calculated by NAS/NRC.

Determination in Water: Gas chromatography (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 5.0$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: DEHP irritates the eyes, skin, and respiratory tract, and may affect the gastrointestinal tract. Symptoms also include irritation of the mucous membranes, nausea, diarrhea.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The very low levels of DEHP to which humans are normally exposed have not been shown to cause adverse health effects. But DEHP causes cancer in rats and mice. It is also known to produce liver damage and male reproductive system damage; affect reproduction; and produce birth defects in laboratory animals. However, none of these effects have been documented in humans. This complicates estimating which kinds of health effects and exposure levels will actually affect humans. However, it is prudent to regard the animal data as indicating some degree of concern for harmful human effects (a potential occupational carcinogen) until research can more reasonably conclude that no harm can occur.

Points of Attack: Eyes, respiratory system, central nervous system, liver, reproductive system, gastrointestinal tract. Cancer site [in animals]: liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination of the nervous system. Any evaluation should include a careful history of past and present symptoms.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with DEHP you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Bis (2-ethylhexyl)phthalate must be stored to avoid contact with oxidizing materials, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where bis (2-ethylhexyl) phthalate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. It may burn but does not easily ignite. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Phthalate Esters: Ambient Water Quality Criteria*. Washington, DC

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Phthalates*, Report PB-274,073. Rockville, MD, pp. 97−103

US Environmental Protection Agency. (April 30, 1980). *Bis (2-Ethylhexyl) Phthalate: Health and Environmental Effects Profile No. 27*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 52−54 (1981) and 2, No. 2, 22−25

US Public Health Service. (December 1987). *Toxicological profile for di-(2-ethylhexyl) phthalate*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (July 1998). *Hazardous Substances Fact Sheet: Bis(2-Ethylhexyl)Phthalate*. Trenton, NJ

Diethyl ketone D:0870

Molecular Formula: $C_5H_{10}O$

Common Formula: $C_2H_5COC_2H_5$

Synonyms: DEK; Diethylcetone (French); Dimethylacetone; Ethyl ketone; Ethyl propionyl; Metacetone; Methacetone; 3-Pentanone; Pentanone-3; 3-Pentanone dimethyl acetone; Propione

CAS Registry Number: 96-22-0

RTECS® Number: SA8050000

UN/NA & ERG Number: UN1156/127

EC Number: 202-490-3 [*Annex I Index No.:* 606-006-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F , Xi; Risk phrases: R11; R37; Safety phrases: S2; S9; S16; S25; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diethyl ketone is a colorless liquid with an acetone-like odor (smells like nail-polish remover). Odor threshold 2.8 ppm. Molecular weight = 86.15; Specific gravity (H_2O:1) = 0,81 at 25°C; Boiling point = 101.6°C; Freezing/Melting point = −42°C; Vapor pressure = 35 mmHg at 25°C; Flash point = 12.8°C (oc); Autoignition temperature = 452°C. Explosive limits: LEL = 1.6%; UEL = 6.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Moderately soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen, Primary Irritant. This compound is used as a solvent; in organic synthesis and making medicines.

Incompatibilities: Violent reaction with oxidizers, causing fire and explosion hazard. Forms explosive mixture with air. Incompatible with strong acids, aliphatic amines. Attacks many plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 200 ppm/705 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm/705 mg/m^3 TWA; 300 ppm/1057 mg/m^3 STEL.

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 300 ppm

PAC-2: 300 ppm

PAC-3: 750 ppm

Australia: TWA 200 ppm (705 mg/m^3), 1993; Belgium: TWA 200 ppm (705 mg/m^3), 1993; Denmark: TWA 200 ppm (700 mg/m^3), 1999; France: VME 200 ppm (705 mg/m^3), 1999; the Netherlands: MAC-TGG 705 mg/m^3, 2003; Norway: TWA 100 ppm (350 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (705 mg/m^3), 1999; United Kingdom: TWA 200 ppm (716 mg/m^3); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 300 ppm. Several states have set guidelines or standards for diethyl ketone in ambient air[60] ranging from 7.05 mg/m^3 (North Dakota) to 12.0 mg/m^3 (Virginia) to 14.1 mg/m^3 (Connecticut) to 16.8 mg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: No tests listed. Octanol–water coefficient: Log K_{ow} = (estimated) 0.99.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: DEK can be absorbed through the skin, thereby increasing exposure. DEK irritates the eyes, skin, and respiratory tract. Higher exposures can cause dizziness, lightheadedness, and unconsciousness. This material is slightly toxic. LD_{50} = (oral-rat) 2140 mg/kg.

Long Term Exposure: Removes the skin's natural oils. Some, but not all, ketones can cause nerve damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Interview for brain effects, including memory, mood, concentration, headaches, altered sleep patterns.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 200 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect diethyl ketone, or in the case of a full-face-piece respirator if you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with DEK you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diethyl ketone must be stored to avoid contact with oxidizing materials (such as peroxides, perchlorates, chlorates, permanganates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Sources of ignition, such as smoking and open flames, are prohibited where diethyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of diethyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of diethyl ketone. Wherever diethyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition

sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78−173

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Diethyl Ketone*. Trenton, NJ

O,O-Diethyl-*S*-methyl phosphorodithioate D:0880

Molecular Formula: $C_5H_{13}O_2PS_2$

Synonyms: Phosphorodithioc acid, *O,O*-diethyl *S*-methyl ester

CAS Registry Number: 3288-58-2

RTECS® Number: TD9670000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): U087.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Land Ban Waste Restrictions.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

Reportable Quantity (RQ): 5000 lb (2270 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: *O,O*-Diethyl-*S*-methyl phosphorodithioate is an organophosphate and the methyl derivative of *O,O*-diethyl dithiophosphoric acid. The compound has partly insecticidal, acaricidal, and fungicidal activity and is useful as an intermediate for organic synthesis.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Many organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: There is no available information on the possible carcinogenic, mutagenic, teratogenic, or adverse reproductive effects of *O,O*-diethyl-S-methyl phosphorodithioate. It, like other organophosphate compounds, is expected to produce cholinesterase inhibition in humans. There are no available data on the aquatic toxicity of this compound. The oral LD_{50} mouse is 156 mg/kg (moderately toxic).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof goggles and face shield if working with the liquid or dust-proof chemical goggles and face shield if working with dry material unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents.

Shipping: Organophosphorus pesticides, liquid, toxic n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

US Environmental Protection Agency. (April 30, 1980). *O, O-Diethyl-S-Methyl Phosphorodithioate: Health and Environmental Effects Profile No. 84*. Washington, DC: Office of Solid Waste

Diethyl-*p*-phenylene-diamine D:0890

Molecular Formula: $C_{10}H_{16}N_2$

Common Formula: $C_6H_4NH_2N(C_2H_5)_2$

Synonyms: *p*-Aminodiethylaniline; 4-Amino-*N*,*N*-diethylaniline; *p*-(Diethylamino)aniline; 4-(Diethylamino)aniline; Diethylaminoaniline; *N*,*N*′-Diethyl-*p*-fenylendiamin; *N*,*N*′-Diethyl-*p*-phenylenediamine; Diethyl-*p*-phenylenediamine; *N*,*N*-Diethyl-*p*-phosphoric acid; DPD

CAS Registry Number: 93-05-0

RTECS® Number: SS9275000

UN/NA & ERG Number: UN1673 (phenylenediamines)/153

EC Number: 202-214-1[*Annex I Index No.:* 612-080-00-X]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: Dropped from listing in 1988.

European/International Regulations: Hazard Symbol: T; Risk phrases: R 25-R34; Safety phrases: S1/2; S26; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: DPD is a clear liquid. Molecular weight = 164-28; Boiling point = 260−262°C; Flash point $\geq$110°C.[52]

Potential Exposure: Used as a dye intermediate and in color photography. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

DFG MAK: Danger of skin sensitization (*p*-phenylenediamine compounds used as rubber components).

Harmful Effects and Symptoms

Short Term Exposure: DPD is poisonous and a skin irritant. The lowest toxic dermal dose reported in humans is 73 μg/kg. The LD_{50} low-oral-cat is 300 mg/kg and the LD_{50} low-dermal-rabbit is 5 mg/kg.

Long Term Exposure: May cause allergic dermatitis.

Points of Attack: Skin.

Medical Surveillance: Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DPD you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phenylenediamines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Diethyl-p-Phenylenediamine*. Washington, DC: Chemical Emergency Preparedness Program

Diethyl phthalate D:0900

Molecular Formula: $C_{12}H_{14}O_4$

Common Formula: $C_6H_4(OCOC_2H_5)_2$

Synonyms: Anozol; *o*-Benzenedicarboxylic acid diethyl ester; 1,2-Benzenedicarboxylic acid, diethyl ester; DEP; Diethyl 1,2-benzenedicarboxylate; Diethyl *p*-phthalate; Estol 1550; Ethyl phthalate; Ftalato de dietilo (Spanish); NCI-C60048; Neantine; Palatinol A; Phthalic acid, diethyl ester; Phthalol; Phthalsaeurediaethylester (German); Placidol E; Solvanol; Unimoll DA

CAS Registry Number: 84-66-2

RTECS® Number: TI1050000

UN/NA & ERG Number: UN3082/171

EC Number: 201-550-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; NCI: Carcinogenesis Studies (dermal); equivocal evidence: mouse; no evidence: mouse, rat.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U088.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.20; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313: Deleted from EPCRA/SARA 313 July 29, 1996 (FR Vol. 61, No. 146, p. 39356-39357).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1; National Pollutant Release Inventory (NPRI).

Mexico, Drinking Water Criteria, Wastewater.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diethyl phthalate is a water-white odorless liquid. Molecular weight = 222.26; Specific gravity (H_2O:1) = 1.12; Boiling point = 296°C; Melting point = −44.5°C; Flash point = 161°C (cc); Autoignition temperature = 457°C. Explosive limits: LEL = 0.7% at 186°C; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.1% at 25°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. This material is used as a plasticizer, dye carrier, and wetting agent; as a solvent for cellulose esters; as a vehicle in pesticidal sprays; as a fixative and solvent in perfumery; as an alcohol denaturant; and as a plasticizer in solid rocket propellants.

Incompatibilities: Violent reaction with strong acids, strong oxidizers, including permanganates, water. Attacks some forms of plastic.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 3 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3 [skin] 1999; France: VME 5 mg/m^3, 1999; Japan: 5 mg/m^3, 1999; Norway: TWA 3 mg/m^3, 1999; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 15 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, 1993; Sweden: NGV 3 mg/m^3, KTV 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3. 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for diethyl phthalate in ambient air[60] ranging from 16.7 μg/m^3 (New York) to 25.0 μg/m^3 (South Carolina) to 50.0 μg/m^3 (Connecticut and Florida) to 50−100 μg/m^3 (North Dakota) to 80.0 μg/m^3 (Virginia) to 119 μg/m^3 (Nevada).

Determination in Air: Collection by OSHA versatile sampler-Tenax; Toluene; Gas chromatography/Flame ionization detection; OSHA Analytical Method #104.

Permissible Concentration in Water: Data are insufficient to draft criterion for the protection of either freshwater or marine organisms. The recommended water quality criterion level for protection of human health is 350 mg/L (350,000 μg/L).[6] Kansas has set guideline for drinking water of 350 mg/L.[61] The Mexican drinking water criteria is 350.0 mg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method #606) or gas chromatography plus mass spectrometry (EPA Method #625). Octanol−water coefficient: Log $K_{ow} = 2.47$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation: Levels above 500 mg/m^3 may cause irritation. Exposure to heated vapors may cause irritation of the nose and throat, dizziness, and nausea. Sensitive individuals may develop an allergic reaction similar to asthma. *Skin:* Can be absorbed. May cause irritation and allergy. *Eyes:* Contact can cause irritation and damage to the cornea. *Ingestion:* Animal studies suggest that about 2.5 liquid ounces may cause death in a 150-lb adult. Symptoms include headache, dizziness, nausea, lacrimation (discharge of tears), possible polyneuropathy, vestibular dysfunction, pain, numbness, weakness, spasms in arms and legs.

Long Term Exposure: Prolonged inhalation may cause irritation of the nose, throat, and respiratory system. Repeated exposure may cause disturbed sleep, with pain, numbness, or weakness in the arms and legs. In animals: reproductive effects.

Points of Attack: Eyes, skin, respiratory system, central nervous system, peripheral nervous system, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following are recommended: medical exam of the nervous system. Complete blood count and differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure *over 5 mg/m^3*, use an NIOSH/MSHA- or European Standard EN 149-approved full-face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full face-piece powered air-purifying respirators. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect diethyl phthalate, or in the case of a full-face-piece respirator if you experience eye irritation, leave the area immediately.

Storage: Color Code—Green: General storage may be used. Prior to working with DEP you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and oxidizing agents (such as permanganates, nitrates, chlorates, perchlorates, and peroxides). Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. However, ignition is difficult. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Water or foam may cause frothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Phthalate Esters: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Diethyl Phthalate: Health and Environmental Effects Profile No. 85*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Diethyl Phthalate*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Diethylstilbestrol D:0910

Molecular Formula: $C_{18}H_{20}O_2$

Synonyms: Acnestrol; Agostilben; Antigestil; Bio-DES; 3,4-Bis(*p*-hydrophenyl)-3-hexene; Bufton; Climaterine; Comestrol; Comestrol estrobene; Cyren; Dawe's destrol; DEB; DES; Desma; DES (synthetic estrogen); Destrol; Diastyl; Dibestrol; Dicorvin; Di-estryl; (*E*)-4,4′-(1,2-Diethyl-1,2-ethenediyl) bisphenol; *trans*-4,4′-(1,2-Diethyl-1,2-ethenediyl)bisphenol; 4,4′-(1,2-Diethyl-1,2-ethenediyl)bis-phenol; α,α′-Diethyl-(*E*)-4,4′d-stilbenediol; α,α′-Diethylstilbenediol; *trans*-α,α′-Diethyl-stilbenediol; 2,2′-Diethyl-4,4′-stilbenediol; *trans*-Diethylstilbestrol; Dietilestilbestrol (Spanish); 4,4′-Dihydroxy-α,β-diethylstilbene; 4,4′-Dihydroxydiethyl-stilbene; 3,4′(4,4′-Dihydroxyphenyl)hex-3-ene; Distilbene; Domestrol; Dyestrol; Estilben; Estril; Estrobene; Estrogen; Estromenin; Estrosyn; Follidiene; Fonatol; Grafestrol; Gynopharm; Hibestrol; Idroestril; Iscovesco; Makarol; Menosyilbeen; Micrest; Microest; Milestrol; Neo-Oestranol 1; NSC-3070; Oekolp; Oestrogenine; Oestrol; Oestromenin; Oestromensil; Oestromensyl; Oestromienin; Oestromon; Pabestrol; Palestrol; Percutatrine oestrogenique iscovesco; Phenol, 4,4′-(1,2-diethyl-1,2-ethenediyl)bis-, (*E*)-; Protectona; Rumestrol 2; Sedestran; Serral; Sexocretin; Sibol; Sintestrol; Stibilium; Stil; Stilbestrol; Stilbestrone; Stilbetin; Stilboefral; Stilboestroform; Stilboestrol; Stilbofollin; Stilbol; Stilkap; Stil-Rol; Synestrin; Synthoestrin; Synthofolin; Syntofolin; Tampovagan stilboestrol; Tylosterone; Vagestrol; Vetag

CAS Registry Number: 56-53-1

RTECS® Number: WJ5600000

UN/NA & ERG Number: UN3077/171

EC Number: 200-278-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, animal Sufficient Evidence*, carcinogenic to humans*, Group 1, 1998.[9]; NTP: Known to be a human carcinogen.

Banned or Severely Restricted (many countries) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U089.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 2/27/87; Developmental/Reproductive toxin 7/1/87.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DES is a white, odorless, crystalline powder or plates. Molecular weight = 268.35; Freezing/Melting point = 172°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solubility = 13,000 mg/L.

Potential Exposure: DES had been used extensively as a growth promoter for cattle and sheep and is used in veterinary medicine to treat estrogen-deficiency disorders. It has been used in humans to prevent spontaneous abortions; to treat symptoms associated with menopause, menstrual disorders, postpartum breast engorgement, primary ovarian failure, breast cancer, and prostate cancers in males. In 1979, the DFA revoked all use of DES in food-producing animals. The Court of Appeals upheld the Commissioner's decision to revoke the use of DES in all food-producing animals on November 24, 1980; the motion to reconsider was denied on December 24, 1980.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.025 mg/m^3
PAC-1: 0.075 mg/m^3
PAC-2: 0.6 mg/m^3
PAC-3: 15 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Nausea, headache, vomiting, local irritation of eyes, skin, and mucous membranes.

Long Term Exposure: A Confirmed Human Carcinogen. May affect the glands. A possible teratogen. May cause vaginal bleeding. In men, it may cause impotence, breast enlargement, and other feminizing effects.

Points of Attack: Cancer sites: skin, liver, and lung; uterine and other reproductive system in the female newborn of exposed women. Glandular system.

First Aid: *Skin Contact*[52]*:* Flood areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately, breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—Green: General storage may be used. Prior to working with DES you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 59−61 (1981) and 6, No. 2, 57−62

Diethyl sulfate D:0920

Molecular Formula: $C_4H_{10}O_4S$
Common Formula: $(C_2H_5)_2SO_4$
Synonyms: DES; Diaethylsulfat (German); Diethyl ester sulfuric acid; Diethyl sulphate; Diethyl tetraoxosulfate; Diethyl tetraoxosulphate; DS; Ethyl sulfate; Ethyl sulphate; Sulfato de dietilo (Spanish); Sulfuric acid, diethyl ester
CAS Registry Number: 64-67-5
RTECS® Number: WS7875000
UN/NA & ERG Number: UN1594/152
EC Number: 200-589-6 [*Annex I Index No.*: 016-027-00-6]
Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: *Aspergillus*—forward mutation; Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: Host-mediated assay; *N. crassa*—reversion; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; *S. pombe*—reversion; Negative: *D. melanogaster*—whole sex chrom. loss; Negative: Rodent dominant lethal; Inconclusive: Cytogenetics—male germ cell; Mouse specific locus.

Banned or Severely Restricted (Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI).

European/International Regulations: Hazard Symbol: T; Risk phrases: R45;R46; R20/21/22; R34; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Diethyl sulfate is a colorless, oily liquid with a faint peppermint-like or ether-like odor. Turns brown on contact with air. Molecular weight = 154.20; Boiling point = 209°C (decomposes); Freezing/Melting point = −25°C; Flash point = 104°C; Autoignition temperature = 436°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Insoluble in water; slight decomposition.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Used as an industrial chemical; ethylating agent (synthesis of dye and pharmaceuticals); synthesizing agent of ammonium chloride compounds; in making isopropyl alcohol, ethyl alcohol, and other chemicals; dehydrating agent; extractant for gasoline.

Incompatibilities: Vigorous reaction with strong oxidizers or water (forms sulfuric acid). The aqueous solution is a strong acid; incompatible with nonoxidizing mineral acids, organic acids, bases, acrylates, aldehydes, alcohols, alkylene oxides, ammonia, aliphatic amines, alkanolamines, aromatic amines, amides, chlorates, epichlorohydrin, fulminates, glycols, isocyanates, ketones, powdered metals, organic anhydrides, perchlorates, picrates, substituted allyls, phenols, and cresols. DS decomposes when heated, producing diethyl ether and fumes of sulfur oxides. DS is a strong reducing agent; reacts with oxidizing materials. Forms explosive hydrogen gas on contact with iron in the presence of water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.075 ppm
PAC-1: 0.2 ppm
PAC-2: 1.5 ppm
PAC-3: 25 ppm

DFG MAK: Carcinogen Category 2; Germ Cell Mutation Category 2 (2006).

Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.03 ppm (0.2 mg/m^3), carcinogen, 1999; United Kingdom: TWA 0.05 ppm (0.32 mg/m^3), [skin], carcinogen 2000.

Harmful Effects and Symptoms

Short Term Exposure: DS is corrosive to the eyes, skin, and respiratory tract. Inhalation of the aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. A poison by subcutaneous and inhalation routes. Moderate acute toxicity by ingestion and skin routes. An experimental tumorigen, transplacental brain carcinogen.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. DS is a probable human carcinogen. May cause heritable genetic damage in humans. May cause lung damage.

Points of Attack: Lungs, central nervous system, skin, reproductive system. Cancer sites: lungs and stomach in animals and throat in humans.

Medical Surveillance: Preclude from exposure those individuals with diseases of central nervous system, kidneys, and liver. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Gastric lavage (stomach wash), if swallowed, followed by saline catharsis. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Protect against physical damage. Store in a cool, dry, well-ventilated location away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from other storage. Before entering confined space where DS may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water or foam may cause frothing and sulfuric acid. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent. Scatter the spray of the solvent into the furnace with afterburner and alkali scrubber.

Reference
New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Diethyl Sulfate*. Trenton, NJ

Diethyl zinc D:0930

Molecular Formula: $C_4H_{10}Zn$
Common Formula: $(C_2H_5)_2Zn$
Synonyms: Ethyl zinc; Zinc, diethyl-; Zinc ethide; Zinc ethyl
CAS Registry Number: 557-20-0
RTECS® Number: ZH2070000
UN/NA & ERG Number: UN1366/135
EC Number: 209-161-3 [*Annex I Index No.*: 030-004-00-8]
Regulatory Authority and Advisory Bodies
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 10,000 lb (4540 kg).
European/International Regulations: Hazard Symbol: F, C, N; Risk phrases: R14; R17; R 34; R50/53; Safety phrases: S1/2; S16; S43; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Diethyl Zinc is a colorless liquid. Molecular weight = 123.51; Boiling point = 124°C; Flash point = Ignites spontaneously in air at room temperature. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3₩ (water reactive). *Do not use water*, foam, or halogenated extinguishing agents. Contact with water causes violent decomposition releasing a flammable gas. It should be used under a dry inert gas, kerosene blanket, or in an evacuated system.
Potential Exposure: Diethyl zinc is used in organic syntheses; as a catalyst in the manufacture of olefin polymers and as a high-energy aircraft and missile fuel.
Incompatibilities: Ignites spontaneously on contact with air or strong oxidizers. Explosive decomposition at 245°F/120°C. Violent reaction with hydrazine, sulfur dioxide, halogens, some alcohols, ozone; possible fire and explosions. Contact with water forms ethane gas.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.3 ppm
PAC-2: 2 ppm
PAC-3: 10 ppm
Harmful Effects and Symptoms
Short Term Exposure: Contact can irritate or burn the eyes and skin.
Long Term Exposure: Unknown at this time.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Because diethyl zinc can ignite spontaneously, protective clothing should be fire-retardant or fire-proof. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to diethyl zinc, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with diethyl zinc you should be trained on its proper handling and storage. Before entering confined space where diethyl zinc may be present, check to make sure that an explosive concentration does not exist. Diethyl zinc must be stored to avoid contact with water, chlorine, hydrazine, and oxidizers since violent reactions occur. Store in sealed tubes or cylinders under a dry, inert gas blanket or in an evacuated system. Shade from radiant heat and protect from rain. Metal containers involving the transfer of 5 gallons or more of diethyl zinc should be grounded and bonded. Wherever diethyl zinc is used, handled, manufactured, or stored, use explosion proof electrical equipment and fittings. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.
Shipping: This compound requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard 4.2 and Packing Group I.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup

is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable and highly reactive liquid. It can ignite spontaneously if it is exposed to air or moisture at room temperature. Poisonous gases, including zinc oxide, are produced in fire. Use dry chemical, soda ash, or lime extinguishers. *Do not use water*, foam, or halogenated extinguishers. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Diethyl Zinc*. Trenton, NJ

Difluorodibromomethane D:0940

Molecular Formula: CBr_2F_2

Synonyms: Dibromodifluoromethane; Freon® 12B2; Halon® 1202; Methane, dibromofluoro-

CAS Registry Number: 75-61-6

RTECS® Number: PA7525000

UN/NA & ERG Number: UN1941/171

EC Number: 200-885-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Difluorodibromomethane is a colorless heavy liquid or gas (above 24°C/76°F) with a characteristic odor. Molecular weight = 209.83; Boiling point = 24°C; Freezing/Melting point = − 146°C; Vapor pressure = 620 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Insoluble in water.

Potential Exposure: This material is used as a fire-extinguishing agent and in making dyes and pharmaceuticals.

Incompatibilities: Reacts with chemically active metals, such as sodium, potassium, calcium, powdered aluminum, zinc, magnesium. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 8.58 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/860 mg/m^3 TWA.

NIOSH REL: 100 ppm/860 mg/m^3 TWA.

ACGIH TLV®[1]: 100 ppm/858 mg/m^3 TWA.

No TEEL available.

DFG MAK: No numerical value established. Data may be available.

NIOSH IDLH: 2000 ppm.

Australia: TWA 100 ppm (860 mg/m^3), 1993; Austria: MAK 100 ppm (860 mg/m^3), 1999; Belgium: TWA 100 ppm (858 mg/m^3), 1993; Denmark: TWA 100 ppm (860 mg/m^3), 1999; Finland: TWA 100 ppm (860 mg/m^3); STEL 150 ppm (1290 mg/m^3), 1999; France: VME 100 ppm (860 mg/m^3), 1993; the Netherlands: MAC-TGG 860 mg/m^3, 2003; the Philippines: TWA 100 ppm (860 mg/m^3), 1993; Switzerland: MAK-W 100 ppm (860 mg/m^3), KZG-W 200 ppm (1720 mg/m^3), 1999; Turkey: TWA 100 ppm (860 mg/m^3), 1993; United Kingdom: TWA 100 ppm (872 mg/m^3); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm. Several states have set guidelines or standards for this compound in ambient air[60] ranging from 8.6 mg/m^3 (North Dakota) to 14.0 mg/m^3 (Virginia) to 17.2 mg/m^3 (Connecticut) to 29.5 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with isopropanol, analysis by gas chromatography. Use NIOSH Analytical Method 1012.[18]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause eye and skin irritation. Inhalation can irritate the nose and throat. High exposures can cause you to become dizzy, lightheaded, and to pass out. Also, high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact with the liquid can cause frostbite.

Long Term Exposure: May cause liver damage. In animals: central nervous system symptoms; liver damage.

Points of Attack: Respiratory system, central nervous system, liver.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: consider chest X-ray following acute overexposure. Liver and lung function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. When working with Difluorodibromomethane gas, wear gas-proof goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *Up to 1000 ppm:* Sa (APF = 10) (any supplied respirator). *Up to 2000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Difluorodibromomethane must be stored to avoid contact with chemically active metals, such as sodium, potassium, calcium, powdered aluminum, zinc, and magnesium since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: This compound does not require a shipping label. It falls in Hazard Class 9 and Packing III. The symbol "A" restricts the application of requirements of this subchapter to materials offered or intended for transportation by aircraft, unless the material is a hazardous substance or a hazardous waste.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate area of spill or leak. If the gas is leaking, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If the liquid is spilled or leaked, allow it to vaporize.

Fire Extinguishing: This chemical is a noncombustible liquid or gas. Poisonous gases, including hydrogen bromide, hydrogen fluoride, carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure

position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Venting to the atmosphere was formerly the preferred method. Now, concern for destruction of the ozone layer has made this method unacceptable. Return to supplier (where possible) or high-temperature incineration must now be used.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Difluorodibromomethane*. Trenton, NJ

Digitoxin D:0950

Molecular Formula: $C_{41}H_{64}O_{13}$

Synonyms: Acedoxin; Asthenthilo; Cardidigin; Cardigin; Carditoxin; Cristapurat; Crystalline digitalin; Crystodigin; (3b,5b)-3-[(*O*-2,6-Dideoxy-β-D-ribohexopyranosyl-(1→4)-*O*-2,6-dideoxy-β-D-ribohexopyranosyl-(1→4)-2,6-dideoxy-β-D-ribo-hexopyranosyl)oxy]-14-hydroxycard-20(22)-enolide; Digilong; Digimed; Digimerck; Digisidin; Digitalin; Digitaline (French); Digitaline cristalliseel digitaline nativelle; Digitalinum verum; Digitophyllin; Digitoxigenin-tridigitoxosid (German); Digitoxigenin tridigitoxoside; Digitoxina (Spanish); Ditaven; Glucodigin; Lanatoxin; Monoglycocoard; Myodigin; Purodigin; Purpurid; Tardigal; Tri-digitoxoside (German); Unidigin

CAS Registry Number: 71-63-6

RTECS® Number: IH2275000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-760-5 [*Annex I Index No.:* 614-022-00-9]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/25; R33; Safety phrases: S1/2; R45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Digitoxin is a white crystalline solid; Molecular weight = 765.05; Freezing/Melting point = 256−257°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Natural Product; Reproductive Effector; Primary Irritant. This material is used as a cardiotonic drug. Digitoxin is the most toxic component of digitalis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0075 mg/m^3

PAC-1: 0.025 mg/m^3

PAC-2: 0.18 mg/m^3

PAC-3: 0.25 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. Symptoms of exposure include nausea and vomiting. Headache, malaise, fatigue, weakness, drowsiness, and abdominal discomfort are symptomatic of toxicity. Visual disturbances (reduction of visual acuity, illusions of flickering or shimmering lights, abnormal color vision) and emotional disorders (including confusion, disorientation, aphasia, delirium, hallucinations, and rarely, convulsions) are also possible toxic effects. This material is bioactive and capable of causing cardiac arrhythmias and electrolyte imbalances that may be fatal. Death is due to ventricular fibrillation or cardiac arrest. Material has a high toxicity hazard rating; it may cause death or permanent injury after a very short exposure. It is classified as super toxic; an estimated single lethal dose is 3−10 mg. LD_{50} = (oral-rat) 56 mg/kg.

Long Term Exposure: May cause reproductive effects.

Points of Attack: Heart.

Medical Surveillance: EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with digitoxin you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator.

Shipping: This compound can be classed under Medicine, solid, toxic, n.o.s. It requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Digitoxin*. Washington, DC: Chemical Emergency Preparedness Program

Diglycidyl ether D:0960

Molecular Formula: $C_6H_{10}O_3$

Synonyms: Bis(2,3-epoxypropyl) ether; Bis(2-3-epoxypropyl) ether; DGE; Diallyl ether dioxide; Di(2,3-epoxy)propyl ether; Di(epoxypropyl) ether; 2-Epoxypropyl ether; Ether, bis(2,3-epoxypropyl); Ether, diglycidyl; NSV 54739; Oxirane, 2,2′-oxybis (methylene) bis-; 2,2′-Oxybis(methylene)bisoxirane

CAS Registry Number: 2238-07-5

RTECS® Number: KN2350000

UN/NA & ERG Number: UN2922 (Corrosive liquid, toxic, n.o.s.)/154 check

EC Number: 218-802-6

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *N. crassa*—reversion.

Listed in the TSCA inventory.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section; NIOSH potential human carcinogen, See *NIOSH Pocket Guide*, Appendix A.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

California Proposition 65 Chemical: Developmental/ Reproductive toxin (male) 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R19; R21/22; R23; R34; Safety phrases: S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diglycidyl ether is a colorless liquid with a strong, irritating odor. Molecular weight = 130.14; Boiling point = 260°C; Vapor pressure = 0.09 mmHg at 25°C; 0.21 mmHg at 20°C; Flash point = 63.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. This material is used as a reactive diluent for epoxy resins; as a textile treating agent; and as a stabilizer for chlorinated organic compounds.

Incompatibilities: Forms explosive mixture with air. May explode when heated. Contact with strong oxidizers may cause fire and explosions. Ethers, as a class, tend to form peroxides upon contact with air and exposure to light. Attacks some forms of plastics, coatings, and rubber.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 ppm/2.8 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.1 ppm/0.5 mg/m^3 TWA; Potential occupational carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 ppm/0.05 mg/m^3; not classifiable as a human carcinogen.

NIOSH IDLH: 10 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.01 ppm

PAC-1: 10 ppm

PAC-2: 10 ppm

PAC-3: 10 ppm

DFG MAK: [skin]; Carcinogen Category 3B.

Australia: TWA 0.1 ppm (0.5 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.6 mg/m^3), Suspected carcinogen, 1999; Belgium: TWA 0.1 ppm (0.53 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.53 mg/m^3), 1999; Finland: STEL 0.2 ppm (1 mg/m^3), [skin], 1999; France: VME 0.1 ppm (0.5 mg/m^3), 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 0.5 ppm (2.8 mg/m^3), 1993; Sweden: TGV 0.2 ppm (1.1 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.5 mg/m^3), KZG-W 0.2 ppm (1.0 mg/m^3), 1999; Thailand: TWA 0.5 ppm (2.8 mg/m^3), 1993; Turkey: TWA 0.5 ppm (2.8 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.53 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The Canadian province of British Columbia: 0.5 ppm/2.8 mg/m^3 Ceiling Concentration. Several states have set guidelines or standards for DFG in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 5−10 μg/m^3 (Connecticut) to 8.0 μg/m^3 (Virginia) to 2380 μg/m^3 (Nevada).

Determination in Air: Adsorption by charcoal tube, analysis by gas liquid chromatography.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Diglycidyl ether can affect you when breathed in and by passing through your skin. Higher levels can cause you to feel dizzy, lightheaded, and to pass out. Death can occur. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. DGE may affect the blood, kidneys, liver, testes. Contact can irritate and burn the eyes and skin, and cause skin allergy. Because this is a mutagen, handle it as a possible carcinogen—with extreme caution. LD_{50} = (oral-rat) 450 mg/kg.

Long Term Exposure: Repeated exposure can damage the liver and kidneys and can lower blood cell count. Diglycidyl ether may damage the lungs and cause clouding of the eyes. Repeated or prolonged contact with skin may cause skin sensitization and dermatitis. Animal tests show that DGE may damage the testes. Designated a potential occupational carcinogen by NIOSH (as glycidyl ethers).

Points of Attack: Eyes, skin, respiratory system, reproductive system. Cancer site in animals: skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Liver and kidney function tests; lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the eyes and vision. NIOSH lists the following tests: complete blood count; chest X-ray; pulmonary function tests; forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with DGE you should be trained on its proper handling and storage. Diglycidyl ether must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, bromine, nitrates, and permanganates since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where diglycidyl ether is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: DGE requires a "CORROSIVE" label. It falls in Hazard Class 8(6.1) and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid that may explode on heating. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Glycidyl Ethers*, Report PB-276-678. Rockville, MD, pp. 116−123

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers*, NIOSH Document No. 78-166. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diglycidyl Ether*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Diglycidyl Ether*. Trenton, NJ

Diglycidyl ether of bisphenol A D:0970

Molecular Formula: $C_{21}H_{24}O_4$

Synonyms: 2,2′-Bis [(*p*-2,3-epoxy propoxy) phenyl] propane; 2,2-Bis[4-(2,3-epoxypropyloxy)phenyl]propane; Bis(4-glycidyloxyphenyl)dimethylamethane; 2,2-Bis(*p*-glycidyloxyphenyl)propane; Bis(4-hydroxyphenyl)dimethylmethane diglycidyl ether; 2,2-Bis(*p*-hydroxyphenyl)propane, diglycidyl ether; 2,2-Bis(4-hydroxyphenyl)propane, diglycidyl ether; D.E. R. 332; Diglycidyl bisphenol A; Diglycidyl ether of 2,2-bis(*p*-hydroxyphenyl)propane; Diglycidyl ether of 2,2-bis(4-hydroxyphenyl)propane; Diglycidyl ether of bisphenol A; Diglycidyl ether of 4,4′-isopropylidenediphenol; *p,p*′-Dihydroxydiphenyldimethylmethane diglycidyl ether; 4,4′-Dihydroxydiphenyldimethylmethane diglycidyl ether; EPI-REZ 508; EPI-REZ 510; Epon 828; Epoxide A; ERL-2774; 4,4′-Isopropylidenediphenol diglycidyl ether; 2,2′-[(1-Methylethylidene)bis(4,1-phenyleneoxymethylene)] bisoxirane

CAS Registry Number: 1675-54-3

RTECS® Number: TX3800000

UN/NA & ERG Number: Not regulated.

EC Number: 216-823-5 [*Annex I Index No.:* 603-073-00-2]

Regulatory Authority and Advisory Bodies

Canada WHMIS Classification D2b Skin sensitizer; DSL listed.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/38; R43; Safety phrases: S2; S28-37/39. WGK (German Aquatic Hazard Class): No value assigned.

Description: Diglycidyl ether of bisphenol A is a colorless to light amber liquid. Slight epoxy odor. Molecular weight = 340.45; Freezing/Melting point = 8−12°C and decomposes in lieu of boiling; Flash point = >251.5°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Diglycidyl ether of bisphenol A is used as a basic active ingredient of epoxy resins.

Incompatibilities: Easily oxidized in air; presumed to form unstable and explosive peroxides in storage. Incompatible with strong acids; strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 6 mg/m^3

DFG MAK: [skin] Danger of sensitization of the skin; Germ Cell Mutagen Category 3A.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Diglycidyl ether of bisphenol A can affect you when breathed in and by passing through your skin. Skin contact can cause irritation and rash. It may also lead to the development of skin allergy. Once allergy develops even low future exposures can trigger rash. Eye contact causes irritation. The vapors can irritate the eyes, nose, throat, and bronchial tubes, causing nosebleeds, coughing, and tightness in the chest. LD_{50} = (oral-rat) >5000 mg/kg.

Long Term Exposure: There is limited evidence that this chemical causes skin cancer in animals. May cause dermatitis; skin sensitization and allergy.

Points of Attack: Skin, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to diglycidyl ether of bisphenol A, use a MSHA/NOSH approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard (skin sensitization): Store in a secure location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area away from strong oxidizers, acids, and heat. Recommended storage (and pumping) temperature = 45−50°C.

Shipping: This material is not covered in DOT's Performance-Oriented Packaging Standards.[19] It may, however, be classified as a Combustible Liquid, n.o.s. This class requires no shipping label. It falls in Hazard Class 3 [each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F], and Packing Group III. The symbol "D" identifies proper shipping names which are appropriate for describing materials for domestic transportation but may be inappropriate for international transportation under the provisions of international regulations (e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (October 12, 1978). *Glycidyl Ethers, NIOSH Current Intelligence Bulletin No. 29*. Cincinnati, OH

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Diglycidyl Ether of Bisphenol A*. Trenton, NJ

Digoxin D:0980

Molecular Formula: $C_{41}H_{64}O_{14}$

Synonyms: Chloroformic digitalin; Card-20(22)-enolide, 3-((o-2,6-dideoxy-β-d-ribo- hexopyranosyl-(hexopyranosyl-(1-4)-2,6-dideoxy-β-d-ribo-hexopyranosyl)oxy)-12,14-dihydroxy-; Digacin; Digitalis glycoside; Digoxigenintridigitoxosid (German); Digoxina (Spanish); Digoxine; Homolle's digitalin; Lanicor; Lanoxin; Rougoxin; SK-Digoxin

CAS Registry Number: 20830-75-5

RTECS® Number: IH6125000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 244-068-1

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (0.454/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Digoxin is a white crystalline solid. Molecular weight = 781.05; Freezing/Melting point = 230−265°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Compound Description: Natural Product; Reproductive Effector. Digoxin is used as a cardiotonic drug.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.04 mg/m^3

PAC-1: 0.125 mg/m^3

PAC-2: 0.2 mg/m^3

PAC-3: 0.35 mg/m^3

Routes of Entry: Ingestion, inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure refer specifically to digitalis and include nausea and vomiting; headache, fatigue, weakness, drowsiness, and abdominal discomfort are symptomatic of toxicity. Visual disturbances (including blurring, halos, and aberrations of color); emotional disorders (including confusion, disorientation, aphasia, delirium, and hallucinations); and convulsions. Material is a digitalis glycoside. Ingestion can cause death. Material is considered super toxic; probable human oral lethal dose is less than 5 mg/kg, a taste (less than 7 drops) for a 70-kg (150-lb) person.

Persons at risk include those taking drugs for thyroid and renal diseases. Quinidine and diuretics taken concurrently with digoxin can be hazardous. It should be used with extreme care during pregnancy and in nursing mothers.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Avoid light. Store in tightly closed containers in a dark, cool, well-ventilated area away from oxidizers and reducing agents.

Shipping: This compound falls in the DOT ID and ERG Number: UN3249. Medicine, solid, toxic, n.o.s. category and requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Digoxin*. Washington, DC: Chemical Emergency Preparedness Program

Dihydrosafrole D:0990

Molecular Formula: $C_{10}H_{12}O_2$

Synonyms: AI3-03435; Benzene, 1,2-(methylenedioxy)-4-propyl-; 1,3-Benzodioxole, 5-propyl-; Dihidrosafrol (Spanish); Dihydroisosafrole; Dihydrosafrol; 2′,3′-Dihydrosafrole; [1,2-(Methylenedioxy)-4-propyl]benzene; NSC 27867; 5-Propyl-1,3-benzodioxole; 4-Propyl-1,2-(methylenedioxy)benzene; Safrole, dihydro-

CAS Registry Number: 94-58-6

RTECS® Number: DA6125000

UN/NA & ERG Number: UN3082/171

EC Number: 202-344-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1987.

US EPA Hazardous Waste Number (RCRA No.): U090.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dihydrosafrole is an oily liquid. Molecular weight = 164.22; Boiling point = 228°C; Wiswesser line notation: T56 BO DO CHJ G3.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Primary Irritant. Workers may be exposed to dihydrosafrole during its use as a chemical intermediate in the production of piperonyl butoxide and related insecticidal synergists; and in the production of fragrances for cosmetic products.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Water: By chromatography.

Harmful Effects and Symptoms

Short Term Exposure: Skin contact can cause irritation. An LD_{50} value of 2260 mg/kg has been reported for rats (slightly toxic).

Long Term Exposure: Dihydrosafrole is recognized as a carcinogen in experimental animals by the International Agency for Research on Cancer IARC: and the National Cancer Institute Bioassay Program.

Points of Attack: Liver, spleen.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter front- or back-mounted organic vapor canister having a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The US EPA recommends packaging of product residues and sorbent media in epoxy-lined drums and disposal at an EPA-approved site. The compound may be destroyed by permanganate oxidation, high-temperature incineration with scrubbing equipment, or microwave plasma treatment. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (May 17, 1984). *Chemical Hazard Information Profile Draft Report: Dihydrosafrole*. Washington, DC

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 2, 51−53

Diisobutyl ketone D:1000

Molecular Formula: $C_9H_{18}O$

Common Formula: $[(CH_3)_2CHCH_2]_2CO$

Synonyms: DIBK; Diisipropyl-acetone; Di-isobutylcetone (French); Diisobutylketon (German); 5-Diisopropylacetone; Diisopropylacetone; 2,6-Dimethyl-4-heptane; 2,6-Dimethylheptan-4-on (German); 2,6-Dimethyl-4-heptanone; 2,6-Dimethylheptan-4-one; 2,6-Dimethylheptanone; 4-Heptanone,2,6-dimethyl-; Isobutyl ketone; Isovalerone; Valerone

CAS Registry Number: 108-83-8

RTECS® Number: MJ5775000

UN/NA & ERG Number: UN1157/128

EC Number: 203-620-1[*Annex I Index No.:* 606-005-00-X]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R37; Safety phrases: S2; S24 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diisobutyl ketone is a colorless liquid with a mild, sweet odor. Molecular weight = 142.27; Specific gravity (H_2O:1) = 0.81; Boiling point = 167.8°C; Freezing/Melting point = −42°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 48.8°C (cc); Autoignition temperature = 396°C. The explosive limits are LEL = 0.8%; UEL = 7.1% at 93°C.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.05%.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Diisobutyl ketone is used as a solvent; as a dispersant for resins; and as an intermediate in the synthesis of pharmaceuticals and pesticides.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, aliphatic amines, strong oxidizers. Attacks some forms of plastics, coatings, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.82 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/290 mg/m^3 TWA.

NIOSH REL: 25 ppm/150 mg/m^3 TWA.

ACGIH TLV®[1]: 25 ppm/145 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 50 ppm

PAC-2: 50 ppm

PAC-3: 500 ppm

DFG MAK: No numerical value established. Data may be available.

NIOSH IDLH: 500 ppm

Australia: TWA 25 ppm (150 mg/m^3), 1993; Austria: MAK 50 ppm (290 mg/m^3), 1999; Belgium: TWA 25 ppm (145 mg/m^3), 1993; Denmark: TWA 25 ppm (150 mg/m^3), 1999; Finland: TWA 25 ppm (150 mg/m^3); STEL 40 ppm (225 mg/m^3), 1999; France: VME 25 ppm (150 mg/m^3), 1999; the Netherlands: MAC-TGG 150 mg/m^3, 2003; the Philippines: TWA 50 ppm (290 mg/m^3), 1993; Poland: MAC (TWA) 150 mg/m^3, MAC (STEL) 300 mg/m^3, 1999; Switzerland: MAK-W 25 ppm (150 mg/m^3), 1999; Turkey: TWA 50 ppm (290 mg/m^3), 1993; United Kingdom: TWA 25 ppm (148 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. Several states have set guidelines or standards for diisobutyl ketone in ambient air[60] ranging from 2.5 mg/m^3 (North Dakota and Virginia) to 2.8 mg/m^3 (Connecticut) to 3.57 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300, NIOSH Analytical Method #2555, and OSHA Analytical Method 7.[18]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: DIBK irritates the eyes, skin, respiratory tract. Exposure to high concentrations could cause headaches, dizziness, unconsciousness.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis, liver, and kidney damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: liver and kidney function tests. NIOSH lists the following tests: pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof goggles and face shield unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with DIBK you should be trained on its proper handling and storage. Before entering confined space where DIBK may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22].

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*. NIOSH Document No. 78-113, Washington, DC

New Jersey Department of Health and Senior Services. (September 1996). *Hazardous Substances Fact Sheet: 2,6-Dimethylheptanone*. Trenton, NJ

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 51−52

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Diisopropylamine D:1010

Molecular Formula: $C_6H_{15}N$

Common Formula: $(CH_3)_2CHNHCH(CH_3)_2$

Synonyms: Bis(isopropyl)amine; DIPA*;* *n*-(1-Methyethyl)-2-propanamine; 2-Propanamine*,* *n*-(1-methylethyl)-

CAS Registry Number: 108-18-9

RTECS® Number: IM4025000

UN/NA & ERG Number: UN1158/132

EC Number: 203-558-5 [*Annex I Index No.:* 612-129-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R20/22; R34; Safety phrases: S2; S16; S26; S36/37/39; R45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diisopropylamine is a colorless liquid with an ammoniacal odor. Molecular weight = 101.22; Boiling point = 83.9°C; Melting point = − 96.1°C; Vapor pressure = 70 mmHg; Flash point = − 6.1°C; Autoignition temperature = 316°C. Explosive limits: LEL = 1.1%; UEL = 7.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Mutagen. This material is used in the preparation of vapor-phase inhibitors and rubber accelerators; as a chemical intermediate in the synthesis of pharmaceuticals and pesticides (diallate, fenamiphos, and triallate, for example).

Incompatibilities: Forms explosive mixture with air. This chemical is a strong base; reacts violently with strong oxidizers, strong acids. Attacks copper, zinc and their alloys, aluminum, and galvanized steel. Attacks some forms of plastics and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 5 ppm/20 mg/m^3 TWA [skin].

NIOSH REL: 5 ppm/20 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/21 mg/m^3 TWA [skin].

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 10 ppm

PAC-2: 75 ppm

PAC-3: 200 ppm

Australia: TWA 5 ppm (20 mg/m^3), [skin], 1993; Belgium: TWA 5 ppm (21 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (20 mg/m^3), [skin], 1999; Finland: STEL 5 ppm (20 mg/m^3), [skin], 1999; France: VME 5 ppm (20 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 20 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (20 mg/m^3), 1999; the Philippines: TWA 5 ppm (20 mg/m^3), [skin], 1993; Russia: STEL 5 mg/m^3, [skin], 1993; Switzerland: MAK-W 5 ppm (20 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (21 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 5 ppm [skin]. Several states have set guidelines or standards for diisopropylamine in ambient air[60] ranging from 200 μg/m^3 (North Dakota) to 350 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 476 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II(4), Method #S141.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: No tests listed. Octanol–water coefficient: Log $K_{ow} = 1.59$.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator. The vapor is corrosive to the eyes and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This can also cause nausea, vomiting, headaches, eye irritation, and visual disturbance. Contact may cause eye damage, causing cloudy vision. Exposure may cause a skin allergy to develop, so that even very small future exposures will result in itching and skin rash.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin allergy, dermatitis, lung damage, and asthma-like allergy.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time of test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™, Viton™, and nitrile are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *200 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*

SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with DIPA you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diisopropylamine must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) or oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where diisopropylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of diisopropylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of diisopropylamine.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID, CORROSIVE.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Diisopropylamine*. Trenton, NJ

Diisopropyl ether D:1020

Molecular Formula: $C_6H_{14}O$

Common Formula: $[(CH_3)_2CH]_2O$

Synonyms: Diisopropyl ether; Diisopropyl oxide; 2-Isopropoxy propane; 2-Isopropoxypropane; Isopropyl ether; 2,2′-Oxybispropane; Propane, 2,2′-oxybis-

CAS Registry Number: 108-20-3

RTECS® Number: TZ5425000

UN/NA & ERG Number: UN1159/127

EC Number: 203-560-6 [*Annex I Index No.:* 603-045-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; R19; R66; R67; Safety phrases: S2; S9; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diisopropyl ether is a colorless liquid with a sharp sweet ether-like odor. Molecular weight = 102.20; Boiling point = 69°C; Freezing/Melting point = −60°C; Vapor pressure = 119 mmHg at 20°C; Flash point = −27.8°C. Autoignition temperature = 443°C. Explosive limits: LEL = 1.4%; UEL = 7.9%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data; Primary Irritant. This material is used as a solvent, additive for gasoline, and a chemical intermediate.

Incompatibilities: Forms explosive mixture with air. Air contact forms explosive peroxides that may explode with heat or shock. Contact with strong oxidizers or strong acids may cause a fire and explosion hazard. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 500 ppm/2100 mg/m^3 TWA.

NIOSH REL: 500 ppm/2100 mg/m^3 TWA.

ACGIH TLV®[1]: 250 ppm/1040 mg/m^3 TWA; 310 ppm/1300 mg/m^3 STEL.

Protective Action Criteria (PAC)

TEEL-0: 250 ppm

PAC-1: 310 ppm

PAC-2: 310 ppm

PAC-3: 1400 ppm

DFG MAK: 200 ppm/850 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group: C.

NIOSH IDLH: 1400 ppm [LEL].

Australia: TWA 250 ppm (1050 mg/m^3); STEL 310 ppm, 1993; Austria: MAK 250 ppm (1050 mg/m^3), 1999; Belgium: TWA 250 ppm (1040 mg/m^3); STEL 310 ppm (1300 mg/m^3), 1993; Denmark: TWA 250 ppm (1050 mg/m^3), 1999; France: VME 250 ppm (1050 mg/m^3) 1999; the Netherlands: MAC-TGG 1050 mg/m^3, 2003; Norway: TWA 125 ppm (525 mg/m^3), 1999; Poland: MAC (TWA) 1000 mg/m^3, MAC (STEL) 1300 mg/m^3, 1999; Russia: STEL 100 mg/m^3, 1993; Switzerland: MAK-W 250 ppm (1050 mg/m^3), 1999; Turkey: TWA 500 ppm (2100 mg/m^3), 1993; United Kingdom: TWA 250 ppm (1060 mg/m^3); STEL 310 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 310 ppm.

Several states have set guidelines or standards for diisopropyl ether in ambient air[60] ranging from 10.5−13.2 mg/m^3 (North Dakota) to 17.5 mg/m^3 (Virginia) to 21.0 mg/m^3 (Connecticut) to 25.0 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1618 or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Diisopropyl ether irritates the eyes, skin, and respiratory tract. May affect the central nervous system. Inhaling or breathing diisopropyl ether may cause drowsiness, dizziness, and nausea. Higher levels may cause unconsciousness and even death.

Long Term Exposure: Prolonged or repeated exposures may cause drying and cracking of the skin.

Points of Attack: Respiratory system, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends nitrile rubber, polyvinyl alcohol, and viton materials as providing good to excellent protection in gloves and clothing. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 1400 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with diisopropyl ether you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diisopropyl ether must be stored to avoid contact with strong oxidizers, such as bromine, chlorine, chlorine dioxide, and nitrates since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, spark, or direct sunlight. Unstable peroxides may form when diisopropyl ether is in contact with the air for a long time. It may then explode by itself or when heated or subjected to shock. Sources of ignition, such as smoking and open flames, are prohibited where diisopropyl ether is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of diisopropyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxide-perforation of a container of the waste from a safe distance followed by open burning.

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Diisopropyl Ether*. Trenton, NJ

Dimefox D:1030

Molecular Formula: $C_4H_{12}FN_2OP$

Synonyms: BFPO; Bis(dimethylamido) fluorophosphate; Bis(dimethylamido)fluorophosphine oxide; Bis(dimethylamido)phosphoryl fluoride; Bis(dimethylamino) fluorophosphate; Bisdimethylaminofluorophosphine oxide; BPF; CR 409; DIFO; DMF; ENT 19,109; Fluophosphoric acid di (dimethylamide); Fluorure de *N*,*N*,*N*′,*N*′-tetramethyle phosphoro-diamide (French); Hanane; Pestox 14; Pestox IV; Pestox XIV; T-2002; Terra-Systam; Terra-Sytam; Terrasytum; Tetramethyldiamidophosphoric fluoride; *N*,*N*,*N*′,*N*′-Tetramethyl-diamido-phosphorsaeure-fluorid (German); *N*,*N*,*N*,*N*-Tetramethylphosphorodiamidic fluoride; Tetramethylphosphorodiamidic fluoride; Tetra systam; TL 792 Wacker 14/10

CAS Registry Number: 115-26-4

RTECS® Number: TD4025000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 204-076-8 [*Annex I Index No.:* 015-061-00-9]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R27/28; Safety phrases: S1/2; S23; S28; S36/37; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimefox is a clear liquid. Molecular weight = 154.14; Boiling point = 86°C at 15 mmHg. Hazard

Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1. Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this pesticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials, strong acids, halogens.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. This material is extremely toxic; the probable oral lethal dose (human) is 5−50 mg/kg or 7 drops to 1 teaspoonful for a 150-lb person. Death may occur from respiratory arrest. Hazards of vapor toxicity are high.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Dimefox may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dimefox you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids, halogens. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. Dimefox falls in Hazard Class 6.1 and because it is extremely toxic, in Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides, nitrogen oxides, and fluorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. *Do not* use halogen extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small batches may be mixed with sand and acid added in a pit or trench in clay soil. Larger quantities may be incinerated in a unit with effluent flue gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimefox*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Dimefox*. Trenton, NJ

Dimethoate D:1040

Molecular Formula: $C_5H_{12}NO_3PS_2$

Common Formula: $H_3COP(S)(OCH_3)SCH_2CONHCH_3$

Synonyms: Acetic acid, *O,O*-dimethyldithiophosphoryl-, *n*-monomethylamide salt; *O,O*-Dimethyl *S*-(*N*-methylcarbamoylmethyl) dithiophosphate; Gygon; Phosphamide; Phosphorodithioic acid, *O,O*-dimethyl *S*-[2-(methylamino)-2-oxoethyl] ester; Rogor

CAS Registry Number: 60-51-5; *(alt.)* 11096-20-1; *(alt.)* 56833-73-9

RTECS® Number: TE1750000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-480-3 [*Annex I Index No.:* 015-051-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat, 1977.

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion; Negative: Carcinogenicity—mouse/rat; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Supported, 1998.

US EPA Hazardous Waste Number (RCRA No.): P044.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada Drinking Water Quality, 0.02 mg/L MAC.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimethoate is a white crystalline solid with a camphor-like odor. Molecular weight = 229.27; Boiling point = 117°C; Freezing/Melting point = 52°C. Hazard Identification (based on NFPA-704 M Rating System):

Health 3, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Dimethoate is a contact and systemic organophosphate insecticide effective against a broad range of insects and mites when applied on a wide range of crops. It has not been produced in the United States since 1982.

Incompatibilities: Strong bases (alkalis). Do not store solid above 77−86°F/25−30°C. Liquid solutions must be stored above 45°F/7°C. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 6 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 30 mg/m^3

Russia[35,43] has set air MAC of 0.5 mg/m^3 in work-place air and limits in the ambient air of residential areas of 0.003 mg/m^3 on either a momentary or a daily average basis.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: A MAC of 0.03 mg/L in water bodies used for domestic purposes has been set by the former USSR.[35,43] States which have set guidelines for dimethoate in drinking water include California at 140 μg/L and Wisconsin at 10 μg/L.

Harmful Effects and Symptoms

Short Term Exposure: Acute exposure to dimethoate may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) and chest pain may be noted. Hypertension (high blood pressure) is not uncommon. Respiratory effects may include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Dimethoate is very toxic; the probable oral lethal dose in humans is between 50 and 500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150-lb) person. Dimethoate is a cholinesterase inhibitor, meaning it affects the central nervous system. Death is due to respiratory arrest arising from failure of the respiratory center, paralysis of respiratory muscles, intense bronchoconstriction, or all three. Dimethoate is a mutagen. Mutagens may have a cancer risk. All contact with this chemical should be reduced to the lowest possible level.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Animal tests indicate that this chemical possibly causes toxic effects upon human reproduction.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under medical observation. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dimethoate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from heat and strong bases. Do not store *solid* Dimethoate above 25−30°C/77−86°F. However, *liquid* solutions of dimethoate must be stored above 7°C/45°F. Keep away from sources of heat, flames, or spark-generating equipment. Unstable in alkaline solution. Hydrolyzed by aqueous alkali. Stable in aqueous solutions. The compound is stable for 2 years under environmental conditions if stored in undamaged, original containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a “POISONOUS/TOXIC MATERIALS” label. They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides, sulfur oxides, and phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be mixed with alkalis and then buried.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethoate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Dimethoate*. Trenton, NJ

3,3′-Dimethoxybenzidine D:1050

Molecular Formula: $C_{14}H_{16}N_2O_2$

Common Formula: $H_2N(OCH_3)C_6H_3{-}C_6H_3(OCH_3)NH_2$

Synonyms: Acetamine diazo black RD; Amacel developed navy SD; Azofix blue B salt; Azogene fast blue B; Azogene fast blue base; Benzidine, 3,3′-dimethoxy-; 4,4′-Bi-*o*-anisidine; (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dimethoxy-; Blue base IRGA B; Blue base NB; Blue BN base; Brentamine fast blue B base; Cellitazol B; C.I. 24110; C.I. Azoic diazo component 48; Cibacete diazo navy blue 2B; C.I. Disperse Black 6; Diacelliton Fast grey G; Diacel navy DC; 4,4′-Diamino-3,3′-dimethoxy-1,1′-biphenyl; *o*-Dianisidin (German); Dianisidina (Spanish); *o,o*′-Dianisidine; *o*-Dianisidine; 3,3′-Dianisidine; Dianisidine; Diato blue base B; 3,3′-Dimethoxybezidine; 3,3′-Dimethoxy-4,4′-diaminodiphenyl; 3,3′-Dimetoxibenzidina (Spanish); Fast blue base B; Fast blue B base; Fast blue DSC base; Hiltonil fast blue B base; Hiltosal fast blue B salt; Hindasol blue B salt; Kako blue B salt; Kayaku blue B base; Lake blue B base; Meisei teryl diazo blue HR; Mitsui blue B base; Naphthanil blue B base; Neutrosel navy BN; Sanyo fast blue salt B; Setacyl diazo navy R; Spectrolene blue B; DMOB.

CAS Registry Number: 119-90-4

RTECS® Number: DD0875000

UN/NA & ERG Number: UN1602 (Dyes, liquid, toxic, n.o. s. or Dye intermediates, liquid, toxic, n.o.s.)/151

EC Number: 204-355-4 [*Annex I Index No.:* 612-036-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A & C.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Histidine reversion—Ames test; Positive: *In vitro* UDS—human fibroblast; Inconclusive: *E. coli* polA without S9.

Banned or Severely Restricted (Germany, Sweden) (UN).[35]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U091.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: DMOB is a colorless crystalline material which may turn purple on standing in air. Molecular weight = 244.32; Freezing/Melting point = 137−138°C; Flash point = 206°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. DMOB or its dihydrochloride is used principally as a chemical intermediate for the production of azo dyes. About 30% of DMOB is used as a chemical intermediate in the production of *o*-dianisidine diisocyanate (3,3′-dimethoxy-4,4′-diisocyanate-biphenyl) that is used in adhesive systems and also as a component of polyurethane elastomers and resins. DMOB is used as a dye itself for leather, paper, plastics, rubber, and textiles. DMOB has also been used in the detection of metals, thiocyanates, and nitrites.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

NIOSH REL: See *NIOSH Pocket Guide*, Appendix A & C.

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Carcinogen Category 2 (2006).

Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000.

Guidelines or standards for dimethoxybenzidine in ambient air have been set[60] by North Dakota at zero, by New York at 0.2 μg/m^3, and by South Carolina at 0.3 μg/m^3.

Routes of Entry: Human exposure to DMOB is possible through inhalation of dye particles from equipment vent systems and through skin absorption from the finished dye product, textile processing, mixing operations, or packaging process.

Harmful Effects and Symptoms

Short Term Exposure: May cause eye and skin irritation.

Long Term Exposure: There is sufficient evidence for the carcinogenicity of 3,3′-dimethoxybenzidine (*o*-dianisidine) in experimental animals.[1] 3,3′-Dimethoxybenzidine administered by stomach tube was carcinogenic in rats, producing tumors at various sites, including intestinal, skin, and Zymbal's gland carcinomas. The findings in hamsters exposed to *o*-dianisidine in the feed also suggest carcinogenicity. The evidence for the carcinogenicity of *o*-dianisidine in humans in inadequate. Most of the workers exposed to this substance were also exposed to related amines, such as benzidine, which are strongly associated with urinary bladder cancer in humans.

Points of Attack: Bladder, breast, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: exam of the breast, bladder, intestine, skin, stomach, and ovary.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any exposure level, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. 3,3′-Dimethoxybenzidine may react with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Store in tightly closed containers in a cool, well-ventilated area. Avoid exposure to light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, liquid, toxic, n.o.s or Dye intermediates, liquid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and 3,3′-dimethoxybenzidine in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 3,3′-Dimethoxybenzidine may burn but does not readily ignite. Use dry chemical, CO_2, water spray, foam or water spray extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 2, 44−47

New Jersey Department of Health and Senior Services. (January 2002). *Hazardous Substances Fact Sheet: 3,3′-Dimethoxybenzidine*. Trenton, NJ

***N*,*N*-Dimethylacetamide D:1060**

Molecular Formula: C_4H_9NO

Common Formula: $CH_3CON(CH_3)_2$

Synonyms: Acetamide *N*,*N*-dimethyl; Acetdimethylamide; Acetic acid, dimethylamide; Acetyldimethylamine; *N*,*N*-Dimethyl acetamide; Dimethylacetamide; Dimethylacetone amide; Dimethylamide acetate; DMA; DMAC

CAS Registry Number: 127-19-5

RTECS® Number: AB7700000

UN/NA & ERG Number: NA1993/128 (A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada).

EC Number: 204-826-4 [*Annex I Index No.:* 616-011-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

California Proposition 65 Chemical: Developmental/Reproductive toxin 5/21/10.

European/International Regulations: Hazard Symbol: T; Risk phrases: R61; R20/21; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethylacetamide is a colorless, nonvolatile liquid with a faint ammonia-like odor. The odor threshold is 47 ppm. Molecular weight = 87.12; Boiling point = 165°C; Freezing/Melting point = −20°C; Flash point = 70°C (oc); Autoignition temperature = 490°C. The explosive limits are LEL = 1.8% at 100°C and UEL = 11.5% at 160°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Primary Irritant. Dimethylacetamide is used primarily as a solvent for synthetic and natural resins, especially acrylic fibers and spandex. About 15% of dimethylacetamide production is used to make alkyl (C_{12-14}) dimethylamine oxide (a surfactant) and rubber chemicals. Dimethylacetamide is also used as an extraction solvent for butadiene manufacture.

Incompatibilities: Forms explosive mixture with air. Incompatible with nonoxidizing mineral acids, strong acids, ammonia, isocyanates, phenols, cresols, halogenated compounds above 185°F/85°C. Incompatible with carbon tetrachloride and other halogenated compounds when in contact with iron and oxidizers. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 10 ppm/35 mg/m^3 TWA [skin].

NIOSH REL: 10 ppm/35 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 10 ppm/36 mg/m^3 TWA [skin]; BEI: 30 mg[*N*-Methylacetamide]/g creatinine in urine at end-of-shift at end-of-work-week.

NIOSH IDLH: 300 ppm.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 75 ppm

PAC-2: 300 ppm

PAC-3: 300 ppm

DFG MAK: 10 ppm/36 mg/m^3, Peak Limitation Category II (2) [skin]; Pregnancy Risk Group C.

Australia: TWA 10 ppm (35 mg/m^3) [skin] 1993; Austria: MAK 10 ppm (35 mg/m^3) [skin] 1999; Belgium: TWA 10 ppm (36 mg/m^3) [skin] 1993; Denmark: TWA 10 ppm (35 mg/m^3) [skin] 1999; Finland: TWA 10 ppm (35 mg/m^3); STEL 20 ppm (70 mg/m^3) [skin] 1993; France: VME 10 ppm (35 mg/m^3) [skin] 1999; Japan: 10 ppm (36 mg/m^3) [skin] 1999; the Netherlands: MAC-TGG 36 mg/m^3 [skin] 2003; Norway: TWA 10 ppm (35 mg/m^3), 1999; the Philippines: TWA 10 ppm (35 mg/m^3) [skin] 1993; Poland: MAC (TWA) 35 mg/m^3, 1999; Switzerland: MAK-W 10 ppm (35 mg/m^3), KZG-W 20 ppm (70 mg/m^3) [skin] 1999; United Kingdom: TWA 10 ppm (36 mg/m^3); STEL 20 ppm (72 mg/m^3) [skin] 2000 Occupational Exposure Limit; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for DMA in ambient air[60] ranging from 350 μg/m^3 (North Dakota) to 429 μg/m^3 (Nevada) to 600 μg/m^3 (Virginia) to 700 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #2004.

Routes of Entry: Inhalation of vapor and absorption through intact skin, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, nose, and throat.

Long Term Exposure: Repeated skin contact with the liquid can cause irritation and destroys the skin's natural oils. DMAC may affect the central nervous system and liver. Liver damage with nausea and/or jaundice can occur from skin or breathing exposure at 400 ppm levels. Repeated or high exposures can cause depression, lethargy, hallucinations, and personality changes. There is limited evidence that DMAC damages the developing fetus.

Points of Attack: Skin, liver, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. An examination of the nervous system emphasizing personality changes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves; Barricade® coated suits; CPF3, Responder™ suits; Trychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm:* Sa (APF = 10) (any supplied-air respirator). *250 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *400 ppm*: SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with DMAC you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dimethylacetamide must be stored to avoid contact with carbon tetrachloride and other halogenated compounds when in contact with iron since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This material is not covered in DOT's Performance-Oriented Packaging Standards.[19] It may, however, be classified as a combustible liquid, n.o.s. This class requires no shipping label. It falls in Hazard Class 3 [each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F] and Packing Group III. The symbol "D" identifies proper shipping names which are appropriate for describing materials for domestic transportation but may be inappropriate for international transportation under the provisions of international regulations (e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxide emissions).

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: N,N-Dimethyl Acetamide*, Report RT 79-607. Rockville, MD, pp. 56−64

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 50−51 (1981). New York: Van Nostrand Reinhold Co.

New York State Department of Health. (March 1986). *Chemical Fact Sheet: N,N-Dimethylacetamide*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dimethylacetamide*. Trenton, NJ

Dimethylamine D:1070

Molecular Formula: C_2H_7N

Common Formula: $(CH_3)_2NH$

Synonyms: AI3-15638-X; *N,N*-Dimethylamine; Dimethylamine, anhydrous; DMA; Methanamine, *n*-methyl-; *n*-Methylmethanamine

CAS Registry Number: 124-40-3

RTECS® Number: IP8750000

UN/NA & ERG Number: UN1032 (anhydrous)/118; UN1160 (solution)/132

EC Number: 204-697-4 [*Annex I Index No.:* 612-001-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U092.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R; Risk phrases: R12; R20; R37/38; R41; Safety phrases: S2; S16; S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: DMA is a colorless, compressed gas or liquid (below 7°C) with a pungent, fishy, or ammonia-like odor. The odor threshold is 0.34 ppm. Molecular weight = 45.10; Boiling point = 6.8°C; Freezing/Melting point = −92.3°C; Flash point = flammable gas; Autoignition temperature = 401°C. Explosive limits: LEL = 2.8%; UEL = 14.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water; solubility = 24% at 60°C.

Potential Exposure: Compound Description: Mutagen. Primary Irritant. This material is used in leather tanning; as an accelerator in rubber vulcanization; in the manufacture of detergents; in drug synthesis and pesticide manufacture.

Incompatibilities: Dimethylamine is a medium strong base. Reacts violently with strong oxidizers; with mercury causing fire and explosion hazard. Incompatible with acids, organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc and alloys, some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.85 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/18 mg/m^3 TWA.

NIOSH REL: 10 ppm/18 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/9.2 mg/m^3 TWA; 15 ppm/27 mg/m^3 STEL; not classifiable as a human carcinogen.

NIOSH IDLH: 500 ppm.

Temporary Emergency Exposure Limits (DOE).

TEEL-0: 10 ppm

PAC-1: 10 ppm

PAC-2: 66 ppm

PAC-3: 250 ppm

DFG MAK: 2 ppm/3.7 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 10 ppm (18 mg/m^3), 1993; Austria: MAK 10 ppm (18 mg/m^3), 1999; Belgium: TWA 10 ppm (18 mg/m^3), 1993; Denmark: TWA 10 ppm (18 mg/m^3), 1999; Finland: STEL 10 ppm (18 mg/m^3), [skin], 1999; France: VLE 10 ppm (18 mg/m^3), 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1.8 mg/m^3, 2003; Norway: TWA 10 ppm (18 mg/m^3), 1999; the Philippines: TWA 10 ppm (18 mg/m^3), 1993; Poland: MAC (TWA) 9 mg/m^3, MAC (STEL) 18 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-W 2 ppm (4 mg/m^3), KZG-W 4 ppm (8 mg/m^3), 1999; United Kingdom: TWA 2 ppm (3.8 mg/m^3); STEL 6 ppm (11 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm. Russia[35,43] set a MAC value of 0.005 mg/m^3 in ambient air in residential areas on either a momentary or a daily average basis. Several states have set guidelines or standards for dimethylamine in ambient air[60] ranging from 42.857 μg/m^3 (Kansas) to 180 μg/m^3 (North Dakota) to 300 μ/m^3 (Virginia) to 360 μg/m^3 (Connecticut) to 429 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2010.

Permissible Concentration in Water: No criterion set but EPA[32] has suggested a permissible ambient goal of 248 μg/L, based on health effects. Russia[35,43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, respiratory tract. Eye or skin contact with the liquid can cause burns and permanent damage. Inhalation of the vapors can cause coughing and/or shortness of breath. Higher levels can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptom include sneezing, coughing and dyspnea, pulmonary edema, conjunctivitis, dermatitis, burns of skin and mucous membranes. LD$_{50}$ = (oral-rat) 698 mg/kg (slightly toxic). Rapid evaporation of the liquid may cause frostbite.

Long Term Exposure: Repeated or prolonged contact with skin may cause irritation, redness, itching, dermatitis. Repeated exposures may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Respiratory system, lungs, skin, eyes.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver function tests. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. If symptoms develop or overexposure has occurred, repeat these tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; neoprene rubber gloves, suits, boots; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid.

Respirator Selection: *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *500 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dimethylamine you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dimethylamine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and mercury because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where dimethylamine is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more of dimethylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of dimethylamine. Wherever dimethylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If in liquid form, allow to vaporize. Keep dimethylamine out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dimethylamine is a flammable gas or liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition

sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Dimethylamine*. Trenton, NJ

4-Dimethylaminoazo-benzene D:1080

Molecular Formula: $C_{14}H_{15}N_3$

Common Formula: $C_6H_5NNC_6H_4N(CH_3)_2$

Synonyms: Benzenamine, *N*,*N*-dimethyl-4-(phenylazo)-; Brilliant fast oil yellow; Brilliant fast spirit yellow; Brilliant oil yellow; Butter yellow; Cerasine yellow GG; C.I. 11020; C.I. Solvent yellow 2; DAB; *p*-(Dimethylamino)azobenzene; 4-(*N*,*N*-Dimethylamino)azob enzene; Dimethylaminoazobenzene; *N*,*N*-Dimethyl-*p*-(phenylazo)aniline; *N*,*N*-Dimethyl-4-phenylazo aniline; Dimethyl yellow; DMAB; Enial yellow 2G; Fast oil yellow B; Fat yellow; Fat yellow A; Fat yellow AD OO; Fat yellow ES; Fat yellow ES extra; Fat yellow extra concentrate; Fat yellow R; Grasal brilliant yellow; Iketon yellow extra; Methyl yellow; Oil yellow 20; Oil yellow 2625; Oil yellow 2G; Oil yellow BB; Oil yellow D; Oil yellow FN; Oil yellow G; Oil yellow GG; Oil yellow II; Oil yellow N; Oil yellow Pel; Oil yellow S; Oleal yellow 2G; Organol yellow ADM; Orient oil yellow GG; Petrol yellow WT; 4-(Phenylazo)-*N*,*N*-dimethylaniline; Resinol yellow GR; Silotras yellow T 2G; Somalia yellow A; Stear yellow JB; Sudan yellow GG; Sudan yellow GGA; Toyo oil yellow G; Waxoline yellow ADS; Yellow G soluble in grease

CAS Registry Number: 60-11-7

RTECS® Number: BX7350000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s./151)

EC Number: 200-455-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: Mammalian micronucleus; Histidine reversion—Ames test; Negative: Cell transform.—BALB/c-3T3; *E. coli* polA with S9; Negative: Sperm morphology—mouse; *S. cerevisiae*—homozygosis; Inconclusive: SHE—clonal assay; *B. subtilis* rec assay; Inconclusive: *E. coli* polA without S9; Inconclusive: *D. melanogaster* sex-linked lethal; Inconclusive: *In vitro* UDS—human fibroblast.

OSHA Specifically Regulated Chemical (29CFR 1910.1015).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1015).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U093.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.13; Nonwastewater (mg/kg), N/A.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DAB is a flaky yellow crystal. Molecular weight = 225.32; Boiling point = (sublimes); Freezing/Melting point = 114−117°C; Vapor pressure = very low (0.0000003 mmHg). Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector DAB is used for coloring polishes and other wax products, polystyrene, petrol, soap, and as a chemical indicator. Human exposure to DAB can occur through either inhalation or skin absorption.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposure of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: Carcinogen; Limit exposure to lowest feasible concentration.

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 75 mg/m^3

Finland: carcinogen, 1993; France: carcinogen, 1993; Sweden: carcinogen, 1993.

States which have set guidelines or standards for this compound in ambient air[60] include North Dakota at zero, New York at 0.03 μg/m^3, and South Carolina at 125.0 μg/m^3.

Determination in Air: G-Chromosorb tube P; 2-Propanol; Gas chromatography/Flame ionization detection; NIOSH II (4) P&CAM Method #284.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This compound can cause irritation of the eyes, skin, and respiratory system. It can cause contact dermatitis.

Long Term Exposure: Enlarged liver, liver and kidney dysfunction, contact dermatitis, cough, wheezing, dyspnea (breathing difficulty), bloody sputum, bronchial secretions, frequent urination, hematuria (blood in the urine), dysuria, and may cause liver or bladder cancer.

Points of Attack: Skin, respiratory system, liver, kidneys, bladder. Cancer site in animals: liver and bladder.

Medical Surveillance: Preplacement and periodic examinations should include a history of exposure to other carcinogens; use of alcohol, smoking, medications, and family history. Special attention should be given to liver size and liver function tests. OSHA Mandated Medical Tests: *Increased Risk:* check for reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and if conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DAB you should be trained on its proper handling and storage. Store in a cool, dry place and protect from exposure to light and air. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." 4-Dimethylaminoazo-benzene falls in Hazard Class 6.1; Packing Group III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. 4-Dimethylaminoazobenzene itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 4-Dimethylaminoazobenzene*. Trenton, NJ

Dimethylaminoethanol D:1090

Molecular Formula: $C_4H_{11}N$

Synonyms: Deanol; 2-Dimethylaminoethanol; β-Dimethylaminoethyl alcohol; Dimethylethanolamine; *N*,*N*-Dimethyl-*N*-(2-hydroxyethyl)amine; *N*,*N*-Dimethyl-2-hydroxyethylamine; Ethanol, 2-dimethylamino-

CAS Registry Number: 108-01-0

RTECS® Number: KK6125000

UN/NA & ERG Number: UN2051/132

EC Number: 203-542-8 [*Annex I Index No.:* 603-047-00-0.]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R36/37/38; R34; Safety phrases: S1/2; S25; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethylaminoethanol is a colorless liquid with a pungent odor. Odor threshold: 0.25 ppm. Molecular weight = 89.16; Boiling point = 133°C; Freezing/Melting point = −59°C; Flash point = 41°C (oc); Autoignition temperature = 295°C. Explosive limits: LEL = 1.6%; UEL = 11.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Dimethylaminoethanol is used as a corrosion inhibitor; pharmaceutical intermediate; in making dyestuffs, textiles, pharmaceuticals; emulsifiers in paints and coatings. Also, it has been used as a medication in the treatment of behavioral problems of children.

Incompatibilities: Forms explosive mixture with air. Violent reaction with oxidizers, strong acids, acid chlorides, and isocyanates. Attacks copper and its alloys, galvanized steel, zinc and its alloys.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 12.5 ppm

PAC-1: 35 ppm

PAC-2: 150 ppm

PAC-3: 150 ppm

Russia: STEL 5 mg/m^3, [skin], 1993; United Kingdom: TWA 2 ppm (7.4 mg/m^3); STEL 6 ppm (22 mg/m^3), 2000; the Netherlands: MAC-TGG 7.4 mg/m^3, 2003.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = -0.6$.

Routes of Entry: Inhalation, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause severe irritation and burns to the eyes and skin, with possible permanent damage. Breathing the aerosol can cause lung irritation, coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, muscle tenderness, restlessness, increased irritability, lack of sleep, and weight loss.

Long Term Exposure: Repeated skin contact may cause dermatitis. May cause an asthma-like allergy. May affect the nervous system. Corrosive substances may cause lung irritation and bronchitis.

Points of Attack: Nervous system, skin, lungs.

Medical Surveillance: Examination of the nervous system. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for

pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with dimethylaminoethanol you should be trained on its proper handling and storage. Before entering confined space where it may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, and chemically active metals. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Label of "CORROSIVE, FLAMMABLE LIQUID." It falls in Hazard Class 8. Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol- or polymer-resistant foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Dimethylaminoethanol*. Trenton NJ

***N,N*-Dimethylaniline D:1100**

Molecular Formula: $C_8H_{11}N$

Common Formula: $C_6H_5N(CH_3)_2$

Synonyms: Aniline, *N,N*-dimethyl-; Benzenamine, *N,N*-dimethyl-; (Dimethylamino)benzene; *N,N*-dimethylaminobenzene; *N*-dimethyl-aniline; Dimethylaniline (which is also a correct synonym for Xylidine); *N,N*-Dimethylbenzenamine; *N,N*-Dimethylphenylamine; Dimethylphenylamine; *N,N*-Dimetilanilina (Spanish); DMA; NCI-C56428; Versneller NL 63/10

CAS Registry Number: 121-69-7; *(alt.)* 162744-63-0; *(alt.)* 168153-21-7; *(alt.)* 171745-67-8

RTECS®Number: BX4725000
UN/NA & ERG Number: UN2253/153
EC Number: 204-493-5 [*Annex I Index No.:* 612-016-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, Inadequate Data; Animal, Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1993; NTP: Carcinogenesis Studies (gavage); some evidence: rat; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R40; R51/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: DMA, an aromatic amine, is a straw-colored liquid with a characteristic amine-like odor. It turns brown on contact with air. Molecular weight = 121.20; Boiling point = 192°C; Freezing/Melting point = 2.2°C; Vapor pressure = 1 mmHg at 20°C; Flash point = 61°C; Autoignition temperature = 371°C. Explosive limits: LEL = 1%; UEL = 7%. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. This material is used as a chemical intermediate in the manufacture of many dyes and rubber chemicals; solvent, emulsifier, and analytical reagent.

Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers, strong acids, benzoyl peroxide may cause fire and explosion hazard. Contact with hypochlorite bleaches form explosive chloramines. Incompatible with anhydrides, isocyanates, aldehydes.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.96 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/25 mg/m^3 TWA [skin].

NIOSH REL: 5 ppm/25 mg/m^3 TWA; 10 ppm/50 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 5 ppm/25 mg/m^3 TWA: 10 ppm/50 mg/m^3 STEL [skin]; not classifiable as a human carcinogen; BEI$_M$ issued for Methemoglobin inducers.

Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 10 ppm
PAC-2: 10 ppm
PAC-3: 100 ppm

DFG MAK: 5 ppm/25 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B; Pregnancy Risk Group D.

NIOSH IDLH: 100 ppm.

Australia: TWA 5 ppm (25 mg/m^3); STEL 10 ppm, [skin], 1993; Austria: MAK 5 ppm (25 mg/m^3), [skin], Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (25 mg/m^3); STEL 10 ppm (50 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (25 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (25 mg/m^3); STEL 10 ppm (50 mg/m^3), [skin], 1993; France: VME 5 ppm (25 mg/m^3), [skin], 1999; Hungary: TWA 5 mg/m^3; STEL 10 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 5 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (25 mg/m^3), 1999; the Philippines: TWA 5 ppm (25 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 40 mg/m^3, 1999; Russia: STEL 0.2 mg/m^3, [skin], 1993; Sweden: TWA 1 ppm (5 mg/m^3); STEL 2 ppm (10 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (25 mg/m^3), KZG-W 10 ppm (50 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (25 mg/m^3); STEL 10 ppm (50 mg/m^3), [skin], 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm (skin). Several states have set guidelines or standards for *N,N*-dimethylaniline in ambient air[60] ranging from 250−500 μg/m^3 (North Dakota) to 500 μg/m^3 (Connecticut) to 560 μg/m^3 (Nevada).

Determination in Air: Adsorption on charcoal, workup with CS_2, analysis by gas chromatography. Use NIOSH Analytical Method #2002 on Amines, aromatic.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested permissible ambient concentrations of 345 μg/L.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = 2.3$.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Exposure: Contact may irritate or burn the eyes, and may irritate the nose and throat. Dimethylaniline can be absorbed through the skin, thereby increasing exposure. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonia. May affect the blood, resulting in the formation of methemoglobin. Symptoms include anoxia, cyanosis, weakness, dizziness, ataxia. Symptoms may be delayed.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. While this chemical has not been identified as a reproductive hazard, there is some evidence that women working with aniline, a related compound, have a higher incidence of reproductive cycle disorders and abortions.

Points of Attack: Blood, kidneys, liver, cardiovascular system.

Medical Surveillance: A blood test for methemoglobin level should be done periodically and after any overexposure, or if any symptoms develop. Any evaluation should include a careful history of past and present symptoms. NIOSH lists the following tests: complete blood count, whole blood (chemical/metabolite), methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended; effects may be delayed.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough>0.1 μg/cm^2/min): Tychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 50 ppm*: Sa (APF = 10) (any supplied-air respirator). *Up to 100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dimethylaniline you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dimethylaniline must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids, and benzoyl peroxide, since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover and mix with a 9:1 mixture of sand and soda ash and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank

discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a furnace equipped with afterburner and scrubber.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 34−41

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Dimethylaniline*. Trenton, NJ

7,12-Dimethylbenz[a]-anthracene D:1110

Molecular Formula: $C_{20}H_{16}$

Synonyms: AI3-50460; Benz(a)anthracene, 7,12-dimethyl-; Benz(a)anthracene, 9,10-dimethyl-; DBA; 6,7-Dimethyl-1,2-benzanthracene; 7,12-Dimethyl-1,2-benzanthracene; 7,12-Dimethylbenzanthracene; 9,10-Dimethyl-1,2-benzanthracene; 9,10-Dimethylbenz(a)anthracene; 9,10-Dimethylbenzanthracene; Dimethylbenz(a)anthracene; Dimethylbenzanthracene; 9,10-Dimethylbenz-1,2-benzanthracene; 9,10-Dimethylbenz-1,2-benzanthrazen (German); 7,12-Dimethylbenzo(a)anthracene; 1,4-Dimethyl-2,3-benzphenanthrene; 7,12-Dimetilbenz(a)antraceno (Spanish); 7,12-DMBA; DMBA; NCI-C03918; NSC 40823

CAS Registry Number: 57-97-6

RTECS$^{®}$Number: CW3850000

UN/NA & ERG Number: UN3082/171

EC Number: 200-359-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as polynuclear aromatic hydrocarbons (PAH).

US EPA Hazardous Waste Number (RCRA No.): U094.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: DBA is a greenish-yellow solid. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 256.36; Freezing/Melting point 122°C. Insoluble in water.

Potential Exposure: DBA is a polycyclic aromatic hydrocarbon (PAH) that is present in the smoke of cigarettes, burned wood and coal, coal tar, gasoline, and diesel exhaust. It is a medical and pharmaceutical research chemical.

Incompatibilities: Oxidizing agents.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: Use #5800, Polycyclic aromatic compounds (PAC).

Permissible Concentration in Water: See regulatory authority above.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the skin and eyes. Irritates the respiratory tract. High exposure may damage the blood cells, causing anemia.

Long Term Exposure: Repeated exposure can irritate the lungs, causing coughing, wheezing, and/or difficult breathing. This chemical has been shown to cause skin and lung cancer in animals and has caused cancer in the offspring of animals exposed during pregnancy. Believed to be a transplacental carcinogen. May damage the male reproductive glands. May cause liver and kidney damage. May cause anemia.

Points of Attack: Lungs, testes, liver, kidneys, blood. Cancer site in animals: lungs, skin.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC). Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DBA you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Benz[a] anthracene, 7,12-dimethyl*. Trenton, NJ

Eller, P. M., & Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

2,3-Dimethylbutane D:1120

Molecular Formula: C_6H_{14}

Common Formula: $CH_3CH(CH_3)CH(CH_3)CH_3$

Synonyms: Biisopropyl; Butane, 2,3-dimethyl-; Diisopropyl; Isohexane diisopropyl; Neohexane; 1,1,2,2-Tetramethylethane

CAS Registry Number: 79-29-8

RTECS®Number: EJ9350000

UN/NA & ERG Number: UN2457/128

EC Number: 201-193-6 [*Annex I Index No.:* 601-007-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Hazard Symbol: Risk phrases: F, Xn, N; R11; R38; R65; R67; R51/53; Safety phrases: S2; S9; S16; S29; S33; S60; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2,3-Dimethylbutane is a colorless liquid. Molecular weight = 86.20; Boiling point = 58°C; Flash point = −29°C; Autoignition temperature = 405°C. Explosive limits: LEL = 1.2%; UEL = 7.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: 2,3-Dimethylbutane is used in high octane fuel and to make organic chemicals.

Incompatibilities: Forms explosive mixture with air. Violent reaction with oxygen, strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH: 100 ppm/350 mg/m^3 TWA; STEL 510 ppm/1800 mg/m^3 [15 min].

ACGIH TLV®[1]: 500 ppm/1760 mg/m^3 TWA; 1000 ppm/3500 mg/m^3 STEL.

NO TEEL available.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin or eyes. Exposure can irritate the eyes, nose, and throat. Exposure can also cause you to feel dizzy, lightheaded, giddy, and to pass out. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonia. Prolonged contact may cause dermatitis.

Long Term Exposure: Repeated exposure may damage the kidneys. May cause dermatitis.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1000 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2500 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5000 ppm*: SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 2,3-dimethylbutane you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2,3-Dimethylbutane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where 2,3-dimethylbutane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of 2,3-dimethylbutane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of 2,3-dimethylbutane. Wherever 2,3-dimethylbutane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is flammable. Poisonous gases, including hydrocarbons and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: 2,3-Dimethylbutane*. Trenton, NJ

Dimethyl carbamoylchloride D:1130

Molecular Formula: C_3H_6ClNO

Common Formula: $(CH_3)_2NCOCl$

Synonyms: Carbamic chloride, dimethyl-; Carbamoyl chloride, *N*,*N*-dimethylaminocarbonyl chloride; Carbamyl chloride, *N*,*N*-dimethyl-; Cloroformic acid dimethylamide; Cloruro de dimetilcarbamolilo (Spanish); DDC; (Dimethylamino)carbonyl chloride; *N*,*N*-Dimethylamino-carbonyl chloride; *N*,*N*-Dimethylcarbamic acid chloride; Dimethylcarbamic acid chloride; Dimethylcarbamic chloride; *N*,*N*-Dimethylcarbamidoyl chloride; Dimethylcarba-midoyl chloride; *N*,*N*-Dimethylcarbamoyl chloride; Dimethylcarbamoyl chloride; *N*,*N*-Dimethylcarbamyl chloride; Dimethylcarbamyl chloride; Dimethylchloroformamide; Dimethylkarbamoylchlorid (German); DMCC

CAS Registry Number: 79-44-7

RTECS®Number: FD4200000

UN/NA & ERG Number: UN2262/156

EC Number: 201-208-6 [*Annex I Index No.*: 006-041-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Host-mediated assay; Mammalian micronucleus; Positive: *E. coli* polA without S9; Histidine reversion—Ames test; Positive: *S. cerevisiae*—homozygosis; Negative: *In vitro* UDS—human fibroblast.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U097.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; R23; R36/37/38; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: DMCC is a liquid. Molecular weight = 107.55; Specific gravity (H_2O:1) = 1.2; Boiling point = 165°C; Freezing/Melting point = −33°C; Vapor pressure = 2.5 mmHg at 25°C; Flash point = 68.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1₩. Reactive with water; decomposes.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. DMCC is used as a chemical intermediate in the production of pharmaceuticals, pesticides, rocket fuel, and dye synthesis. Human exposure is limited to, but not restricted to, chemical workers, pesticide formulators, dye makers, and pharmaceutical workers. DMCC has been found at levels up to 6 ppm during the production of phthaloyl chlorides. It is possible that levels of exposure might be higher in facilities in which the chemical is used for further synthesis. When DMCC is used as a dye intermediate, exposure can occur from the amount of residue in the product and its ability to migrate.

Incompatibilities: Strong oxidizers; strong acids; strong bases. Reacts with water (rapidly hydrolyzes to carbon dioxide, dimethylamine, dimethylcarbamic acid, and hydrochloric acid). Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: Potential occupational carcinogen; limit exposure to lowest feasible level.

ACGIH TLV®[1]: 0.005 ppm/0.02 mg/m^3 TWA [skin]; Suspected Human Carcinogen; See *NIOSH Pocket Guide*, Appendix A.

Protective Action Criteria (PAC)

TEEL-0: 0.005 ppm

PAC-1: 0.125 ppm

PAC-2: 0.75 ppm

PAC-3: 20 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: carcinogen, 1993; Austria: carcinogen, 1999; Belgium carcinogen, 1993; Finland: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for DMCC in ambient air[60] ranging from zero in North Dakota to 0.03 $\mu g/m^3$ (New York) to 0.24 $\mu g/m^3$ (Pennsylvania) to 3.0 $\mu g/m^3$ (Virginia).

Determination in Air: No method available.

Determination in Water: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the skin and eyes. Breathing dimethyl carbamoylchloride can irritate the nose, throat, and lungs, causing cough, wheezing, shortness of breath, dyspnea (breathing difficulty), headache, nausea, vomiting.

Long Term Exposure: Repeated exposure may cause laryngitis, bronchitis, liver damage. A Suspected Human Carcinogen.

Points of Attack: Eyes, skin, respiratory system, liver. Cancer site in animals: nasal cavity.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Exposed workers should check their skin from time to time for new growths, changes in moles and sores that would not heal. In case skin exposure occurs, it is usually easily cured when treated promptly.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DMCC you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids, strong bases, and moisture, since violent reactions can occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dimethyl carbamoylchloride is a combustible liquid. Do not allow water to get inside containers. Use dry chemical, CO_2, or foam extinguishers. Poisonous gases, including carbon monoxide, hydrochloric acid, and nitrogen oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with scrubbing of flue gas for HCl and nitrogen oxides removal. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dimethylcarbamoyl Chloride*. Trenton, NJ

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 1, 51−54

2,5-Dimethyl-2,5-di(*tert*-butyl-peroxy) hexane D:1140

Molecular Formula: $C_{16}H_{34}O_2$

Common Formula: $[(H_3C)_3COOC(CH_3)_2{-}CH_2]_2$

Synonyms: Aztec® 2,5-Di; 2,5-Dimethyl-2,5-di(*tert*-butyl-peroxy)hexane; Esperal®120; Luperco 101-P20; Lupersol 101; Peroxide, (1,1,4,4-tetramethyl-1,4-butanediyl)bis(1,1-dimethylethyl); Peroxide, (1,1,4,4-tetramethyltetramethylene)bis(*tert*-butyl); Polyvel CR-5F; Trigonox® 101-101/45; Varox

CAS Registry Number: 78-63-7

RTECS®Number: MO1835000

UN/NA & ERG Number: UN3105/145

EC Number: 201-128-1

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2,5-Dimethyl-2,5-di (*tert*-butyl peroxy) hexane is a colorless to yellow substance. Molecular weight = 290.50; Boiling point = 55−57°C at 0.1 mmHg; Freezing/Melting point = 8°C; Flash point = 65°C. Insoluble in water.

Potential Exposure: It is used as a catalyst in making polyethylene, polystyrene, and polyester resins.

Incompatibilities: Unstable organic peroxide. Strong oxidizer; potentially explosive. Forms explosive mixture with air. Reacts with reducing agents, strong oxidizers, strong acids, combustible materials.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Little is known about the health effects of this substance; however, similar chemicals can irritate, or may burn, the skin and eyes. Exposure to high levels may cause you to feel dizzy, lightheaded, and to pass out.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to 2,5-dimethyl-2,5-di(*tert*-butyl peroxy)hexane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a

NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), and combustibles. Sources of ignition, such as smoking and open flames, are prohibited where 2,5-dimethyl-2,5-di(*tert*-butyl peroxy)hexane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of 2,5-dimethyl-2,5-di(*tert*-butyl peroxy)hexane. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "ORGANIC PEROXIDE." It falls in Hazard Class 5.2 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: 2,5-Dimethyl-2,5-Di (tert-Butyl Peroxy)Hexane*. Trenton, NJ.

Dimethyldichlorosilane D:1150

Molecular Formula: $C_2H_6Cl_2Si$

Common Formula: $SiCl_2(CH_3)_2$

Synonyms: A13-51462; Dichlorodimethylsilane; Dichlorodimethylsilicone; Dimetildiclorosilano (Spanish); DMCS; Inerton AW-DMCS; Inerton DW-DMC; NSC 77070; Silane, dichlorodimethyl-

CAS Registry Number: 75-78-5

RTECS®Number: VV3150000

UN/NA & ERG Number: UN1162/155

EC Number: 200-901-0 [*Annex I Index No.:* 014-003-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36/37/38; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethyldichlorosilane is a colorless liquid with sharp, irritating odor. Molecular weight = 129.07; Specific gravity = 1.07 at 25°C; Boiling point = 70.5°C; Melting point = − 86°C; Vapor pressure = 110 mmHg at 20°C; Flash point = −7°C; Autoignition temperature = 375°C. Explosive limits: LEL = 3.4%; UEL ≥9.5°C. Hazard Identification (based on NFPA-704 M Rating

System): Health 3, Flammability 3, Reactivity 2₩. Decomposes in water.

Potential Exposure: Compound Description: Primary Irritant. Used as an intermediate in the manufacture of silicone polymers.

Incompatibilities: Forms explosive gas mixture with air. Water, steam, and moisture forms toxic and corrosive hydrogen chloride gas. Incompatible with acetone, amines, ammonia, alcohols, strong oxidizers, caustics. Attacks most metals. Do not store in temperatures above 122°F/50°C.

Permissible Exposure Limits in Air

AIHA WEEL: 2 ppm, Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.3 ppm

PAC-1: **0.90** ppm

PAC-2: **11** ppm

PAC-3: **50** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: Not established. However, this chemical is highly corrosive and a dangerous fire hazard.

Permissible Concentration in Water: Reacts with water. No criteria set.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Acute inhalation exposure may result in sneezing, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation, and chest pain. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, pulmonary edema, chronic bronchitis, and pneumonia may also occur. If the eyes have come in contact with dimethyldichlorosilane, irritation, pain, swelling, corneal erosion, and blindness may result. Dermatitis (red, inflamed skin), severe burns, pain, and shock generally follow dermal exposure. Inhalation irritates mucous membranes. Severe gastrointestinal damage may occur. Vapors cause severe eye and lung injury. Upon short contact, second- and third-degree burns may occur. Signs and symptoms of acute ingestion of dimethyldichlorosilane may be severe and include increased salivation, intense thirst, difficulty in swallowing, chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of dimethyldichlorosilane.

Long Term Exposure: Very irritating substances may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim *is conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dimethyldichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Dimethyldichlorosilane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, or moisture, because toxic and corrosive hydrogen chloride gas can be produced. Do not store at temperatures above 50°C/122°F. Sources of ignition, such as smoking and open flames, are prohibited where dimethyldichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of dimethyldichlorosilane should be grounded and bonded.

Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of dimethyldichlorosilane.

Shipping: Dimethyldichlorosilane requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use water spray to reduce vapors; however, do not get water inside containers. *Small spills*: Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Use effective fume removal device. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.3/2.0

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Move container from fire area if it can be done without risk. Do not get water inside container. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethyldichlorosilane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Dimethyl Dichlorosilane.* Trenton, NJ

Dimethyldiethoxysilane D:1160

Molecular Formula: $C_6H_{16}O_2Si$

Common Formula: $(CH_3)_2Si(OC_2H_5)_2$

Synonyms: Diethoxydimethylsilane; Diethoxy(dimethyl) silane; Silane, diethoxydimethyl-

CAS Registry Number: 78-62-6

RTECS$^{®}$Number: VV3590000

UN/NA & ERG Number: UN2380/127

EC Number: 201-127-6

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimethyldiethoxysilane is a highly flammable, colorless liquid. Molecular weight = 148.31; Specific gravity (H_2O:1) = 0.83 at 25°C; Boiling point = 114°C; Flash point = 15°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: This material is used in water-repellent formulations.

Incompatibilities: Forms explosive mixture with air. Keep away from strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 15 ppm
PAC-2: 100 ppm
PAC-3: 500 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, nose, and throat. Contact may irritate the skin causing a rash or burning feeling on contact.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Dimethyldiethoxysilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where dimethyldiethoxysilane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of dimethyldiethoxysilane should be grounded and bonded. Drums must be equipped with well-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of dimethyldiethoxysilane.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Dimethyldiethoxysilane*. Trenton, NJ

Dimethyl disulfide D:1170

Molecular Formula: $C_2H_6S_2$

Common Formula: CH_3SSCH_3

Synonyms: Methyl disulfide

CAS Registry Number: 624-92-0

RTECS®Number: JO1927500
UN/NA & ERG Number: UN2381/130
EC Number: 210-871-0
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dimethyl disulfide is a flammable liquid. The odor threshold in water is 0.3−1.2 parts per billion. Molecular weight = 94.20; Boiling point = 110°C; Flash point = 7°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Reacts with water.

Potential Exposure: Compound Description: Primary Irritant. This material may be used as an organic intermediate.

Incompatibilities: Forms explosive mixture with air. Contact with water or acids forms flammable and toxic vapors of hydrogen sulfide. Contact with oxidizing materials or acids can cause a violent reaction.

Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.5 ppm/2 mg/m^3 TWA [skin].
Protective Action Criteria (PAC)*
TEEL-0: 0.5 ppm
PAC-1: 1.5 ppm
PAC-2: **50** ppm
PAC-3: **250** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Russia[43] set a MAC of 0.7 mg/m^3 in ambient air in residential areas on a momentary basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.04 mg/L in water bodies used for domestic purposes.

Harmful Effects and Symptoms
Short Term Exposure: Eye contact can cause severe irritation and burns. This material is highly irritating and toxic by inhalation. Health hazards resemble those of sulfides and alkyl disulfides. The related dimethyl sulfide causes softening and irritation of the skin.

Long Term Exposure: Highly irritating substances may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.

Respirator Selection: Use any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Dimethyl disulfide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from any form of moisture, oxidizers, acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of

spill or leak. Use water spray to reduce vapors. *Small spills:* Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may be ignited by heat, sparks, or flames. Poisonous gases, including sulfur oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Stay upwind; keep out of low areas. Wear positive-pressure breathing apparatus and special protective clothing. Vapor explosion and poison hazard indoors, outdoors or in sewers. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Disulfide.* Washington, DC: Chemical Emergency Preparedness Program

Dimethyl ether D:1180

Molecular Formula: C_2H_6O

Synonyms: Dimethyl ether; Dimethyl oxide; DME; Eter metilico (Spanish); Methane oxybis-; Methyl ether; Oxybismethane; Wood ether

CAS Registry Number: 115-10-6

RTECS®Number: PM4780000

UN/NA & ERG Number: UN1033/115

EC Number: 204-065-8 [*Annex I Index No.:* 603-019-00-8]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F +; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethyl ether is a colorless compressed liquefied gas or liquid. Molecular weight = 46.08; Boiling point = −24°C; Freezing/Melting point = − 141°C; Vapor pressure = 5200 hPa at 20°C; Flash point = flammable gas (−41°C); Autoignition temperature = 350°C. Explosive limits: LEL = 3.4%; UEL = 27.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 1. Soluble in water.

Potential Exposure: Used as a refrigerant, solvent, propellant for aerosol sprays; and in making plastics.

Incompatibilities: Flammable gas. Forms explosive mixture with air. Forms unstable peroxides in containers that have been opened or remain in storage for more than 6 months. Peroxides can be detonated by friction, impact or heating. Violent reaction with strong oxidizers, aluminum hydride, lithium aluminum hydride. Keep away from heat, air, sunlight.

Permissible Exposure Limits in Air

AIHA WEEL: 1000 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 10,000 ppm

PAC-3: 60.000 ppm (LEL)

DFG MAK: 1000 ppm/1900 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group D.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. High exposure can cause headache, dizziness, lightheadedness, and unconsciousness. Rapid evaporation of the liquid can cause severe frostbite. May affect the nervous system.

Points of Attack: Nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers recommend butyl and Neoprene™ as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. For gas wear gas-proof goggles and face shield, for liquid wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. May form peroxides in storage. Prior to working with DME you should be trained on its proper handling and storage. Before entering confined space where DME may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, dark, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Note: Forms unstable peroxides in ether containers that have been opened and remain in storage for more than 6 months. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1 and there is no Packing Group listed.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or liquid under pressure. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference
New Jersey Department of Health and Senior Services. (June 1996). *Hazardous Substances Fact Sheet: Dimethyl Ether.* Trenton, NJ

N,N-Dimethylformamide D:1190

Molecular Formula: C_3H_7NO
Common Formula: $HCON(CH_3)_2$
Synonyms: AI3-03311; Dimethylformamid (German); *N,N*-Dimethylformamide*;* *N*-Dimethylformamide; *N,N*-Dimethylmethanamide; Dimetilformamida (Spanish); DMF; DMFA; Dynasolve 100; Formamide, *N,N*-dimethyl-; Formic acid, amide, *N,N*-dimethyl-*;* *N*-Formyldimethylamine; NCI-C60913; NSC-5356; U-4224; Weld-On P-70 primer
CAS Registry Number: 68-12-2
RTECS®Number: LO2100000
UN/NA & ERG Number: UN2265/129
EC Number: 200-679-5 [*Annex I Index No.:* 616-001-00-X]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence; Animal, No Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999.
US EPA Gene-Tox Program, Negative: SHE—clonal assay; Sperm morphology—mouse; Negative: *In vitro* UDS in rat liver; Inconclusive: Mammalian micronucleus.
NTP: Toxicity studies, RPT#TOX-22, October 2000.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T; Risk phrases: R61; R20/21; R36; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Dimethylformamide is a flammable, colorless liquid with a fishy, unpleasant, amine-like odor at relatively low concentrations. The odor threshold is 0.47−100 ppm. Molecular weight = 73.11; Specific gravity (H_2O:1) = 0.95; Boiling point = 153°C; Freezing/Melting point = −61°C; Vapor pressure = 3 mmHg at 20°C; Flash point = 58°C; Autoignition temperature = 444.5°C. Explosive limits are: LEL = 2.2%; UEL = 15.2% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. DMFA is used as a solvent for liquids, gases, and as a gasoline additive. Dimethylformamide has powerful solvent properties for a wide range of organic compounds. Because of its physical properties, this chemical has been used when solvents with a slow rate of evaporation are required. It finds particular usage in the manufacture of polyacrylic fibers, butadiene, purified acetylene, pharmaceuticals, dyes, petroleum products, and other organic chemicals.
Incompatibilities: Forms explosive mixture with air. Contact with carbon tetrachloride and other halogenated compounds, particularly in contact with iron or strong oxidizers, may cause fire and explosions. Violent reaction with alkylaluminums. Incompatible with nonoxidizing mineral acids, strong acids, chlorinated hydrocarbons, isocyanates, inorganic nitrates, phenols, cresols, ammonia, bromine, chromic anhydride, magnesium nitrate, methylene diisocyanate (possible violent polymerization), phosphorous trioxide, triethylaluminum. Attacks some plastics, rubber, and coatings.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.99 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm/30 mg/m^3 TWA [skin].
NIOSH REL: 10 ppm/30 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 10 ppm/30 mg/m^3 TWA [skin]; BEI: 15 mg (*N*-Methylformamide)/g creatinine in urine at end-of-shift; 40 mg [*N*-Acetyl-*S*-(*N*-methylcarbamoyl)cystein]/g in urine prior to last shift of workweek; not classifiable as a human carcinogen.
NIOSH IDLH: 500 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 2 ppm
PAC-1: **2** ppm
PAC-2: **91** ppm
PAC-3: **530** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 5 ppm/15 mg/m^3, [skin]; Peak Limitation Category II(4); Pregnancy Risk Group B; BAT: 15 mg (*N*-Methylformamide)/g creatinine in urine at end of exposure or end-of-shift.
Australia: TWA 10 ppm (30 mg/m^3), [skin], 1993; Austria 10 ppm (30 mg/m^3), [skin], 1999; Belgium: TWA 10 ppm (30 mg/m^3), [skin], 1993; Denmark: TWA 10 ppm (30 mg/m^3), [skin], 1999; Finland: TWA 10 ppm (30 mg/m^3); STEL 20 ppm (60 mg/m^3), [skin], 1999; France: VME 10 ppm (30 mg/m^3), [skin], 1999; Hungary: TWA 10 mg/m^3; STEL 20 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 15 mg/m^3, [skin], 2003; the Philippines: TWA 10 ppm (30 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 60 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 10 ppm (30 mg/m^3), KTV 15 ppm (45 mg/m^3), [skin], 1999; Switzerland: MAK-W 10 ppm (30 mg/m^3), KZG-W 20 ppm (60 mg/m^3), [skin], 1999; Turkey: TWA

10 ppm (30 mg/m^3), [skin], 1993; United Kingdom: TWA 10 ppm (30 mg/m^3); STEL 20 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for DMF in ambient air[60] ranging from 8.1 μg/m^3 (Massachusetts) to 300 μg/m^3 (North Dakota) to 500 μg/m^3 (Virginia) to 600 μg/m^3 (Connecticut) to 714 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Method (IV) #2004[18] or OSHA Analytical Method 66.

Permissible Concentration in Water: A MAC value in water bodies used for domestic purposes has been set by Russia[35,43] at 10.0 mg/L. Beyond that a MAC in water bodies used for fishery purposes is 0.28 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 1.0$.

Routes of Entry: Inhalation of vapor, and absorption through intact skin; ingestion and skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: DMF irritates the eyes, skin, and respiratory tract. *Inhalation:* Thirteen workers exposed to concentrations below 20 ppm and occasionally to higher levels for up to 32 weeks complained of nausea, vomiting, and colicky abdominal pain; some cases of liver enlargement were detected. A worker who was splashed over 20% of his body surface and simultaneously exposed to high concentrations initially suffered only skin irritation; abdominal pain began 62 h after the exposure and became progressively more severe, with vomiting and high blood pressure; the effects were gone by the 7th day after exposure. Some workers have noted facial flushing (especially after alcohol ingestion). May also cause loss of appetite, stomach pain, constipation, diarrhea, nausea, vomiting, and liver injury. *Skin:* Rapidly penetrates the skin. May cause or increase the severity of effects reported above. It is also highly irritating to skin. *Eyes:* Highly irritating to eyes and mucous membranes. *Ingestion:* Fatal dose for humans has been estimated at 10 g (about 1/3 oz).

Long Term Exposure: Prolonged or repeated skin contact with the liquid defats the skin and may cause irritation and rash. Prolonged inhalation at 100 ppm has caused liver damage in animals. Kidney and liver damage in animals has also been reported. May cause damage to the developing fetus and there is limited evidence that DMF is a teratogen in animals.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, cardiovascular system.

Medical Surveillance: Preplacement and periodic examinations should be concerned particularly with liver and kidney function, and with possible effects on the skin. Liver function tests. Kidney function tests. Urine *n*-methylformamide level should not be above 40 mg/g creatinine. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, liver function tests; urine (chemical/metabolite), urine (chemical/metabolite) 24-hour collection; urine (chemical/metabolite), end-of-shift, end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves, CPF3® suits; Responder™ suits, Trellchem HPS™ suits; Trychem 10000® suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm:* Sa (APF = 10) (any supplied-air respirator). *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *500 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away

from ignition sources and corrosive and reactive materials. Prior to working with DMF you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dimethylformamide must be stored to avoid contact with carbon tetrachloride and other halogenated compounds, particularly when in contact with iron; with strong oxidizers (such as chlorine, chlorine dioxide, and bromine); and with alkyl aluminums, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including dimethylamine and nitrogen oxides, are produced in fire. *Do not* use halogenated extinguishing media. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Burn in solution in flammable solvent in furnace equipped with alkali scrubber.[22] Recovery and recycling is an alternative to disposal for DMF from fiber spin baths and from PVC reactor cleaning solvents.

References

US Environmental Protection Agency. (April 13, 1978). *Chemical Hazard Information Profile: N,N-Dimethylformamide*. Washington, DC

National Institute for Occupational Safety and Health. (December 1979). *Information profiles on potential occupational hazards—Single chemicals: N,N-Dimethyl formamide*, 65-73, Report TR 79-607. Rockville, MD

Sax, N. I. (Ed.). (1981). *Dangerous properties of industrial materials report*, 1, No. 3, 61−62

New Jersey Department of Health and Senior Services. (September 1996). *Hazardous substances fact sheet: N,N-Dimethylformamide*. Trenton, NJ

1,1-Dimethylhydrazine D:1200

Molecular Formula: $C_2H_8N_2$

Common Formula: $(CH_3)_2NNH_2$

Synonyms: Dimazin; Dimazine®; Dimethylhydrazine; 1,1-Dimethyl hydrazine; *asym*-Dimethylhydrazine; *N,N*-Dimethylhydrazine; U-Dimethylhydrazine; Hydrazine, 1,1-dimethyl-; UDMH

CAS Registry Number: 57-14-7

RTECS®Number: MV2450000

UN/NA & ERG Number: UN1163/131

EC Number: 200-316-0 [*Annex I Index No.:* 007-012-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE; Positive: Histidine reversion—Ames test; Negative: Rodent dominant lethal; L5178Y cells *In vitro*—TK test; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast;

Negative: *S. cerevisiae* gene conversion; Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

US EPA Hazardous Waste Number (RCRA No.): U098.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 10/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, T, N; Risk phrases: R45; R11; R23/25; R34; R51/53; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: UDMH is a fuming colorless liquid that turns yellow on contact with air, with a fishy, amine-like odor. The odor threshold is 6.1−14 ppm.[41] Molecular weight = 60.12; Boiling point = 63.9°C; Freezing/Melting point = −57.7°C; Vapor pressure = 103 mmHg at 20°C; Flash point = −15°C; Autoignition temperature = 249°C. Explosive limits: LEL = 2.0%; UEL = 95%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1. Highly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. This material is used as a component in liquid rocket propellant combinations; it is also used in photography; as an absorbent; and to make other chemicals.

Incompatibilities: Forms explosive mixture with air; may spontaneously ignite on contact with air and porous materials, such as asbestos, wood, earth, cloth, etc. Reacts with oxygen causing fire and explosion hazard. A strong reducing agent, this chemical is incompatible with strong acids, halogens, metallic mercury, copper alloys, brass, iron, iron salts. Contact with strong oxidizers, such as nitric acid, nitrogen tetroxide, hydrogen peroxide, may cause spontaneous ignition. A strong base, this chemical is corrosive and reacts violently with acids. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 ppm/1 mg/m^3 TWA [skin].

NIOSH REL: 0.06 ppm/0.15 mg/m^3 Ceiling Concentration [2-h]; Potential human carcinogen; limit exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 ppm/0.025 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 15 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.01 ppm

PAC-1: 0.4 ppm

PAC-2: **3** ppm

PAC-3: **11** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2.

Australia: TWA 0.5 ppm (1 mg/m^3), [skin], carcinogen, 1993; Denmark: TWA 0.1 ppm (0.25 mg/m^3), [skin], 1999; Finland: STEL 0.1 ppm (0.25 mg/m^3), [skin], carcinogen, 1999; France: VME 0.1 ppm (0.2 mg/m^3), carcinogen, 1999; Norway: TWA 0.1 ppm (0.25 mg/m^3), 1999; the Philippines: TWA 0.5 ppm (1 mg/m^3), [skin], 1993; Sweden: NGV 0.1 ppm, KTV 0.5 ppm, [skin], carcinogen, 1999; Switzerland: MAK-W 0.5 ppm (1.2 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 0.5 ppm (1 mg/m^3), [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Use NIOSH Analytical Method (IV) #3515.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 13.8 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

This compound exhibits high acute toxicity as a result of exposure by all routes. Death or permanent injury may result after very short exposure to small quantities. Chronic exposure may cause pneumonia, liver damage, and kidney damage. Signs and symptoms of acute exposure to dimethylhydrazine may include eye irritation, facial numbness, facial swelling, and increased salivation. Headache, twitching, seizures, convulsions, and coma may also occur. Gastrointestinal effects include anorexia, nausea, and vomiting. Pulmonary edema and hypotension (low blood pressure) are common. Dimethylhydrazine is toxic to the liver, ruptures red blood cells, and may cause kidney damage. Dermal contact may result in strong skin and mucous membrane irritation.

Short Term Exposure: UDMH can be absorbed through the skin, thereby increasing exposure. It is corrosive to the eyes, skin, respiratory tract. Contact with the liquid may cause permanent eye damage. Inhalation of vapors can cause headache, nausea, dizziness, coughing, and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. UDMH may affect the central nervous system, kidneys, and liver.

Long Term Exposure: UDMH may be carcinogenic to humans. It may affect the nervous system, liver, kidneys, and blood.

Points of Attack: Central nervous system; liver, gastrointestinal tract; blood, respiratory system; eyes, skin. Cancer sites in animals: lungs, liver, blood vessels, and intestines. May sensitize the skin and lungs, causing dermatitis and asthma-like symptoms.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Examination by a qualified allergist. Consider chest X-ray following acute overexposure. NIOSH lists the following tests: whole blood (chemical/metabolite): blood urea nitrogen, calcium, carbon dioxide; sugar/glucose; complete blood count; liver function tests; pulmonary function tests; urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Barricade® coated suits; Responder™ suits, Trellchem HPS™ suits; Trychem 10000® suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (3) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with UDMH you should be trained on its proper handling and storage. Outside or detached storage is preferred. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Keep dry and separate from porous materials, oxidizing agents, and other incompatible materials, some of which are listed above. Store in an inert atmosphere below 50°C. Do not use copper containers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, POISON GAS, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Do not touch spilled material. Stop leak if this can be done without risk. Use water spray to reduce vapors. Take up *small spills* with vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Dike far ahead of *large spills* for later disposal. Spills also may be removed with an aspirator. Transfer to glass container and neutralize with dilute sulfuric acid. Drain with copious amounts of water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 1.5/2.4

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, hydrogen, ammonia, dimethylamine, and hydrazoic acid, are produced in fire. Use dry chemical, carbon dioxide, or foam for small fires. Water may be ineffective. For *large fires* use water fog, carbon dioxide; bicarbonate agents may allow flashback and explosive reignition. Move containers from fire area if it can be done without risk. Dike fire control water for later disposal, do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Isolation distances are listed above. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices). Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines*, NIOSH Document No. 78-172. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 60−67

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 1,1-Dimethylhydrazine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: 1,1-Dimethylhydrazine*. Trenton, NJ

1,2-Dimethylhydrazine D:1210

Molecular Formula: $C_2H_8N_2$
Common Formula: $H_3CNHNHCH_3$
Synonyms: *N*,*N*′-Dimethylhydrazine; 1,2-Dimethylhydrazin (German); *sym*-Dimethylhydrazine; 1,2-

Dimethylhydrazine; *sim*-Dimetilhidrazina (Spanish); 1,2-Dimetilhidrazina (Spanish); DMH; Hydrazomethane; Hydroazomethane; SDMH

CAS Registry Number: 540-73-8

RTECS®Number: MV2625000

UN/NA & ERG Number: UN2382/131

EC Number: 007-013-00-0[ICSC]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U099.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; Classification B3 Flammable liquid, D2B Toxic Material Causing Other Toxic Effects.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R23/24/25; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1,2-Dimethylhydrazine is a flammable, colorless, fuming liquid with a fishy, amine-like odor. Molecular weight = 60.12; Boiling point = 80−81°C; Freezing/Melting point = −9°C; Flash point = ≤23°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Soluble in water.

Potential Exposure: 1,2-Dimethylhydrazine is an experimental rocket fuel and is used in chemical synthesis; a laboratory chemical. Mutagen.

Incompatibilities: Forms explosive mixture with air. A strong reducing agent and strong base. Violent reaction with strong oxidizers, strong acids, metallic oxides. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 ppm

PAC-1: 1.5 ppm

PAC-2: 3 ppm

PAC-3: 11 ppm

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2.

South Carolina has set a guideline for ambient air of 5.0 μ/m^3.

Determination in Air: Bubbler; phosphomolybdic acid; visible spectrophotometry; NIOSH Analytical Method (IV) #3515 (for 1,1-Dimethylhydrazine).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: SDMH is corrosive to the skin, eyes, and respiratory system. It is probably a hemolytic agent.

Long Term Exposure: SDMH is a mutagen, teratogen, and carcinogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (3) Color Code—Blue: Health Hazard/Poison (mutagen): Store in a secure poison location. Prior to working with SDMH you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cold, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.1/1.8

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See entry for "1,1-Dimethylhydrazine." Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 67−70

2,4-Dimethylphenol D:1220

Molecular Formula: $C_8H_{10}O$

Common Formula: $HOC_6H_3(CH_3)_2$

Synonyms: 4,6-Dimethylphenol; 2,4-Dimetilfenol (Spanish); 2,4-DMP; 1-Hydroxy-2,4-dimethylbenzene; 4-Hydroxy-1,3-dimethylbenzene; Phenol, 2,4-dimethyl-; *m*-Xylenol; 2,4-Xylenol

CAS Registry Number: 105-67-9

RTECS®Number: ZE5600000

UN/NA & ERG Number: UN2261/153

EC Number: 203-321-6 [*Annex I Index No.:* 604-006-00-X]

Regulatory Authority and Advisory Bodies

Water Pollution Standard Proposed (EPA)[6] (California, Kansas).[61]

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U101.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 1.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R34; R51/53; Safety phrases: S1/2; S26; S36/3739; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 2,4-DMP is a combustible, colorless, crystalline solid. The 2,4-isomer is 1 of 5 isomers of this formula. Molecular weight = 122.18; Boiling point 212°C; Freezing/Melting point = 27−28°C; Flash point = 110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug. 2,4-DMP finds use commercially as an important chemical feedstock or constituent for the manufacture of a wide range of commercial products for industry and agriculture. 2,4-Dimethylphenol is used in the manufacture of phenolic antioxidants, disinfectants, solvents, pharmaceuticals, insecticides, fungicides, plasticizers, rubber chemicals, polyphenylene oxide wetting agents, and dyestuffs; and is an additive or constituent of lubricants, gasolines, and cresylic acid. 2,4-Dimethylphenol (2,4-DMP) is a naturally occurring substituted phenol derived from the cresol fraction of petroleum or coal tars by fractional distillation and extraction with aqueous alkaline solutions. It is the cresylic acid or tar acid fraction of coal tar. Workers involved in the fractionation and distillation of petroleum or coal, and coal tar products comprise one group at risk. Workers who are intermittently exposed to certain commercial degreasing agents containing cresol may also be at risk. Cigarette and marijuana smoking groups and those exposed to cigarette smoke inhale microgram quantities of 2,4-demthylphenol.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.3 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: *To protect freshwater aquatic life:* 2120 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* no criterion established due to insufficient data. *To protect human health:* in view of the relative paucity of data on the mutagenicity, carcinogenicity, teratogenicity, and long-term oral toxicity of 2,4-dimethylphenol, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It is recommended that studies to produce such information be conducted before limits in drinking water are established. A criterion of 400 μg/L is suggested by EPA on an organoleptic basis.[6] Kansas and California have set guidelines[61] at 400 μg/L also.

Determination in Water: Methyl chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *m*-Xylenol can be absorbed through the skin, thereby increasing exposure. Causes severe skin and eye irritation. Inhalation can cause lung irritation, with coughing and shortness of breath. May cause headaches, dizziness, nausea, vomiting, stomach pain, and exhaustion.

Long Term Exposure: High or repeated exposure may affect the liver and kidneys.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers, eyewash, and self-contained breathing apparatus (SCBA).

Respirator Selection: Use any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and sources of ignition.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS" for xylenols. It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. *Do not DRY SWEEP.* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *2,4-Dimethylphenol: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *2,4-Dimethylphenol: Health and Environmental Effects Profile No. 87*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 3, 87−90

New Jersey Department of Health and Senior Services. (November 1998). *Hazardous Substances Fact Sheet: 2,4-Dimethylphenol*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Dimethyl-*p*-phenylenediamine D:1230

Molecular Formula: $C_8H_{12}N_2$

Common Formula: $(H_3C)_2NC_6H_4NH_2$

Synonyms: 4-(Dimethylamino) aniline; *N*,*N*-Dimethyl-*p*-phenylenediamine; Dimetil-*p*-fenilendiamina (Spanish)

CAS Registry Number: 99-98-9

RTECS®Number: ST0874000

UN/NA & ERG Number: UN1673 (phenylenediamines)/153

EC Number: 202-807-5 [*Annex I Index No.:* 612-031-00-2]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.5/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimethyl-*p*-phenylenediamine is a colorless to reddish-violet crystalline solid; Molecular weight = 136.23; Boiling point = 262°C; Freezing/Melting point = 41°C; Flash point = 90°C. Insoluble in water.

Potential Exposure: Used in the production of Methylene blue and photodeveloper. It is a reagent for hydrogen sulfide, cellulose, organic synthesis. Chemical intermediate for dyes and diazonium chloride salts; analytical reagent for chloramine detection in water. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.025 mg/m^3

PAC-1: 0.075 mg/m^3

PAC-2: 0.13 mg/m^3

PAC-3: 1 mg/m^3

European/International Regulations: Hazard Symbol: T; Risk phrases R23/24/25; Safety phrases: S1/2; S28; S45.

DFG MAK: Danger of skin sensitization (*p*-phenylenediamine compounds used as rubber components).

Harmful Effects and Symptoms

Short Term Exposure: Irritant to skin and eyes. Lowest toxic dose with skin effect is 14 mg/kg. LD_{50} = (oral-rat) 50 mg/kg (moderately toxic).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in cool, dry place away from strong oxidizers and acids.

Shipping: Phenylenediamines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethyl-p-Phenylenediamine*. Washington, DC: Chemical Emergency Preparedness Program

Dimethyl phosphorochloridothioate D:1240

Molecular Formula: $C_2H_6ClO_2PS$

Common Formula: $(CH_3O)_2PSCl$

Synonyms: Chlorodimethoxyphosphine sulfide; Dimethoxythiophosphonyl chloride; *O,O*-Dimethyl chlorothionophosphate; Dimethyl chlorothionophosphate; *O,O*-Dimethyl chlorothiophosphate; Dimethyl chlorothiophosphonate; *O,O*-Dimethyl phosphorochloridothioate; Dimethyl phosphorochloridothioate; Dimethyl phosphorochloridothionate; *O,O*-Dimethyl phosphorochlorothioate; Dimethylphosphorochlorothioate; *O,O*-Dimethylphosphorothionochloridate; Dimethyl thionochlorophosphate; *O,O*-Dimethylthionophosphorochloridate; Dimethylthionophosphorochloridate; *O,O*-Dimethyl thionophosphoryl chloride; *O,O*-Dimethylthiophosphoric acid chloride; Dimethylthiophosphorochloridate; *O,O*-Dimethyl thiophosphoryl chloride; Dimethyl thiophosphoryl chloride; Methyl PCT; NSC 132984; Phosphonothioic acid, chloro-, *O,O*-dimethyl ester; Phosphorochloridothioic acid, *O,O*-dimethyl ester

CAS Registry Number: 2524-03-0

RTECS®Number: TD1830000

UN/NA & ERG Number: UN2267/156

EC Number: 219-754-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimethyl chlorothiophosphate is a colorless to light amber, combustible liquid. Molecular weight = 160.56; Specific Gravity (H_2O:1) 1.32 at 25°C; Boiling point = 66−67°C at 16 mmHg; flash point = 104.8°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: This material is used as a chemical intermediate for insecticides, pesticides, and fungicides; oil and gasoline additives; plasticizers; corrosion inhibitors; flame retardants; and flotation agents. It is not registered as a pesticide in the United States.[EPA]

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.5 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 32 mg/m^3
PAC-3: 150 mg/m^3

Russia[43] set a MAC of 0.5 mg/m^3 in work-place air.

Permissible Concentration in Water: Russia[43] set a MAC of 0.07 mg/L in water bodies used for domestic purposes.

Harmful Effects and Symptoms

Short Term Exposure: Contact with the skin, eyes, or mucous membranes may result in severe irritation, burns, and pain. Acute exposure to methyl PCT may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may either decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur.

Long Term Exposure: Corrosive materials may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. EKG. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dimethyl thiophosphoryl chloride requires a shipping label of "POISONOUS/TOXIC MATERIALS/CORROSIVE." This compound falls in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation. Apply powdered limestone, slaked lime, soda ash, or sodium bicarbonate. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. This material may ignite combustibles (wood, paper, oil, etc.). May react violently with water. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Wear positive-pressure breathing apparatus and special protective clothing. Move container from fire area if you can do so without risk. Poisonous gases are produced in fire, including poisonous oxides of phosphorus and sulfur. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethyl Phosphorochloridothioate*. Washington, DC: Chemical Emergency Preparedness Program

Dimethyl phthalate D:1250

Molecular Formula: $C_{10}H_{10}O_4$

Common Formula: $C_6H_4(COOCH_3)_2$

Synonyms: Avolin; 1,2-Benzenedicarboxylic acid, dimethyl ester; Dimethyl 1,2-benzenedicarboxylate; Dimethyl benzene-*o*-dicarboxylate; Dimethyl *o*-phthalate; DMF (insect repellent); DMP; ENT 262; Fermine; Ftalato de dimetilo (Spanish); Kemester DMP; Kodaflex DMP; Mipax; NTM; Palatinol M; Phthalic acid, dimet; Phthalic acid, methyl ester; Phthalsaeuredimethylester (German); Repeftal; Solvanom; Solvarone; Unimoll DM; Uniplex 110

CAS Registry Number: 131-11-3; *(alt.)* 64441-70-9

RTECS® Number: TI1575000

UN/NA & ERG Number: UN3082/171

EC Number: 205-011-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U102.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.047; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethyl phthalate is a colorless, oily liquid with a slight ester odor. Molecular weight = 124.90; Specific gravity (H_2O:1) = 1.19; Boiling point = 285°C; Freezing/Melting point = 5.5°C; Vapor presure = 0.1 mmHg at 20°C; Flash point = 146°C; Autoignition temperature = 490°C. The LEL is 0.9% at 180°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.4%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant. Dimethyl phthalate is used as a solvent, dye carrier, plasticizer for cellulose ester plastics, and as an insect repellent.

Incompatibilities: Nitrates, strong oxidizers, strong alkalis, strong acids.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA.

NIOSH IDLH: 2000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 3 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, [skin], 1993; Sweden: NGV 3 mg/m^3, KTV 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA mg/m^3. Several states have set guidelines or standards for DMP in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Collection by OSHA versatile sampler-Tenax; Toluene; analysis by gas chromatography/flame ionization; OSHA Analytical Method #104.

Permissible Concentration in Water: To protect freshwater and saltwater aquatic life: no criteria developed due to insufficient data. *To protect human health:* 313 mg/L.[6] Kansas[61] has set 313 mg/L as a guideline for drinking water also.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 626). Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation of the nose and throat with coughing. Prolonged inhalation of high levels may cause dizziness, disorientation, loss of coordination, and slowing of heart and respiratory rate. Animal studies suggest that irritation may occur at 2000 mg/m^3 and may cause death at 9000 mg/m^3 for 6.5 h. *Skin:* No effects reported.

Eyes: May cause irritation and chemical burns. *Ingestion:* May cause irritation of the lips, tongue, mouth, and stomach, vomiting, diarrhea, dizziness, unconsciousness, and coma. Animal studies suggest that the lethal dose for an adult is 6−18 oz.

Long Term Exposure: No information available. Dimethyl phthalate is a possible teratogen in humans; there is limited evidence that it is a teratogen in animals. It may reduce fertility in males and females.

Points of Attack: Eyes, respiratory system, gastrointestinal tract.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended. NIOSH lists the following tests: urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter). *125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *2000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with dimethyl phthalate you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dimethyl phthalate must be stored to avoid contact with nitrates; strong alkalis, such as sodium hydroxide, potassium hydroxide, and lithium hydroxide; strong oxidizers, such as chlorine, chlorine dioxide, and bromine; and strong acids, such as sulfuric acid, hydrochloric acid, and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Dimethyl Phthalate*. Trenton, NJ

Dimethyl sulfate D:1260

Molecular Formula: $C_2H_6O_4S$

Common Formula: $(CH_3)_2SO_4$

Synonyms: Dimethyl monosulfate; Dimethyl sulphate; DMS; Methyle (sulfate de) (French); Methyl sulfate; Sulfate dimethylique (French); Sulfate de methyle (French); Sulfato de dimetilo (Spanish); Sulfuric acid, dimethyl ester

CAS Registry Number: 77-78-1

RTECS® Number: WS8225000

UN/NA & ERG Number: UN1595/156

EC Number: 201-058-1 [*Annex I Index No.:* 016-023-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Suspected human carcinogen.

US EPA Gene-Tox Program, Positive: *Aspergillus*—forward mutation; Carcinogenicity—mouse/rat; Positive: *In vitro* cytogenetics—nonhuman; Positive: *D. melanogaster*—whole sex chrom. loss; Positive: *D. melanogaster*—reciprocal translocation; Positive: Host-mediated assay; *E. coli* polA without S9; Positive: *In vitro* SCE—nonhuman; *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae*—reversion; *S. pombe*—reversion; Positive/dose response: *In vitro* SCE—human; Negative: *D. melanogaster*—partial sex chrom. loss; Inconclusive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U103.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
California Proposition 65 Chemical: Cancer 1/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R45; R25; R26; R34; R43; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dimethyl sulfate is an oily, colorless liquid with a faint onion-like odor. Molecular weight = 126.14; Boiling point = 187.7°C (decomposes); Freezing/Melting point = − 33.8°C; Specific gravity (H_2O:1) = 1.33; Vapor pressure = 0.1 mmHg at 20°C; Flash point = 83.3°C (oc); Autoignition temperature = 188°C. Explosive limits: LEL = 3.6%; UEL = 23.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Slightly soluble in water (hydrolysis above 18°C).

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Industrial use of dimethyl sulfate is based upon its methylating properties. It is used as an alkylating agent; in the manufacture of methyl esters, ethers, and amines; in dyes, drugs, perfume, phenol derivatives, and other organic chemicals; as a solvent in the separation of mineral oils; as an intermediate in the manufacture of sodium acetylide synthesis, as well as many pharmaceuticals and pesticides.

Incompatibilities: The aqueous solution is a medium strong acid. Forms explosive mixture with air. Violent reaction with strong oxidizers, strong acids, strong alkalies, concentrated ammonia solutions with risks of fire and explosions. Reacts with water evolving heat and forming sulfuric acid. Attacks some plastics, rubber, and coatings. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air
OSHA PEL: 1 ppm/5 mg/m^3 [skin].
NIOSH REL: 0.1 ppm/0.5 mg/m^3 TWA, [skin] Potential carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.1 ppm/0.52 mg/m^3 TWA, [skin]; confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: 7 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.024 ppm
PAC-1: **0.024** ppm
PAC-2: **0.12** ppm
PAC-3: **1.6** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: [skin] Carcinogen Category 2.
Australia: TWA 0.1 ppm (0.5 mg/m^3), [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 0.1 ppm (0.52 mg/m^3), [skin], carcinogen, 1993; Denmark: TWA 0.01 ppm (0.05 mg/m^3), [skin], 1999; Finland: STEL 0.01 ppm (0.05 mg/m^3), [skin], carcinogen, 1999; France: VME 0.1 ppm (0.5 mg/m^3), carcinogen, 1999; Hungary: STEL 0.1 mg/m^3, [skin], carcinogen, 1993; Japan: 0.1 ppm (0.52 mg/m^3), [skin], 2A carcinogen, 1999; Norway: TWA 0.01 ppm (0.05 mg/m^3), 1999; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 0.1 mg/m^3, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.02 ppm (0.1 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 0.1 ppm (0.5 mg/m^3), [skin], 1993; United Kingdom: TWA 0.05 ppm (0.26 mg/m^3), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for dimethyl sulfate in ambient air[60] ranging from zero (North Carolina and North Dakota) to 1.67 μg/m^3 (New York) to 2.5 μg/m^3 (Connecticut and South Carolina) to 5.0 μg/m^3 (Florida and Virginia) to 12.0 μg/m^3 (Nevada and Pennsylvania).

Determination in Air: Use NIOSH Analytical Method (IV) #2524.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Dimethyl sulfate is corrosive to the eyes, skin, and the respiratory tract. Corrosive if ingested. Ingestion of the substance may cause edema of lips, tongue, and pharynx. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Extremely toxic vapors and liquid: a few whiffs or contact on skin could be fatal. Also acutely toxic if ingested. Delayed effects which are ultimately fatal may also occur. Lethal concentrations as low as 97 ppm/10 min have been reported in humans. DNA inhibitions and damage to human somatic cells, and sister chromatid exchange in human fibroblast cells were observed. Delayed appearance of symptoms may permit unnoticed exposure to lethal quantities. Immediate effects of vapor exposure are eye irritation, cough, swelling of tongue, lips, and larynx, and lungs (later). Ingestion or direct contact with mucous membranes causes corrosion. Once absorbed, lung damage and liver and kidney injury will occur. Liquid dermal exposure causes blistering, followed by convulsions, delirium, coma, and death in severe cases.

Long Term Exposure: Lungs may be affected. May affect the liver, kidneys, and central nervous system. Dimethyl sulfate is probably carcinogenic to humans. May damage the developing fetus. In animals: nasal and lung cancer.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, central nervous system. Cancer site in animals: nasal cavity and lung.

Medical Surveillance: Preplacement and periodic medical examinations should give special consideration to the skin, eyes, central nervous system, lungs. Chest X-rays should be taken and lung, liver, and kidney functions evaluated. Sputum and urinary cytology may be useful in detecting the presence or absence of carcinogenic effects. NIOSH lists the following tests: blood gas analysis, blood urea nitrogen, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, forced vital capacity, forced expiratory volume (1 s), sputum cytology, urine (chemical/metabolite): sediment; urinalysis (routine); white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Barricade® coated suits; Responder™ suits; Trychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At *any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Dimethyl sulfate must be stored to avoid contact with water, strong oxidizers (such as chlorine, bromine, and fluorine), and strong ammonia solutions, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Do not allow this chemical to contact water. Sources of ignition, such as smoking and open flames, are prohibited where dimethyl sulfate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2
Night 0.1/0.2
Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur oxides, are produced in fire. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 1.5 s minimum) of dilute, neutralized dimethyl sulfate waste is recommended. The incinerator must be equipped with efficient scrubbing devices for oxides of sulfur. Alkaline hydrolysis may also be used, as may landfill burial.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Dimethyl Sulfate*, Report TR79-607. Rockville, MD, pp. 74−84

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 51−53

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethyl Sulfate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Dimethyl Sulfate*. Trenton, NJ

Dimethyl sulfide D:1270

Molecular Formula: C_2H_6S

Common Formula: $(CH_3)_2S$

Synonyms: Dimethyl monosulfide; Dimethyl sulphide; Dimethyl thioether; DMS; Methanethiomethane; Methyl monosulfide; Methyl sulphide; Methylthiomethane; 2-Thiapropane; Thiobismethane; 2-Thiopropane

CAS Registry Number: 75-18-3

RTECS® Number: PV5075000

UN/NA & ERG Number: UN1164/130

EC Number: 200-846-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dimethyl sulfide is a colorless to yellow liquid with an unpleasant wild radish or cabbage-like odor. Molecular weight = 62.14; Boiling point = 37°C; Freezing/Melting point = −98°C; Flash point ≤ −18°C; Autoignition temperature = 206°C. Explosive limits: LEL = 2.2%; UEL = 19.7%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Practically insoluble in water.

Potential Exposure: It is used as a presulfiding agent for variety of catalysts used by petroleum industry; a gas odorant; catalyst impregnator; as a solvent for anhydrous mineral salts; a chemical intermediate for solvents and dimethyl sulfoxide; as a flavoring ingredient in foods and beverages.

Incompatibilities: Reacts violently with strong oxidizing materials, causing fire and explosion hazard.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 10 ppm/25 mg/m^3 TWA (2001).

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 500 mg/m^3

Poland: MAC (TWA) 1 mg/m^3, 1993; Russia: STEL 50 mg/m^3, [skin], 1993; Sweden: NGV 1 ppm, 1999. Russia[43] set a MAC of 0.08 mg/m^3 in ambient air of residential areas on a momentary basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 0.84.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Dimethyl sulfide causes softening and irritation of the skin. Orally, it is an irritant. Inhalation can cause dizziness and unconsciousness.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode or any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with dimethyl sulfide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen sulfide and sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, fog, or foam extinguishers. Wear self-contained breathing apparatus and full protective clothing. If it can be done safely, move container from fire area. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Isolate for 1/2 mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimethyl Sulfide.* Washington, DC: Chemical Emergency Preparedness Program

Dimethyl sulfoxide D:1280

Molecular Formula: C_2H_6O
Common Formula: $(CH_3)_2SO$

Synonyms: A-10846; Deltan; Demasorb; Demavet; Demeso; Demsodrox; Dermasorb; Dimethyl sulphoxide; Dimexide; Dipiratril-Tropico; DMS-70; DMS-90; DMSO; Dolicur; Doligur; Domoso; Durasorb; Gamasol-90; Hyadur; Infiltrina; M-176; Methyl sulfoxide; NSC-763; Rimso-50; Somi-Pront; SQ 9453; Sulficyl bis(methane); Syntexan; Topsym

CAS Registry Number: 67-68-5

RTECS® Number: PV6210000

UN/NA & ERG Number: No citation.

EC Number: 200-664-3

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *Aspergillus*—aneuploidy; *S. cerevisiae* gene conversion; Negative: SHE—clonal assay; Cell transform.—mouse embryo; Negative: Cell transform.—RLV F344 rat embryo; Negative: *D. melanogaster*—whole sex chrom. loss; Host-mediated assay; Negative: *N. crassa—aneuploidy*; *E. coli* polA with S9; Negative: Histidine reversion—Ames test; *In vitro* SCE—nonhuman; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: *Aspergillus*—recombination; Carcinogenicity—mouse/rat; Inconclusive: *D. melanogaster*—reciprocal translocation; Inconclusive: Rodent dominant lethal; *B. subtilis* rec assay; Inconclusive: *E. coli* polA without S9.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DMSO is a hygroscopic colorless to yellow liquid. Molecular weight = 78.14; Boiling point = 189°C; Freezing/Melting point = 18−19°C; Flash point = 95°C; Autoignition temperature = 215°C. Explosive limits: LEL = 2.6%; UEL = 42%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slight solubility in water.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as a solvent and in the preparation of vanillin from lignin; as an antifreeze; as a pharmaceutical (FDA—proprietary drug); in chemicals production.

Incompatibilities: Violent reaction with strong oxidizers. Reacts with ethanoyl chloride, boron compounds, halides, metal alkoxides, perchlorates.

Permissible Exposure Limits in Air

AIHA WEEL: 250 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 250 ppm

PAC-1: 750 ppm

PAC-2: 1250 ppm

PAC-3: 2000 ppm

DFG MAK: 50 ppm/160 mg/m^3 TWA [skin]; Peak Limitation Category II(2); Pregnancy Risk Group D.

Russia: STEL 20 mg/m^3, 1993; Sweden: TWA 50 ppm (150 mg/m^3), KTV 150 ppm (500 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (160 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 150 mg/m^3, [skin], 2003.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = -2.03$.

Routes of Entry: Skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Systemically, it produces anesthesia, vomiting, chills, cramps, and lethargy. LD_{50} = (oral-rat) 14,500 mg/kg (insignificantly toxic). It reportedly irritates the eyes, skin, and the respiratory tract. However,[57] it also affects the blood. All routes of exposure can produce an intense garlic-like taste and breath odor. *Eyes:* A 7.5% solution can cause irritation and burning. *Inhalation:* Exposure to high concentrations of DMSO can cause some sedation and lowering of consciousness. Animal studies indicate that exposures of 900 ppm for 24 h produced no ill effects. *Skin:* A 10% solution applied for 14 consecutive days produced some sedation, headache, nausea, and dizziness along with such skin effects as irritation, drying, and scaling. Contact with a 70−90% solution has resulted in immediate stinging and burning. DMSO is very readily absorbed through the skin and may increase the absorption of other substances dissolved in it or on the surface of the skin. *Ingestion:* No human data available. Animal studies indicate that symptoms from swallowing DMSO include throat and stomach irritation, vomiting, and sedation.

Long Term Exposure: Repeated or prolonged contact with skin may cause irritation and dermatitis. DMSO may affect the liver, resulting in impaired function.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Protect from physical damage. Store in cool, dry place away from oxidizers and ignition sources. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: DMSO is not specifically cited in DOT's Performance-Oriented Packaging Standards.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur dioxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 42−43

New York State Department of Health. (March 1986). *Chemical Fact Sheet: DMSO*. Albany, NY: Bureau of Toxic Substance Assessment

Dimethyl terephthalate D:1290

Molecular Formula: $C_{10}H_{10}O_4$

Common Formula: $CH_3OCOC_6H_4COOCH_3$

Synonyms: 1,4-Benzenedicarboxylic acid dimethyl ester; Dimethyl *p*-phthalate; DMT; Terephthalic acid dimethyl ester

CAS Registry Number: 120-61-6

RTECS® Number: WZ1225000

UN/NA & ERG Number: Not regulated.

EC Number: 204-411-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: mouse; no evidence: rat.

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (UNEP).[43]

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DMT is a combustible, white, flaky solid. Molecular weight = 194.19; Boiling point = 284−288°C; Freezing/Melting point = 141°C; Flash point = 153°C (oc); 146°C; Autoignition temperature = 515−550°C; Explosive limits: LEL = 0.8%; UEL = 11.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Essentially all DMT is consumed in the production of polyethylene terephthalate, the polymer for polyester fibers and polyester films. Less than 2% of production is used to make polybutylene terephthalate resins and other specialty products.

Incompatibilities: Incompatible with strong acids, nitrates, strong oxidizers.

Permissible Exposure Limits in Air

AIHA WEEL: 5 mg/m^3 total dust TWA.

No TEEL available.

Russia: STEL 0.1 mg/m^3, 1993.

Permissible Concentration in Water: Russia[43] set a MAC of 1.5 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation of dust or vapor, ingestion, skin and eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: DMT appears to have a very low order of toxicity. Acute animal studies indicate oral, i.p., and LD_{50} = (oral-rat)>3200 mg/kg; dermal values in excess of 3400 mg/kg; and subchronic oral (10,000 ppm DMT in the diet for 96 days) and inhalation exposures (2−10 ppm, 4 h/day × 58 days) have not resulted in any hematologic, blood chemical, or pathologic alterations attributable to DMT. Results of other experiments with rats and rabbits demonstrated that DMT is rapidly absorbed and excreted (primarily in the urine), and that no significant quantities accumulate in tissues following single or repeated oral, intratracheal, dermal, or ocular administration, DMT does not appear to irritate or sensitize rodent skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DMT you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, nitrates, acids, and sources of ignition. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Molten DMT will burn if ignited. It ignites at 153°C. Vapor or dust can form explosive mixtures in air. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Dimethyl Terephthalate*, Report TR 79-607. Rockville, MD, pp. 84−97

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Dimethyl Terephthalate*. Albany, NY: Bureau of Toxic Substance Assessment

Dimetilan D:1300

Molecular Formula: $C_{10}H_{16}N_4O_3$

Synonyms: Carbamic acid, dimethyl-, 1-[(dimethylamino) carbonyl]-5-methyl-1H-pyrazol-2-yl ester; Carbamic acid, dimethyl-, ester with 3-hydroxy-*N*,*N*-5-trimethylpyrazole-1-carboxamide; Dimethyl carbamate ester of 3-hydroxy-*N*,*N*-5-trimethylpyrazole-1-carboxamide; Dimethylcarbamic acid 1-[(dimethylamino)carbonyl]-5-methyl-1H-pyrazol-3-yl ester; Dimethylcarbamic acid ester with 3-hydroxy-*N*,*N*,5-trimethylpyrazole-1-carboxamide; Dimethylcarbamic acid 5-methyl-1H-carboxamine; Dimethylcarbamic acid 5-methyl-1H-pyrazol-3-yl ester; 2-Dimethylcarbamoyl-3-methylpyrazolyl-(5)-*N*,*N*-dimethylcarbamate; 1-Dimethylcarbamoyl-5-methylpyrazol-3-yl dimethylcarbamate; Dimethylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate; Dimetilane; ENT25,595-X; ENT 25,922; Geigy 22870; 3-Hydroxy-*N*,*N*,5-trimethylpyrazole-1-

carboxamidedimethylcarbamate (ester); 5-Methyl-1H-pyrazol-3-yl dimethylcarbamate; Snip; Snip fly
CAS Registry Number: 644-64-4
RTECS® Number: EZ9084000
UN/NA & ERG Number: UN2757/151
EC Number: 211-420-0 [*Annex I Index No.:* 613-047-00-2]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Portugal) (UN).[13]

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 1 lb (0.454 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R25; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dimetilan is a yellow to reddish-brown solid. Molecular weight = 240.30; Freezing/Melting point = 68−71°C (the technical grade at 55−65°C). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Soluble in water; solubility = 24% at 25°C.

Potential Exposure: Formerly an insecticide for insect control on livestock, especially housefly control. It is no longer produced commercially in the United States.

Incompatibilities: Hydrolyzed by acids and alkalis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Routes of Entry: Skin contact, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Very toxic; probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150-lb) person. LD_{50} = (oral-rat) 25 mg/kg. Dimetilan is highly toxic by ingestion and moderately toxic by contact with the skin. Death is primarily due to respiratory arrest of central origin; paralysis of the respiratory muscles; intense bronchoconstriction; or all three. This compound is a cholinesterase inhibitor. Symptoms are similar to carbaryl poisoning: nausea, vomiting, abdominal cramps, diarrhea, pinpoint pupils, excessive salivation, and sweating are common symptoms. Running nose and tightness in chest are common in inhalation exposures. Difficulty in breathing, raspy breathing, loss of muscle coordination may also be seen. Exposure may also result in random jerky movements, incontinence, convulsions, coma, and death.

Long Term Exposure: Many carbamates affect the central nervous system.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Carbamate pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They are in Hazard Class 6.1 and dimetilan is in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for types of surrounding fire, as the material itself burns with difficulty. Use water in flooding quantities as a fog. Wear positive-pressure breathing apparatus and special protective clothing. Move container from fire area. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkali treatment followed by soil burial.[22] Large amounts should be incinerated in a unit equipped with efficient gas scrubbing. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dimetilan*. Washington, DC: Chemical Emergency Preparedness Program

Dinitolmide D:1310

Molecular Formula: $C_8H_7N_3O_5$

Common Formula: $H_3CC_6H_2(NO_2)_2CONH_2$

Synonyms: Benzamide, 2-methyl-3,5-dinitro-; Coccidine A; Coccidot; D.O.T.; 2-Methyl-3,5-dinitrobenzamide, *o*-Dinitro-toluamide; Zoalene®; Zoamix®

CAS Registry Number: 148-01-6

RTECS® Number: XS4200000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 205-706-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dinitolmide is a yellowish crystalline substance. Molecular weight = 225.18; Freezing/Melting point = 177.2°C. Very slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Those involved in the manufacture, formulation, and application of this veterinary coccidiostat, an antiparasite medicine used in poultry.

Incompatibilities: A weak oxidizing agent, but high temperatures and pressures may cause violent reactions. Heat can cause a violent exothermic reaction above 248°C. Contact with alkalies may form explosive metal salts.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 1 mg/m^3 TWA; not classifiable as a human carcinogen (2006).

No TEEL available.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; France: VME 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Switzerland: MAK-W 5 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set standards or guidelines for dinitolmide in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact eczema; in animals. LD_{50} = (oral-rat) 600 mg/kg (slightly toxic).

Long Term Exposure: Dinitolmide may cause mutations. All contact with this chemical should be reduced to the lowest possible level. In animals: methemoglobinemia, liver changes.

Points of Attack: Liver, blood, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Evaluation by a qualified allergist. Complete blood count. Methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. If while wearing a filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect dinitolmide, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinitolmide you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalies and heat.

Shipping: Pesticides, solid, toxic, n.o.s. require a “POISONOUS/TOXIC MATERIALS” label. They fall in Hazard Class 6.1 and dinitolmide in Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Dinitolmide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Dinitolmide*. Trenton, NJ

Dinitroanilines D:1320

Molecular Formula: $C_6H_5N_3O_4$

Synonyms: 2,4-Dinitraniline; 2,4-Dinitroanilin (German); 2,4-Dinitrobenzenamime; DNA; NCI-C60753

CAS Registry Number: 97-02-9 (2,4-); 602-03-9 (2,3-); 606-22-4 (2,6-); 618-87-1 (3,5-); 26471-56-7 (mixed isomers)

RTECS$^{®}$ ***Number:*** BX9100000 (2,4-dinitroaniline)

UN/NA & ERG Number: UN1596/153

EC Number: 202-553-5 [*Annex I Index No.:* 612-040-00-1] (2,4-); 210-108-1 (2,6-); 210-567-8 (3,5-)

Regulatory Authority and Advisory Bodies (2,4-dinitroaniline)

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (***all isomers***): Hazard Symbol: T+, N; Risk phrases: R26/27/28; R33; R51/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*2,4-isomer*).

Description: Dinitroanilines are yellow to greenish-yellow, needle-like crystals with a musty odor. Molecular weight = 183.14 (*2,4-isomer*); Boiling point = 57°C; Freezing/Melting point = 188°C; Flash point = 224°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 3. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant. Used as a corrosion inhibitor, as a dye or pigment intermediate, as a toner pigment in printing inks.

Incompatibilities: Decomposes in moderate heat forming toxic vapors that form an explosive mixture with air. Violent reaction with strong oxidizers, strong acids, strong bases, acid chlorides, acid anhydrides, and chloroformates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

2,4-isomer

TEEL-0: 0.035 mg/m^3

PAC-1: 0.1 mg/m^3

PAC-2: 0.75 mg/m^3

PAC-3: 12.5 mg/m^3

Russia: STEL 0.3 mg/m^3, 1993 (2,4-dinitroaniline).

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 1.78.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. High levels can cause methemoglobinemia, causing headache, dizziness, and blue color to the skin and lips. Higher levels can cause difficult breathing; collapse and possible death.

Long Term Exposure: See entry above. May cause liver and kidney damage.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: Blood methemoglobin level. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. In the case of poisoning, special first aid is required; antidotes for the formation of methemoglobin should be available, including instructions.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DNA you should be trained on its proper handling and storage. Before entering confined space where DNA may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases, and other incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." Nitroanilines fall into Hazard Group 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but does not readily ignite. However, moderate heat causes decomposition that produces toxic vapors that form an explosive mixture with air. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide and nitrogen oxides. Heated vapors in confined spaces can explode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers can explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Dinitroanilines*. Trenton, NJ

Dinitrobenzenes D:1330

Molecular Formula: $C_6H_4N_2O_4$

Common Formula: $C_6H_4(NO_2)_2$

Synonyms: *o-isomer:* Benzene, *o*-dinitro-; Benzene, 1,2-dinitro-; *o*-Dinitrobenceno (Spanish); 1,2-Dinitrobenzene; 1,2-Dinitrobenzol; 1,2-DNB

m-isomer: Benzene, *m*-dinitro-; Benzene, 1,3-dinitro-; *m*-Dinitrobenceno (Spanish); 1,3-Dinitrobenzene; 1,3-Dinitrobenzol; 1,3-DNB

p-isomer: Benzene, *p*-dinitro-; Benzene, 1,4-dinitro-; *p*-Dinitrobenceno (Spanish); 1,4-Dinitrobenzene; 1,4-Dinitrobenzol; Dithane A-4; 1,4-DNB

CAS Registry Number: 528-29-0 (*o*-); 99-65-0 (*m*-); 100-25-4 (*p*-); 25154-54-5 (mixed isomers)

RTECS® Number: CZ7450000 (*o*-); CZ7350000 (*m*-); CZ7525000 (*p*-); CZ7340000 (mixed isomers)

UN/NA & ERG Number: UN1597/152

EC Number: 208-431-8 (1,2-); 202-776-8 (1,3-); 202-833-7 (1,4-); 246-673-6 (mixed isomers); [*Annex I Index No.:* 609-004-00-2] (*all isomers*)

Regulatory Authority and Advisory Bodies

Carcinogenicity EPA (*o- & m-isomers*): Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (UNEP).[43]

Mixed isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as dinitrobenzene, n.o.s., waste number not listed.

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (**all isomers**): Hazard Symbol: T+, N; Risk phrases: R26/27/28; R33; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61.

m-isomer:

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

o-isomer:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

p-isomer:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 2.3.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*all isomers*).

Description: Dinitrobenzene exists in three isomers (*o*-, *m*-, and *p*-); the meta form is the most widely used. All are white to yellow crystalline solids having a characteristic odor. Molecular weight = 168.12; Boiling point = (*o*-) 318°C; (*m*-) 300°C; (*p*-) 299°C; (mixed) 305°C; Freezing/Melting point = (*o*-) 117−118°C; (*m*-) 90°C; (*p*-) 173−174°C; (mixed) 75−85°C; Flash point = (*o*-, *m*-, and *p*-) 149−150°C. NFPA 704 M Hazard Identification (ortho-): Health 3, Flammability 1, Reactivity 4. Solubility in water is poor for *o*-, *m*-, and mixed isomers; none for *p*-isomer.

Potential Exposure: Compound Description (*m*-isomer): Mutagen; Reproductive Effector; Human Data; Primary Irritant; (*o*- and *p*-isomers) Mutagen. Dinitrobenzenes are used in the synthesis of dyestuffs, dyestuff intermediates, and explosives; in celluloid production.

Incompatibilities: Dinitrobenzene is impact-, friction-, and heat-sensitive; may explode. [*Note:* Prolonged exposure to fire and heat may result in an explosion due to *spontaneous* decomposition.] Dust explosion possible if mixed with air. Reacts violently with strong oxidizers, strong bases, and chemically active metals, causing fire and explosion hazard. Mixtures with nitric acid are highly explosive. Attacks some plastics.

Permissible Exposure Limits in Air

All isomers

OSHA PEL: 1 mg/m^3 TWA [skin].

NIOSH REL: 1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.15 ppm/1 mg/m^3 TWA [skin]; BEI$_M$ issued; Methemoglobin inducers.

DFG MAK: [skin] Carcinogen Category 3B.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

o-, m-, and p-isomers

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 50 mg/m^3

m- and o-isomers

Austria: [skin], Suspected: carcinogen, 1999; Denmark: TWA 0.15 ppm (1 mg/m^3), [skin], 1999; France: VME 0.15 ppm (1 mg/m^3), 1999; Japan: 0.15 ppm (1 mg/m^3), [skin], 1999; United Kingdom: TWA 0.15 ppm (1.0 mg/m^3); STEL 0.5 ppm, [skin], 2000; the Netherlands: MAC-TGG 1 mg/m^3, 2003.

p-isomer

Austria: [skin], Suspected: carcinogen, 1999; Denmark: TWA 0.15 ppm (1 mg/m^3), [skin], 1999; Japan: 0.15 ppm (1 mg/m^3), [skin], 1999; the Netherlands; MAC-TGG 1 mg/m^3, 2003.

Several states have set guidelines or standards for dinitrobenzenes in ambient air[60] as follows (all values in μg/m^3):

State	ortho-	meta-	para-
Connecticut	20.0	20.0	100.0
Florida	–	10.0	–
Nevada	–	24.0	–
New York	–	3.3	–
North Dakota	10.0	10.0	10.0
South Carolina	–	10.0	–
Virginia	16.0	16.0	16.0

Determination in Air: Use NIOSH II(4) Method #S214.

Permissible Concentration in Water: The MAC in water bodies used for domestic purposes has been set by Russia.[43]

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 1.46−1.69.

Routes of Entry: Inhalation, percutaneous absorption of liquid, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Dinitrobenzene irritates the eyes, skin, and respiratory tract. Dinitrobenzene may affect the lungs and the ability of the blood to carry oxygen, resulting in the formation of methemoglobin. This can cause headache, weakness, fatigue, dizziness, and blue color to the skin and lips. Higher levels may cause difficulty in breathing, collapse, unconsciousness, and may result in death. The effects may be delayed. Consuming alcohol, exposure to sunlight, or hot baths may make symptoms worse. Exposure to dinitrobenzene may produce yellowish coloration of the skin, eyes, and hair.

Exposure to any isomer of dinitrobenzene may produce methemoglobinemia, symptoms of which are headaches, irritability, dizziness, weakness, nausea, vomiting, dyspnea, drowsiness, and unconsciousness. If treatment is not given promptly, death may occur. Dinitrobenzene may also cause a bitter almond taste or burning sensation in the mouth, dry throat, and thirst. Reduced vision may occur. In addition, liver damage, hearing loss, and ringing of the ears may be produced. Repeated or prolonged exposure may cause anemia.

Long Term Exposure: Repeated exposure may cause hearing loss and changes to vision. Prolonged exposure may lead to liver damage and may cause anemia. Can cause serious reproductive toxicity in humans. The substance may have effects on the respiratory tract formation of methemoglobin.

Points of Attack: Blood, liver, cardiovascular system, eyes, central nervous system.

Medical Surveillance: Preemployment and periodic examinations should be concerned particularly with a history of blood dyscrasias, reactions to medications; alcohol intake; eye disease; skin; cardiovascular status. Liver and renal functions should be evaluated periodically as well as blood and general health. Blood methemoglobin levels should be followed until normal in all cases of suspected cyanosis. Dinitrobenzene can be determined in the urine; levels greater than 25 mg/L may indicate significant absorption. Complete blood count (CBC). Examination of the eyes and color vision. People with a medical condition called "G-6-P-D deficiency" may have worse problems if exposed to dinitrobenzene. NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; whole blood (chemical/metabolite), methemoglobin/end-of-shift; Complete blood count; Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinitrobenzene you should be trained on its proper handling and storage. Dinitrobenzene must be stored to avoid contact with strong oxidizers (such as chloride, bromine, chlorine dioxide, nitrates, and permanganates), since violent reactions occur. Contact with caustics and chemically active metals (such as tin and zinc) may evolve heat, causing a buildup in pressure. Store in tightly closed containers in a cool, well-ventilated area away from shock or heat, which may cause this chemical to explode. Storage outdoors or in explosion-proof areas is preferred. Sources of ignition, such as smoking and open flames, are prohibited where dinitrobenzene is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more of dinitrobenzene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of dinitrobenzene. Wherever dinitrobenzene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dinitrobenzenes all require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dinitrobenzene is an extremely explosive solid. Prolonged exposure to fire and heat may result in an explosion due to *spontaneous* decomposition. May explode on heating under confinement. Fight fires from an explosion-resistant location. Cool fire-exposed containers of dinitrobenzene with water. In advanced or massive fires, evacuate the area. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a more secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) followed by removal of the oxides of nitrogen that are formed using scrubbers and/or catalytic or thermal devices. The dilute wastes should be concentrated before incineration.

References

US Environmental Protection Agency. (April 30, 1980). *Dinitrobenzenes: Health and Environmental Effects Profile No. 89*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 80−82 (1983) (*p*-Dinitrobenzene); 5, No. 3, 51−53 (1985) (*o*-Dinitrobenzene); and 6, No. 1, 49−52 (1986) (*m*-Dinitrobenzene)

New Jersey Department of Health and Senior Services. (October 2006). *Hazardous Substances Fact Sheet: Dinitrobenzene (Mixed Isomers)*. Trenton, NJ

Dinitro-*o*-cresol & salts D:1340

Molecular Formula: $C_7H_6N_2O_5$

Common Formula: $CH_3C_6H_2(NO_2)_2OH$

Synonyms: Antinonin; Antinonnin; Arborol; *o*-Cresol, 4,6-dinitro-; Degrassan; Dekrysil; Detal; Dillex; Dinitro; 3,5-Dinitro-*o*-cresol; Dinitro-*o*-cresol; Dinitrocresol; 4,6-Dinitro-*o*-cresol and salts; Dinitrodendtroxal; 3,5-Dinitro-2-hydroxytoluene; Dinitrol; 2,4-Dinitro-6-methylphenol; 4,6-Dinitro-2-methylphenol; DINOC; Dinurania; Ditrosol; DNOC; Effusan; Effusan 3436; Elgetol; Elgetol 30; Elipol; Extrar; Flavin-Sandoz; Hedolit; Hedolite; K III; K IV; Kreozan; Krezotol 50; Lipan; 2-Methyl-4,6-dinitrophenol; 6-Methyl-2,4-dinitrophenol; Neudorff DN 50; Nitrofan; Phenol, 2-methyl-4,6-dinitro-; Prokarbol; Rafex; Rafex 35; Raphatox; Sandolin; Sandolin A; Selinon; Sinox; Winterwash

CAS Registry Number: 534-52-1 [(may also apply to salts: 2980-64-5 (ammonium salt); 5787-96-2 (potassium salt); 2312-76-7 (sodium salt)]

RTECS® Number: GO9625000

UN/NA & ERG Number: UN1598/153

EC Number: 208-601-1 [*Annex I Index No.:* 609-020-00-X]; 221-037-0 [*Annex I Index No.:* 609-022-00-0] (ammonium salt of DNOC); 219-007-7 [*Annex I Index No.:* 609-021-00-5] (sodium salt of DNOC); [*Annex I Index No.:* 609-021-00-5] (also applies to potassium salt of DNOC).

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Sweden) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US EPA Gene-Tox Program, Negative: Rodent dominant lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P047.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.28; Nonwastewater (mg/kg), 160.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (150); 8270 (50).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [as dinitro-*ortho*-cresol (DNOC) and its salts (such as ammonium salt, potassium salt, and sodium salt)].

European/International Regulations (*DNOC*): Hazard Symbol: T+, N; Risk phrases: R26/27/28; R38; R41; R43; R44; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61; (*ammonium salt 2980-64-5*) Hazard Symbol: T+, N; Risk phrases: R26/27/28; R33; R50/53; Safety phrases: S1/2; S13-S28-S45; S60; S61; (*sodium salt 2312-76-7; potassium *salt 5787-96-2*) Hazard Symbol: T+ , N; Risk phrases: R23/24/25; R33; R50/53; Safety phrases: S1/2; S13-S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: DNOC exists in 9 isomeric forms of which 4,6-dinitro-*o*-cresol is the most important commercially and the most heavily regulated. It is a noncombustible, yellow crystalline solid. Molecular weight = 198.15; Boiling point = 312°C; Freezing/Melting point = 88°C; Vapor pressure = 5×10^{-5} mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Primary Irritant. DNOC is used as free radical polymerization inhibitor and agricultural chemical intermediate; widely used in agriculture as an herbicide and pesticide; it is also used in the dyestuff industry. Although 4,6-dinitro-*o*-cresol (DNOC) is no longer manufactured in the United States, a limited quantity is imported and used as a blossom-thinning agent on fruit trees and as a fungicide, insecticide, and miticide, on fruit trees during the dormant season. Hence, individuals formulating or spraying the compound incur the highest risk of exposure to the compound.

Incompatibilities: Dust can form an explosive mixture with air. Keep away from strong oxidizers, strong bases. Protect from heat and shock.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [skin].

NIOSH REL: 0.2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.2 mg/m^3 TWA [skin].

NIOSH IDLH: 5 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.2 mg/m^3

PAC-2: 0.5 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK: [skin]; No numerical value established.

Austria: MAK 0.2 mg/m^3, [skin], 1999; Denmark: TWA 0.2 mg/m^3, [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; The Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Norway: TWA 25 ppm (125 mg/m^3), 1999; United Kingdom: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 2000; Russia[43] set a MAC value of 0.003 mg/m^3 for the ambient air in residential areas on a momentary basis and 0.0008 mg/m^3 on a daily average basis. Several states have set guidelines or standards for DNOC in ambient air[60] ranging from 2.0 μg/m^3 (North Dakota) to 3.0 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH (II-5) Method #S166.

Permissible Concentration in Water: *To protect human health*, 13.4 μg/L.[6] Russia set a MAC of 0.05 mg/L in water bodies used for domestic purposes and 0.002 mg/L in water bodies used for fishery purposes.[43]

Determination in Water: Filter/Bubbler; 2-Propanol; High-pressure liquid chromatography/Ultraviolet detection; NIOSH II(5) Method #S166. Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection. EPA Method 604 or gas chromatography plus mass spectrometry EPA Method 625.

Routes of Entry: Inhalation, percutaneous absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Early manifestations of acute dinitrocresol exposure include fever, sweating, headache, and confusion. Blood pressure, pulse, and respiratory rate are often elevated. Severe exposure may result in restlessness, seizures, and coma. Other signs and symptoms include dyspnea (shortness of breath), cyanosis (blue tint to skin and mucous membranes), pulmonary edema, nausea, vomiting, and abdominal pain. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Dermal exposure results in yellow staining of the skin, and may produce burns. Dinitrocresol may irritate and burn the eyes and mucous membranes. DNOC is an extremely toxic material; probable oral lethal dose is 5−50 mg/kg in humans or between 7 drops and 1 teaspoon for a 70-kg (150-lb) person.

Long Term Exposure: May damage the liver, kidneys, and blood cells. May stain yellow the skin, eyes, and fingernails. Repeated exposure can cause anxiety, fatigue, insomnia, excessive perspiration, unusual thirst, weight loss, and cataracts in the eyes.

Points of Attack: Cardiovascular system, endocrine system.

Medical Surveillance: Before beginning employment, at regular times after that and if symptoms develop or overexposure has occurred, the following may be useful: examination of eyes for cataracts. Examination of skin and nails for staining. Blood tests for 4,6-dinitro-*o*-cresol. Persons with blood levels *over 10 ppm* (10 mg/L) should be kept away from further exposure until levels return to normal. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Complete blood count. NIOSH lists the following tests: blood analyzed weekly.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If high fever is present, drench victim's clothes in cool water, or immerse person in cool bath before transfer.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends Saranex™ coated suits, natural rubber, Neoprene™ and chlorinated polyethylene as providing good to excellent protection. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2 mg/m^3:* Any air-purifying full-face-piece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100. *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or any self-contained breathing apparatus with a full face-piece; or SCBAF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH condition:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. 4,6-Dinitro-*o*-cresol must be stored to avoid contact with strong oxidizers (such as bromine, chlorine, chlorine dioxide, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 4,6-dinitro-*o*-cresol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of 4,6-dinitro-*o*-cresol. Wherever 4,6-dinitro-*o*-cresol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if it can be done without risk. Take up *small spills* with sand or other noncombustible absorbent material; place into containers for later disposal. *Small dry spills*: collect powdered material in the most convenient and safe manner and deposit in sealed containers. Large spills should be diked for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 4,6-Dinitro-*o*-cresol may burn but does not easily ignite. The dust can form an explosive mixture with air. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (593°C minimum) with adequate scrubbing and ash disposal facilities.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Dinitro-ortho-Cresol*, NIOSH Publication No. 78-131. Washington, DC

US Environmental Protection Agency. (1980). *Nitrophenols: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *4,6-Dinitro-o-Cresol: Health and Environmental*

Effects Profile No. 90. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 54–59 (1982) and 4, No. 1, 62–66 (1984)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dinitrocresol*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: 4,6-Dinitro-o-Cresol*. Trenton, NJ

Dinitronaphthalenes D:1350

Molecular Formula: $C_{10}H_6N_2O_4$
Common Formula: $C_{10}H_6(NO_2)_2$
Synonyms: 1,3-Dinitronaphthalene; 1,5-Dinitronaphthalene; Naphthalene, 1,3-dinitro-; Naphthalene, 1,8-dinitro-
CAS Registry Number: 606-37-1 (1,3-); 605-71-0 (1,5-); 602-38-0 (1,8-); 27478-34-8 (all isomers)
RTECS® Number: QJ4550800 (1,3-); QJ4551000 (1,5-); QJ4552000 (1,8-); QJ4550000 (all isomers)
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151
EC Number: 210-116-5 (1,3-); 210-016-1(1,8-); 248-484-4 (all isomers)
Regulatory Authority and Advisory Bodies
Water Pollution Standard Set (Russia).[43]
WGK (German Aquatic Hazard Class): No value assigned.
Description: Dinitronaphthalene is a yellowish crystalline solid. Molecular weight = 218.18; Freezing/Melting points: (1,3-) 146–148°C; (1,5-) 218°C; (1,8-) 173°C. These substances are highly flammable, potentially explosive; shock and heat sensitive.
Potential Exposure: Used as a dye intermediate; in the manufacture of explosives.
Incompatibilities: The 1,3- and 1,8-isomers are strong oxidizers. All are potentially explosive materials. These materials may form explosive metal salts with alkalies. Violent reaction with aluminum, sulfur, and sulfuric acid in the presence of heat.
Permissible Exposure Limits in Air
No TEEL available.
DFG MAK: Carcinogen Category 3B.
Permissible Concentration in Water: Russia[43] set a MAC of 1 mg/L in water bodies used for domestic purposes.
Harmful Effects and Symptoms
Short Term Exposure: Irritation of the skin, eyes, and mucous membranes; headache, dizziness, nausea, vomiting.[52]
Long Term Exposure: A suspected carcinogen. Insomnia, fatigue, weight loss; central nervous system depression; skin pigmentation; liver damage; toxic hepatitis; kidney damage; anemia, and cyanosis.
First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20–30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue (all isomers): Health Hazard/Poison: Store in a secure poison location. Prior to working with dinitronaphthalenes you should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area away from alkalies, aluminum, sulfur,

sulfuric acid, and heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Nitronaphthalene is not specifically cited in DOT's Performance-Oriented Packaging Standards. But it may be considered "Toxic solids, organic, n.o.s." This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It may fall into DOT Hazard Class 6.1 and Packing Group III. Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s. carry the same label and other requirements shown.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These are very flammable materials. They are sensitive to heat and shock. Hence, extreme care must be exercised in firefighting. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Dinitrophenols D:1360

Molecular Formula: $C_6H_4N_2O_5$

Common Formula: $C_6H_3(NO_2)_2OH$

Synonyms: *2,4-isomer:* Aldifen; Chemox PE; 2,4-Dinitrofenol (Spanish); α-Dinitrophenol; Dinofan 51285; 2,4-DNP; Fenoxyl carbon N; 1-Hydroxy-2,4-dinitrobenzene; Maroxol-50; Nitro kleenup; NSC-1532; Phenol, α-dinitro-; Phenol, 2,4-dinitro-; Solfo black 2B supra; Solfo black B; Solfo black BB; Solfo black G; Solfo black SB; Tertrosulphur black PB; Tertrosulphur PBR

2,5-isomer: 2,5-Dinitrofenol (Spanish); 2,5-DNP; γ-Dinitrophenol; 1-Hydroxy-2,5-dinitrobenzene; Phenol, 2,5-dinitro-

2,6-isomer: 2,6-Dinitrofenol (Spanish); β-Dinitrophenol; *O, O*-Dinitrophenol; 2,6-DNP; 1-Hydroxy-2,6-dinitrobenzene; Phenol, 2,6-dinitro-

Mixed isomers: Dinitrofenol (Spanish); Dinitrophenol (mixed isomers); Hydroxydinitrobenzene; Phenol, dinitro-

CAS Registry Number: 51-28-5 (2,4-); 66-56-8 (2,3-); 329-71-5 (2,5-); 573-56-8 (2,6-); 577-71-9 (3,4-); 586-11-8 (3,5-); 25550-58-7 (mixed isomers)

RTECS® Number: SL2700000 (2,3-); SL2800000 (2,4-); SL2900000 (2,5); SL2795000 (2,6); SL3000000 (3,4); SL3050000 (3,5)

UN/NA & ERG Number: UN1320 (Dinitrophenol, wetted [with not<15% water, by mass])/113; UN1599 (Dinitrophenol solutions)/153

EC Number: 200-087-7 [*Annex I Index No.:* 609-041-00-4] (2,4-); 200-628-7 [*Annex I Index No.:* 609-054-00-5] (2,3-); 206-348-1 [*Annex I Index No.:* 609-054-00-5] (2,5-); 209-357-9 [*Annex I Index No.:* 609-054-00-5] (2,6-); 209-415-3 [*Annex I Index No.:* 609-054-00-5] (3,4-); 247-096-2 [*Annex I Index No.:* 609-016-00-8] (mixed isomers); (3,5-isomer not listed)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Explosive Substances (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

2,3-isomer; 2,4-isomers:

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P048.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), 160.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (150); 8270 (50).

Safe Drinking Water Act: Priority List (55FR1470).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R50; Safety phrases: S1/2; S28; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.
2,5- and 3,4-isomers:
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R51; Safety phrases: S1/2; S28; S37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
2,6-isomer:
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R51; Safety phrases: S1/2; S28; S37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): *No value assigned.*
Mixed isomers:
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R51; Safety phrases: S1/2; S28; S37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: The dinitrophenols, $C_6H_3(NO_2)_2OH$, are yellow crystalline solids with a sweet, musty odor. Molecular weight = 184.12. Hazard Identification (based on NFPA-704 M Rating System) (*2,4-*): Health 4, Flammability 3, Reactivity 3. Very slightly soluble in water.

Properties:

Isomer	Melting Point	Boiling Point
2,3-	144°C	
2,4-	112−115°C	sublimes
2,5-	104°C	
2,6-	63.5°C	
3,4-	134°C	
3,5-	122−123°C	

As noted in the "Regulatory" section above, 2,4-, 2,5-, 2,6-, and mixed isomers of dinitrophenol are the most heavily regulated of this group. Due to its explosive properties, dinitrophenol is used in the form of a wetted solution or water paste.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. 2,4-DNP is used as an intermediate for making dyes, photochemicals, pest control agents, wood preservatives, explosives, chemical indicators, photographic developers, and also in chemical synthesis.

Incompatibilities: Dust forms an explosive mixture with air. Explosion can be caused by heat, friction, or shock. Contact with reducing agents; combustibles, may cause fire and explosions. Forms shock-sensitive explosive salts with ammonia, strong bases, and most metals. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
2,4-isomer
TEEL-0: 1.25 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 30 mg/m^3
2,3-isomer
TEEL-0: 0.75 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 75 mg/m^3
2,6-isomer
TEEL-0: 0.15 mg/m^3
PAC-1: 0.4 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 15 mg/m^3
Mixed isomers
TEEL-0: 0.035 mg/m^3
PAC-1: 0.1 mg/m^3
PAC-2: 0.75 mg/m^3
PAC-3: 4 mg/m^3
Russia[43] set a MAC of 0.05 mg/m^3 in work-place air.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 230 μg/L on an acute toxicity basis for nitrophenols as a class. *To protect saltwater aquatic life*: 4850 μg/L on an acute toxicity basis for nitrophenols as a class. *To protect human health:* 70.0 μg/L.[6] This compares to a limit of 30 μg/L set in the USSR.[43] Kansas and Maine have set guidelines for 2,4-dinitrophenol in drinking water of 31 μg/L and 110 μg/L, respectively.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, through the skin, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Dinitrophenol can affect you when breathed and by passing through skin. Contact with the 2,4-isomer can cause severe irritation and burns to the eyes and skin. May affect the metabolism, causing very high body temperature. May affect the peripheral nervous system causing numbness, "pins and needles," and/or weakness of the hands and feet. Exposure can cause a bluish color to skin and lips, headaches, temperature rise, dizziness, collapse, convulsions (fits), coma, and even death. Exposure may irritate the lungs, causing coughing and shortness of breath. Higher levels can cause a buildup of fluid in the lungs, a medical emergency, which can cause death.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis with rash and drying and itching of the skin. Dinitrophenol may have effects on the eyes, causing cataracts. Exposure can damage the liver and kidneys, and affect the thyroid gland. May cause lung irritation and the development of bronchitis with coughing and shortness of breath. May damage the nervous system. High exposure may damage the developing fetus. Repeated exposure to the 2,4-isomer can damage blood cells, causing anemia.

Points of Attack: Skin, liver, kidneys, lungs, peripheral nervous system, eyes, thyroid gland, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: eye examination for cataracts. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin level. Complete blood count (CBC). Lung function tests. Liver and kidney function tests. Thyroid function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dinitrophenol, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Dinitrophenol should be kept wet and protected from thermal and mechanical shock. Dinitrophenol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), metals, and metal compounds, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where dinitrophenol is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of dinitrophenol. Wherever dinitrophenol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dinitrophenol, wetted with not <15% water, by mass, requires a shipping label of "FLAMMABLE SOLID, POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 4.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wet spilled material with water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep dinitrophenol out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dry dinitrophenol is a severe explosion hazard when exposed to heat or shock. Wetted dinitrophenol in solution may be combustible or flammable depending on the solvent. Poisonous gases are produced in fire, including oxides of nitrogen and carbon monoxide. Use flooding quantities of water to extinguish fire. If water is not available use dry chemical or dirt. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) with adequate scrubbing equipment for the removal of nitrogen oxides. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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New York State Department of Health. (March 1986). *Chemical Fact Sheet: 2,4-Dinitrophenol*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: 2,4-Dinitrophenol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2003). *Hazardous Substances Fact Sheet: Dinitrophenol*. Trenton, NJ

Dinitrotoluene D:1370

Molecular Formula: $C_7H_6N_2O_4$

Common Formula: $C_6H_3(NO_2)_2CH_3$

Synonyms: Dinitrophenylmethane; Dinitrotoluene (2,4 & 2,6 mixture); dinitrotoluene (mixed isomers); Dinitrotoluene, solid; Dinitrotoluenes; Dinitrotoluenos (Spanish); Dinitrotoluol; Dinitrotoluènes (French); DNT; Methyldinitrobenzene TDNT; Toluene, AR, AR-dinitro

2,4-isomer

Benzene, 2,4-DNT; Benzene, 1-methyl-2,4-dinitro-; 2,4-Dinitrotolueno (Spanish); 2,4-DNT; 1-Methyl-2,4-dinito-benzene; NCI-C01865; Toluene, 2,4-dinitro-

CAS Registry Number: 121-14-2 (2,4-); 602-01-7 (2,3-); 606-20-2 (2,6-); 610-39-9 (3,4-); 618-85-9 (3,5-); 25321-14-6 (mixture of isomers)

RTECS® Number: XT1300000; XT1575000 (2,4-); XT1400000 (2,3-); XT1925000 (2,6-); XT2100000 (3,4-)

UN/NA & ERG Number: UN1600 (molten)/152; UN2038 (liquid, solid)/152

EC Number: 204-450-0 [*Annex I Index No.:* 609-007-00-9] (2,4-); 210-013-5 [*Annex I Index No.:* 609-050-00-3] (2,3-); 210-106-0 [*Annex I Index No.:* 609-049-00-8] (2,6-); 210-222-1 [*Annex I Index No.:* 609-051-00-9] (3,4-); (3,5-) 210-566-2 [*Annex I Index No.:* 609-052-00-4]; 246-836-1 [*Annex I Index No.:* 609-007-00-9] (mixed isomers); NIOSH: potential human carcinogen.

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*2,4- & 2,6-isomers*): Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1996; EPA (*mixed isomers*): Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; *(3,5 isomer*) Human Inadequate Evidence; Animal, No Evidence, *not classifiable as carcinogenic to humans*, Group 3.

US EPA Gene-Tox Program, Positive: Sperm morphology—human (mixture of isomers, 25321-14-6); Inconclusive: CHO gene mutation (2,3-isomer, 602-01-7; 2,4-isomer, 121-14-2; 2,6-isomer, 606-20-2; 3,4-isomer, 610-39-9).

NCI: Carcinogenesis Bioassay (feed); some evidence: rat; (feed); no evidence: mouse.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15) as dinitrotoluene.

US EPA Hazardous Waste Number (RCRA No.): U105; D030.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.13 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 140.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (0.2); 8270 (10).

Safe Drinking Water Act: Priority List (55FR1470).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/88; male 8/20/99 (2,4-); Cancer 7/1/95; male 8/20/99 (2,6-); Developmental/Reproductive toxin (male, female) (technical grade) 8/20/99; Cancer (mixture, 2,4- & 2,6-) 5/1/96.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations *(2,4-; 2,3-; & mixed isomers*): Hazard Symbol: T, N; Risk phrases: R45; R23/24/25; R48/22; R62; R68; R50/53; Safety phrases: S53; S45; S60; S61; (*2,6-isomer*) Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/24/25; R48/22; R62; R68; R52/53; Safety phrases: S53; S45; S61; (*3,4- & 3,5-isomers*):

Hazard Symbol: T, N; Risk phrases: R45; R23/24/25; R48/22; R62; R68; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water *polluting (2,4- and 2,6-isomers)*.

Description: Six isomers of DNT exist, the most important being 2,4-dinitrotoluene, an orange-yellow crystalline solid. Commercial grades of DNT typically consist of a mixture of all 6 isomers, but mainly 2,4-DNT (75−78%) and 2,6-DNT (19−22%). Molecular weight, all isomers = 182.15; Boiling point = 300°C; Freezing/Melting point = 70°C; Flash point = 207°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1 (must be preheated to burn), Reactivity 3 (heat or shock may cause detonation). Insoluble in water.

Potential Exposure: Compound Description (mixture of isomers, 25321-14-6): Tumorigen, Mutagen; Reproductive Effector; (602-01-7) Tumorigen, Drug, Mutagen, Primary Irritant; (121-14-2) Tumorigen, Mutagen; Reproductive Effector; Primary Irritant; (606-20-2) Tumorigen, Mutagen, Primary Irritant; (610-39-9) Mutagen, Primary Irritant. DNT is used in the preparation of polyurethane foams and manufacture of toluene diisocyanate for the production of polyurethane plastics; in the production of military and commercial explosives; to plasticize cellulose nitrate in explosives, to moderate the burning rate of propellants and explosives; in the manufacture of gelatin explosives; as a water-proofing coating for smokeless powders; as an intermediate in TNT manufacture; and in the manufacture of azo dye intermediate.

Incompatibilities: A strong oxidizer and explosive. Dust forms explosive mixture with air. Heat forms corrosive nitrogen oxide fumes and may cause explosion. Commercial grades will decompose at 250°C/482°F, with self-sustaining decomposition at 280°C/536°F. Contact with other strong oxidizers, caustics, and reducing agents may cause fire and explosions. Contact with nitric acid forms an explosive material. Contact with sodium oxide causes ignition. Not compatible with chemically active metals, such as tin and zinc.

Permissible Exposure Limits in Air

OSHA PEL: 1.5 mg/m^3 TWA [skin].

NIOSH REL: 1.5 mg/m^3 TWA [skin], potential carcinogen, reduce to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA [skin], confirmed animal carcinogen with unknown relevance to humans; BEI$_M$ issued for Methemoglobin inducers.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

2,4-isomer
TEEL-0: 0.2 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 50 mg/m^3

2,6-isomer
TEEL-0: 0.2 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 50 mg/m^3

3,4-isomer
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 1 mg/m^3
PAC-3: 50 mg/m^3

Mixed isomers
TEEL-0: 0.2 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 50 mg/m^3

DFG MAK (*mixture of isomers*): [skin]; Carcinogen, Category 2.

Arab Republic of Egypt: TWA 1.5 mg/m^3, [skin], 1993; Australia: TWA 1.5 mg/m^3, [skin], 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 1.5 mg/m^3, [skin], 1993; Denmark: TWA 1.5 mg/m^3, [skin], 1999; Finland: TWA 1.5 mg/m^3; STEL 3 mg/m^3, [skin], 1999; India: TWA 1.5 mg/m^3, [skin], 1993; Norway: TWA 0.15 mg/m^3, 1999; the Philippines: TWA 1.5 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 5 mg/m^3, 1999; Sweden: NGV 0.15 ppm, KTV 0.3 ppm, [skin], 1999; Switzerland: carcinogen, [skin], 1999; Turkey: TWA 1.5 mg/m^3, [skin], 1993; United Kingdom: LTEL 1.5 mg/m^3; STEL 5 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. (602-01-7): Denmark: TWA 1.5 mg/m^3, [skin], 1999. (606-20-2): United Kingdom: carcinogen, 2000. Several states have set guidelines or standards for DNT in ambient air[60] ranging from 15 μg/m^3 (Connecticut and North Dakota) to 25 μg/m^3 (Virginia) to 36 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #44.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 300 μg/L on an acute toxicity basis and 230 μg/L on a chronic toxicity basis. *To protect saltwater aquatic life:* 590 μg/L on an acute toxicity basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a concentration of 1.1 μg/L of 2,4-DNT.[6] Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes. In addition, the states of Kansas and Minnesota have set guidelines for DNT in drinking water,[61] both at a level of 1.1 μg/L.

Determination in Water: Methylene chloride extraction followed by exchange to toluene and gas chromatography with flame ionization detection (EPA Method 609) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May affect the central nervous system, cardiovascular system, and the blood, resulting in the formation of methemoglobin. Symptoms may be delayed for up to 4 h. Both the nervous system and the blood are affected. Nervous system effects may include confusion, disorientation, dizziness, weakness, drowsiness, and coma. Convulsions may occur. Blood effects are from a decreased ability to carry oxygen and may include moderate to severe headache, nausea, vomiting, blue coloring of skin, fall in blood pressure, and an irregular heartbeat. Ingestion of alcohol is reported to aggravate toxic effects. *Skin:* Readily absorbed through the skin. Small amounts absorbed from clothes or shoes may cause or increase the severity of the symptoms listed above. Irritates the skin. *Eyes:* Hot fumes may cause severe burning of eyelids and cornea, resulting in permanent scarring. *Ingestion:* Animal studies suggest that ingestion causes symptoms listed under Inhalation.

Long Term Exposure: Reported or prolonged exposure may cause anemia, decrease of oxygen-carrying capacity of the blood, blue skin coloration, liver damage and jaundice, anemia, weight loss, and skin rash. May affect the nervous system causing fatigue, nausea, vomiting, personality changes, such as irritability, anxiety, confusion, and depression. May be a cancer-causing agent in humans since it has been shown to cause liver cancer in animals. The 2,6-isomer caused mutations, liver cancer in animals; and may decrease fertility in males and females.

Points of Attack: Blood, liver, cardiovascular system, reproductive system. Cancer sites in animals: liver, skin, and kidney.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: complete blood count (CBC). Urinary dinitrotoluene level. Liver and kidney function tests. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The formation of methemoglobin may be delayed; medical observation is recommended.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinitrotoluenes you should be trained on its proper handling and storage. 2,4-Dinitrotoluene must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, bromine, nitrates, and permanganates; caustics, such as sodium hydroxide and potassium hydroxide; and chemically active metals, such as tin or zinc, since violent reactions occur. Contact with strong oxidizers can cause fire or explosions. Also, striking it or dropping it may cause detonation and explosion. Store in tightly closed containers in a cool, well-ventilated area away from heat (temperatures above 250°C). Sources of ignition, such as smoking and open flames, are prohibited where 2,4-dinitrotoluene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of 2,4-dinitrotoluene. Wherever 2,4-dinitrotoluene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dinitrotoluenes, solid or molten, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of

potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Molten 2,4-dinitrotoluene is combustible. It may burn but does not readily ignite. Use extreme caution when fighting a fire, since 2,4-dinitrotoluene could explode. Use dry chemical, CO_2, or water spray extinguishers. If the fire is advanced, evacuate the area. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves contact of the dinitrotoluene contaminated waste with $NaHCO_3$ and solid combustibles followed by incineration in an alkaline scrubber-equipped incinerator unit. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Dinitrotoluenes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (March 9, 1978). *Chemical Hazard Information Profile: 2,4-Dinitrotoluene*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Dinitrotoluenes: Health and Environmental Effects Profile No. 92*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *2,4-Dinitrotoluene: Health and Environmental Effects Profile No. 93*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 2, 70−72

New York State Department of Health. (May 1986). *Chemical Fact Sheet: 2,4-Dinitrotoluene*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (January 2006). *Hazardous Substances Fact Sheet: 2,4-Dinitrotoluene*. Trenton, NJ

Dinoseb D:1380

Molecular Formula: $C_{10}H_{12}N_2O_5$; $C_{12}H_{14}N_2O_6$ (acetate)

Common Formula: $C_6H_2(NO_2)_2(C_4H_9)OH$

Synonyms: Aatox; AI3-01122; Aretit; Basanite; BNP 20; BNP 30; Butaphene; 2-*sec*-Butyl-4,6-dinitrophenol; Caldon; Caswell No. 392DD; Chemox; Chemox general; Chemox P. E.; DBNF; Dinitrall; Dinitro; Dinitro-3; 2,4-Dinitro-6-*sec*-butylphenol; 4,6-Dinitro-*o*-*sec*-butylphenol; 4,6-Dinitro-2-*sec*-butylphenol; Dinitro-*o*,*sec*-butylphenol; Dinitrobutylphenol; 2,4-Dinitro-6-(1-methylpropyl)phenol; 4,6-Dinitro-2-(1-methyl-*N*-propyl)phenol; 4,6-Dinitro-2-(1-methyl-propyl)phenol; Dinoseb; DN 289; DNBP; DNOSBP; DNPB; DNSBP; Dow general; Dow general weed killer; Dow selective weed killer; Dynamyte; Dytop; Elgetol 318; ENT 1,122; EPA pesticide chemical code 037505; Gebutox; Hel-Fire; Ivosit; Kiloseb; Knox-Weed; Ladob; Laseb; Liro DNBP; 2-(1-Methylpropyl)-4,6-dinitrophenol; Nitropone C; NSC 202753; Phenol, 2-*sec*-butyl-4,6-dinitro-; Phenol, 2-(1-methylpropyl)-4,6-dinitro-; Phenotan; Premerge; Premerge 3; Sinox general; Sparic; Spurge; Subitex; Unicrop DNBP; Vertac dinitro weed killer; Vertac general weed killer; Vertac selective weed killer

CAS Registry Number: 88-85-7; 2813-95-8 (acetate)

RTECS® Number: SJ9800000; AF7140000 (acetate)

UN/NA & ERG Number: UN2779 (substituted nitrophenol pesticide, solid, toxic)/153; UN3014 (substituted nitrophenol pesticide, liquid, toxic, Dinoseb acetate)/153

EC Number: 201-861-7 [*Annex I Index No.:* 609-025-00-7]; 609-026-00-2 (acetate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Banned or Severely Restricted (several countries) (UN).[13]

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; *E. coli* polA without S9; Positive: *S. cerevisiae* gene conversion; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA Hazardous Waste Number (RCRA No.): P020.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.066; Nonwastewater (mg/kg), 2.515.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (1); 8270 (10).
Safe Drinking Water Act: MCL, 0.007 mg/L; MCLG, 0.007 mg/L; Regulated chemical (47FR9352).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (dinoseb and its salts and esters).
California Proposition 65 Chemical: Developmental/Reproductive toxin (male) 1/1/89.
European/International Regulations (*88-85-7*): Hazard Symbol: T, N; Risk phrases: R61; R62; R24/25; R36; R44; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dinoseb is an orange crystalline solid when pure, or may be formulated with a flammable solvent as a brown viscous liquid with a pungent odor. Molecular weight = 240.24; 282.32 (acetate); Freezing/Melting point = 38−42°C; 26.7°C (acetate); Flash point (hydrocarbon solvent) = 16−29°C (for 3 commercial products). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. This material is used for herbicide formulation; as a plant growth regulator, insecticide, and herbicide. Dinoseb is primarily used as a contact herbicide for postemergence weed control in cereals, undersown cereals, seedling lucerne and peas. Dinoseb is also used as a corn yield enhancer and an insecticide and miticide.[US EPA]

Incompatibilities: The solution in water is a weak acid. Attacks many metals in the presence of water.

Permissible Exposure Limits in Air

88-85-7
Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 4.5 mg/m^3
PAC-3: 4.5 mg/m^3

Permissible Concentration in Water: A health advisory of 3.5 μg/L has been developed by EPA based on possible teratogenic action of dinoseb as described in the EPA document below. Several states have set guidelines for dinoseb in drinking water[61] ranging from 2.0 μg/L (Maine) to 5.0 μg/L (Massachusetts) to 13.0 μg/L (Wisconsin) to 39.0 μg/L (Kansas). Russia set a MAC of 0.1 mg/L in surface water. Octanol−water coefficient: Log $K_{ow} = 3.7$. Values above 3.0 are likely to bioaccumulate in marine organisms.

Determination in Water: Extraction with ether, conversion to methyl ester and determination by electron capture gas chromatography. Fish Tox = 2.85539000 ppb (MATC) High.

Harmful Effects and Symptoms

Short Term Exposure: Dinoseb causes eye irritation. May affect the gastrointestinal tract and central nervous system. Early manifestations of dinoseb exposure include fever, sweating, headache, and confusion. Elevations of blood pressure, pulse, and respiratory rate are common. Severe exposure may result in restlessness, seizures, and coma. Other signs and symptoms include dyspnea (shortness of breath), nausea, vomiting, and abdominal pain. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias may be noted. Inhalation of the aerosol may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Muscle weakness may be pronounced. Dermal exposure results in yellow staining of the skin and may produce burns. Human Tox = 0.70000 ppb (EXTRA HIGH).

Warning: Exposure to dinoseb fumes or aerosol in hot environment may cause death. Effects may be delayed from several hours to 2 days. Caution is advised. Toxicity of dinoseb is enhanced by high ambient temperature and physical activity. Dinoseb is extremely toxic: Probable oral lethal dose is 5−50 mg/kg; between 7 drops and 1 teaspoonful for 70-kg (150-lb) person.

Long Term Exposure: Dinoseb may affect the kidneys, liver, blood, immune system, and eyes; may cause cataracts. May cause reproductive toxicity in humans.

Points of Attack: Liver, kidneys, blood, cardiovascular system, immune system, eyes.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC). Eye examination. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Consult poison center on use of antidotes.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. If working with liquid wear splash-proof chemical goggles, if working with dry material wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.2 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinoseb you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Dinoseb and dinoseb acetate are toxic pesticide and should be labeled "SUBSTITUTED NITROPHENOL PESTICIDES, SOLID (or LIQUID), TOXIC." They fall into DOT/UN Hazard Class 6.1(b) and Packing Group III.

Spill Handling: Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water.

Dry material: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep spilled material wet. Do not attempt to sweep up dry material. Use HEPA vacuum or wet method to reduce dust during cleanup. *Do not dry sweep*. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep material out of water sources and sewers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep material out of water sources and sewers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish by flooding with water. Cool all affected containers with flooding quantities of water. Wear self-contained breathing apparatus and full protective clothing. If fire becomes uncontrollable, evacuate for a radius of 1 mile. It is dangerously explosive. When not water-wet it is a high explosive. Dry, the material is easily ignited and it will burn very vigorously. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Conduct at 1000°C for 2.0 s minimum with scrubber for nitrogen oxides removal is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dinoseb*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (August 1987). *Health Advisory: Dinoseb*. Washington, DC: Office of Drinking Water

Dinoterb D:1390

Molecular Formula: $C_{10}H_{12}N_2O_5$
Common Formula: $C_6H_2(NO_2)_2(C_4H_9)(OH)$
Synonyms: *o*,*tert*-Butyl-4,6-dinitrophenol; 2-(1,1-Dimethylethyl)-4,6-dinitrophenol; 2,4-Dinitro-6-*tert*-butylphenol; Dinitroterb; DNTBP; Herbogil; Phenol-2-*tert*-butyl-4,6-dinitro-; Phenol, 2-(1,1-dimethylethyl)4,6-dinitro-
CAS Registry Number: 1420-07-1
RTECS® Number: SK0160000
UN/NA & ERG Number: UN1599/153; UN2779 (Substituted nitrophenol pesticides, solid, toxic)/153
EC Number: 215-813-8 [*Annex I Index No.:* 609-030-00-4]
Regulatory Authority and Advisory Bodies
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 500 lb (227 kg).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R61; R24; R28; R44; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Dinoterb is a yellow solid. May be formulated in a hydrocarbon solvent which changes the physical properties shown here. Molecular weight = 240.24; Freezing/Melting point = 126°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Practically insoluble in water.

Potential Exposure: This material is an herbicide and a rodenticide.

Incompatibilities: Strong caustics. Heat may cause material to explode.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of poisoning are similar to other dinitrophenols and may include nausea, gastric distress, restlessness, sensation of heat, flushed skin, sweating, thirst, deep and rapid breathing, rapid heart rate, fever, and lack of oxygen to tissues (blueness of skin). This compound is toxic by all routes of exposure. The dangerous single oral dose of dinitro-*o*-cresol, a structurally similar compound, is estimated to be about 29 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dinoterb, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dinoterb you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Substituted nitrophenol pesticides, solid, toxic, require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and dinoterb in Packing Group II.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Wet spills: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Heat may cause material to explode. Use dry chemical, carbon dioxide, water spray, or foam for *small fires*, and for *large fires* use water spray, fog, or foam. Move container from fire area if it can be done safely. Isolate hazard area, stay upwind, and keep out of low areas. Wear self-contained breathing apparatus and full protective clothing. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dinoterb.* Washington, DC: Chemical Emergency Preparedness Program

Di-*n*-octyl phthalate D:1400

Molecular Formula: $C_{24}H_{38}O_4$

Common Formula: $C_6H_4(COOC_8H_{17})_2$

Synonyms: 1,2-Benzenedicarboxylic acid, di-*n*-octyl ester; Bis(2-ethylhexyl)phthalate; Cellulex DOP; Di-*sec*-(2-ethylhexyl)phthalate; Dinopol NOP; Di-*n*-octyl phthalate; Di-*sec*-octyl phthalate; DNOP; DOP; *n*-Octyl phthalate; Octyl phthalate; Phthalic acid, dioctyl ester; PX-138; Vinicizer-85

CAS Registry Number: 117-84-0

RTECS® Number: TI1925000

UN/NA & ERG Number: UN3082/171

EC Number: 204-214-7

Regulatory Authority and Advisory Bodies

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U107.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (30); 8270 (10).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DNOP is a liquid. Molecular weight = 390.62; Boiling point = 230°C under 5 mmHg; Flash point = 215°C; Autoignition temperature = 390°C. Explosive Limits: LEL = 0.3% at 245°C; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: DNOP is used as a plasticizer in the manufacture of plastic products.

Incompatibilities: Water contact causes foaming. Incompatible with oxidizers, strong acids, alkyl halides, since violent reactions occur.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 50 mg/m^3

PAC-2: 400 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: Insufficient data are available to permit EPA to define criteria to prevent damage to aquatic life or harm to humans.[6] Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Di-*n*-octyl phthalate can affect you when breathed in and may enter the body through the skin. Eye contact may cause irritation. Repeated skin contact may cause dryness, cracking, and rash. Breathing the vapor may irritate the nose, throat, and bronchial tubes. High exposure levels can irritate the lungs and, if prolonged, could cause death.

Long Term Exposure: High or repeated exposure may affect the liver or kidneys. Repeated skin contact can cause dryness, cracking, and rash. This chemical has been shown to be a teratogen in animals.

Points of Attack: Skin, liver, kidneys.

Medical Surveillance: Liver, kidney, and lung function tests. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends butyl rubber, nitrile rubber, and Viton as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to di-*n*-octyl phthalate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Di-*n*-octyl phthalate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric); and alkyl halides, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Phthalate Esters: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Di-n-Octyl Phthalate: Health and Environmental Effects Profile No. 95*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 1, 52−56

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Dioctyl Phthalate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Di-n-Octyl Phthalate*. Trenton, NJ

Dioxane D:1410

Molecular Formula: $C_4H_8O_2$

Synonyms: 6200 drum cleaning solvent; 6500 drum cleaning solvent; Chlorothene SM solvent; 1,4-Diethylene dioxide; Diethylene dioxide; Diethylene ether; Di(ethylene oxide); Diethylene oxide; Diokan; 1,4-Dioxacyclohexane; 1,4-Dioxan (German); Dioxan; Dioxan-1,4 (German); *p*-Dioxane; 1,4-Dioxane; Dioxane; Dioxanne (French); 1,4-Dioxin, tetrahydro-; Dioxyethylene ether; Glycol ethylene ether; NCI-C03689; NE 220; Solvent 111; STCC 4909155; Tetrahydro-*p*-dioxin; Tetrahydro-1,4-dioxin

CAS Registry Number: 123-91-1

RTECS® Number: JG8225000

UN/NA & ERG Number: UN1165/127

EC Number: 204-661-8 [*Annex I Index No.*: 603-024-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (oral); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Negative: Cell transform.—SA7/SHE.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U108.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 12.0; Nonwastewater (mg/kg), 170.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (150).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R19; R36/37; R40; Safety phrases: S2; S9; S16; S36/37; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dioxane is a volatile, colorless liquid that may form explosive peroxides during storage. Molecular weight = 88.12; Specific gravity (H_2O:1) = 1.03; Boiling point = 101°C; Freezing/Melting point = 12°C; Vapor pressure = 29 mmHg at 20°C; Flash point = 12°C; Autoignition temperature = 180°C. Explosive limits: LEL = 2.0%; UEL = 22%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Dioxane is used as a stabilizer in chlorinated solvents, and as a solvent for cellulose acetate; other primary uses include as a solvent for dyes, fats, greases, lacquers, mineral oil; paints, polyvinyl polymers; resins, varnishes, and waxes. It finds particular usage in paint and varnish strippers; as a wetting agent and dispersing agent in textile processing; dye baths; stain and printing compositions; and in the preparation of histological slides.

Incompatibilities: Forms explosive mixture with air. Moisture forms unstable and explosive peroxides. Incompatible with strong oxidizers, strong acids, decaborane, triethyl aluminum, oxygen, halogens, reducing agents, moisture, and heat. Reacts explosively with catalysts, such as Raney nickel (above 210°C). Attacks many plastics. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.60 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/360 mg/m^3 TWA [skin].

NIOSH REL: 1 ppm/3.6 mg/m^3/30 min, Ceiling Concentration [skin], Potential carcinogen. Limit exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 20 ppm/72 mg/m^3 TWA [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 17 ppm

PAC-1: **17** ppm

PAC-2: **320** ppm

PAC-3: **760** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 20 ppm/73 mg/m^3; [skin]; Peak Limitation Category I(2); Carcinogen Category 4; Pregnancy Risk Group C.

Australia: TWA 25 ppm (90 mg/m^3), [skin], 1993; Austria: MAK 50 ppm (180 mg/m^3), [skin], Suspected: carcinogen, 1999; Belgium: TWA 25 ppm (90 mg/m^3), [skin], 1993;

Denmark: TWA 10 ppm (36 mg/m^3), [skin], 1999; Finland: TWA 25 ppm (90 mg/m^3); STEL 40 ppm (135 mg/m^3), [skin], 1999; France: VME 10 ppm (35 mg/m^3), VLE 40 ppm, continuous carcinogen, 1999; Hungary: STEL 10 mg/m^3, [skin], carcinogen, 1993; the Netherlands: MAC-TGG 40 mg/m^3, [skin], 2003; the Philippines: TWA 100 ppm (360 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 80 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 25 ppm (90 mg/m^3), KTV 50 ppm, [skin], carcinogen, 1999; Switzerland: MAK-W 25 ppm (90 mg/m^3); STEL 50 ppm, [skin], 1999; Turkey: TWA 100 ppm (360 mg/m^3), [skin], 1993; United Kingdom: TWA 25 ppm (91 mg/m^3); STEL 100 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[35, 43] set a MAC of 0.7 mg/m^3 in the ambient air of residential areas[35] on a once-daily basis. Several states have set guidelines or standards for Dioxane in ambient air[60] ranging from zero (North Carolina) to 2.4 μg/m^3 (Massachusetts) to 214.286 μ/m^3 (Kansas) to 300 μg/m^3 (New York) to 311 μ/m^3 (Pennsylvania) to 450 μg/m^3 (Connecticut and South Carolina) to 900 μg/m^3 (Florida, South Dakota) to 1500 μg/m^3 (Virginia) to 2140 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1602 or OSHA Analytical Method 7.[18]

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 2480 μg/L based on health effects. The EPA[48] has developed a 1-day health advisory of 4 mg/L and a 10-day health advisory of 0.4 mg/L but notes that carcinogenicity makes formulation of a long-term advisory inadvisable. Connecticut[61] has set a guideline for dioxane in drinking water of 20 μg/L.

Determination in Water: Purge and trap; gas chromatography-mass spectrometry may be used.[48] Octanol−water coefficient: Log $K_{ow} = < -0.5$.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact with dioxane can cause eye and skin irritation and burns. Inhalation can cause irritation of the respiratory tract with coughing and shortness of breath. Higher exposure to dioxane vapor can cause headache, lightheadedness, dizziness, loss of appetite, headache, nausea, vomiting, stomach pain, drowsiness, and unconsciousness. Overexposure may cause liver and kidney damage. Prolonged skin exposure to the liquid may cause drying and cracking.

Long Term Exposure: Prolonged or repeated exposure may cause liver and kidney damage. The liquid defats the skin, causing drying and cracking. This chemical is a potential occupational carcinogen.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys. Cancer site in animals: lung, liver, and nasal cavity.

Medical Surveillance: Preplacement and periodic examinations should be directed to symptoms of headache and dizziness, as well as nausea and other gastrointestinal disturbances. The condition of the skin should be considered. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended, before beginning work and at regular times after that: Liver function tests. Kidney function tests, including routine urine test.

NIOSH lists the following tests: whole blood (chemical/metabolite), during exposure; blood plasma; blood urea nitrogen; chest X-ray; kidney function tests; liver function tests; pulmonary function tests; urine (chemical/metabolite); urine (chemical/metabolite), sediment; urine (chemical/metabolite) end-of-shift; urinalysis (routine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves, Tychem 10000® suits; **4 h** (at least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *NIOSH: At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with dioxane you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,4-Dioxane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where 1,4-dioxane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of 1,4-dioxane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,4-dioxane. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Do not use halogens. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Dioxane*, NIOSH Document No. 77-226

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Dioxane*. Washington, DC

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 1, 32−42

New York State Department of Health. (January 1986). *Chemical Fact Sheet: 1,4-Dioxane*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: 1,4-Dioxane*. Trenton, NJ

Dioxathion D:1420

Molecular Formula: $C_{12}H_{26}O_6P_2S_4$

Synonyms: AC 528; Bis(dithiophospate de *O,O*-diethyle) de *S,S*′-(1,4-dioxanne-2,3-diyle) (French); Delnatex; Delnav; 1,4-Dioxan-2,3-diyl *S,S*-di(*O,O*-diethyl phosphorodithioate); 2,3-Dioxanedithiol *S,S*-bis(*O,O*-diethylphosphorodithioate); *S,S*′-*p*-Dioxane-2,3-diyl bis(*O,O*-diethylphosphorodithioate); *S,S*′-1,4-Dioxane-2,3-diyl bis(*O,O*-diethyl phosphorodithioate); *S,S*′-(1,4-Dioxane-2,3-diyl) *O,O,O*′,*O*′-tetraethylbis(phosphorodithioate); *S,S*′-1,4-Dioxane-2,3-diyl *O,O,O*-tetraethyl ester; ENT 22879; Hercules AC528; Kavadel; Navadel; NCI-C00395; Phosphorodithioic acid, *O,O*-diethyl ester, *S,S*-diester with *p*-dioxane-2,3-dithiol; Phosphorodithioic acid, *S,S*′-*p*-dioxane-2,3-diyl *O,O,O*′,*O*′-tetraethyl ester; Phosphorodithioic acid, *S,S*′-1,4-dioxane-2,3-diyl *O,O,O*′,*O*′-tetraethyl ester;

Phosphorodithioic acid, 5,5′-, 1,4-dioxane-2,3-diyl *O,O,O′*, *O′*-tetraethyl ester

CAS Registry Number: 78-34-2

RTECS® Number: TE3350000

UN/NA & ERG Number: UN1599/153

EC Number: 201-107-7 [*Annex I Index No.:* 015-063-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24; R26/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dioxathion is a viscous, reddish-brown liquid or powder with a garlic-like odor. Technical product is a mixture of *cis*- and *trans*-isomers. Molecular weight = 456.56; Boiling point = (decomposes)>135°C; Freezing/Melting point = −20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Human Data. Those involved in the manufacture, formulation, or application of this insecticide and acaricide for control of insects and mites on grapes, citrus, etc.

Incompatibilities: Incompatible with strong acids. Decomposes above 135°C, forming toxic oxides of phosphorus and sulfur. Attacks iron and tin surfaces. Hydrolyzed by alkalies. Dioxathion is hydrolyzed by strong bases; attacks iron and tin surfaces. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin] inhalable fraction and vapor; Not Suspected as a Human Carcinogen (2001); TLV-BEI$_A$ issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 3.4 mg/m^3

PAC-3: 150 mg/m^3

Australia: \TWA 0.2 mg/m^3, [skin], 1993; Belgium: TWA 0.2 mg/m^3, [skin], 1993; Denmark: TWA 0.2 mg/m^3, [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Switzerland: MAK-W 0.2 mg/m^3, [skin], 1999; United Kingdom: TWA 0.2 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for Dioxathion in ambient air[60] ranging from zero (New York) to 2.0 μg/m^3 (North Dakota) to 3.0 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Dioxathion is a cholinesterase inhibitor. It may affect the nervous system, resulting in convulsions and respiratory failure. Exposure to high levels may cause death. Acute exposure to dioxathion may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Dioxathion is very toxic. Probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoonful and 1 oz for a 70-kg (150-lb) person. It is a cholinesterase inhibitor. Death is primarily due to respiratory arrest arising from failure of the respiratory center, paralysis of respiratory muscles, intense bronchoconstriction, or all three. LD$_{50}$ = (oral-rat) 20 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions and respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.2 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Dioxathion requires a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and in Packing Group II. This chemical is a regulated marine pollutant.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Small spill: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dioxathion does not burn. Use fire extinguishing agents suitable for surrounding fire. Decomposes above 135°C; Poisonous gases, including nitrogen, phosphorus, and sulfur oxides, are produced. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For small quantities: mix with lime and bury. For large amounts, use incineration with effluent gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 60−63. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dioxathion*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dioxathion*. Trenton, NJ

Dioxolane D:1430

Molecular Formula: $C_3H_6O_2$

Synonyms: 1,3-Dioxacyclopentane; 1,3-Dioxolan; Ethylene glycol formal; Formal glycol; Glycol formal

CAS Registry Number: 646-06-0

RTECS® Number: JH6760000

UN/NA & ERG Number: UN1166/127

EC Number: 211-463-5 [*Annex I Index No.:* 605-017-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S16 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dioxolane is a water-white liquid. Molecular weight = 74.09; Boiling point = 74°C; Flash point = 2°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. Soluble in water.

Potential Exposure: It is a low-boiling solvent and used for extraction of oils, fats, waxes, dyes, and cellulose derivatives. May be used as a cross-linking agent in phenolic resins.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 20 ppm/61 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 60 ppm

PAC-2: 69 ppm

PAC-3: 3000 ppm

DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C.

Russia[43] has set a workplace MAC: 50 mg/m^3.

Determination in Air: No method available.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Moderately toxic by inhalation and ingestion. May be poisonous if inhaled or absorbed through skin. Contact may irritate or burn skin and eyes. Vapors may cause dizziness or suffocation.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to the chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: This chemical is a flammable liquid. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. If material is not on fire and not involved in fire, then keep sparks, flames, and other sources of ignition away. Build dikes to contain flow as necessary. Attempt to stop leak if this can be done without hazard. Use water spray to disperse vapors, and dilute standing pools of liquid. Avoid breathing vapors. Keep upwind. Wear boots, protective goggles, and gloves. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Do not extinguish unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Use "alcohol" foam, carbon dioxide, or dry chemical. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Dioxolane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Dioxolane*. Trenton, NJ

Dipentene D:1440

Molecular Formula: $C_{10}H_{16}$

Synonyms: Cajeputene; Cinene; DL-*p*-Mentha-1,8-diene; Limonene; DL-Limonene; *p*-Mentha-1,8-diene; 1-Methyl-4-(1-methylethenyl) cyclohexane; Terpinene

CAS Registry Number: 138-86-3

RTECS® Number: OS8100000

UN/NA & ERG Number: UN2052/128

EC Number: 205-341-0 [*Annex I Index No.:* 601-029-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity as (*D-limonene 5989-27-5*): IARC: Human Inadequate Evidence; Animal, No Evidence, *not classifiable as carcinogenic to humans*, Group 3.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R38; R43; R50/53 Safety phrases: S2; S24; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dipentene is a colorless liquid with a lemon-like odor. A racemic mixture of the D- and L-isomers. Molecular weight = 136.26; Boiling point = 170°C; Flash point = 45°C; Autoignition temperature = 237°C. Explosive limits: LEL = 0.7% at 150°C; UEL = 6.1% at 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Dipentene is used as a solvent; in rubber compounding and reclamation; and to make paints, enamels, lacquer, and perfumes.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

AIHA WEEL: 30 ppm TWA [*as D-limonene (CAS:138-86-3)*].

No TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Dipentene can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. High exposures may damage the kidneys.

Long Term Exposure: Dipentene may cause a skin allergy. If allergy develops, very low future exposures can cause itching and a skin rash. There is limited evidence that dipentene causes kidney cancer in male rats.

Points of Attack: Skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dipentene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 78−79

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Dipentene*. Trenton, NJ

Diphacinone D:1450

Molecular Formula: $C_{23}H_{16}O_3$

Synonyms: Didandin; Dipaxin; Diphacin; Diphacinon; Diphenacin; Diphenadion; Diphenadione; 2-Diphenylacetyl-1,3-diketohydrindene; 2-(Diphenylacetyl)indan-1,3-indandione; 2-(Diphenylacetyl)-1H-indene-1,3(2H)-dione; Oragulant; PID; Promar; Ramik; Ratindan 1; Solvan; U 1363

CAS Registry Number: 82-66-6

RTECS® Number: NK5600000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 201-434-5 [*Annex I Index No.:* 606-038-00-X]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R28; R48/23/24/25; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diphacinone is an odorless, pale yellow, crystalline solid. Molecular weight = 340.39; Freezing/Melting point = 146−147°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Very slightly soluble in water.

Potential Exposure: This material is used as a rodenticide and as an anticoagulant medication.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.15 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 0.9 mg/m^3

PAC-3: 500 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: This material is extremely toxic; probable oral lethal dose in humans is 5−50 mg/kg, or between 7 drops and 1 teaspoonful for a 150-lb person. Diphacinone is an anticoagulant (inhibits blood clotting). Hemorrhage is the most common effect and may be manifested by nose bleeding, gum bleeding, bloody stools and urine, ecchymoses (extravasations of blood into skin), and hemoptysis (coughing up blood). Bruising is heightened. Abdominal and flank pains are also common. Other signs and symptoms include flushing, dizziness, hypotension (low blood pressure), dyspnea (shortness of breath), cyanosis (blue tint to the skin and mucous membranes), fever, and diarrhea.

Long Term Exposure: May affect the liver and kidneys. Repeated exposure may cause low white blood cell count and affect the brain.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: Blood test for clotting time (PT, INR, or PTT). Stool and urine tests for blood. Liver and kidney function tests. Complete blood count (CBC). EEG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to a health-care facility. Acute exposure to Diphacinone may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies, such as plastic sheeting and disposable plastic bags, to assist in preventing spread of contamination.

Personal Protective Methods: For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Diphacinone, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Coumarin-derivative pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and diphacinone in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Diphacinone*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Diphacinone*. Trenton, NJ

Diphenamid D:1460

Molecular Formula: $C_{16}H_{17}NO$

Common Formula: $(CH_3)_2NCOCH(C_6H_5)_2$

Synonyms: 80W; Acetamide, *N*,*N*-dimethyl-2,2-diphenyl-; Benzeneacetamide, *N*,*N*-dimethyl-α-phenyl-; DIF 4; Difenamid (Spanish); *N*,*N*-Dimethyl-α,α-diphenylacetamide; *N*,*N*-Dimethyl-2,2-diphenylacetamide; *N*,*N*-Dimethyldiphenylacetamide; *N*,*N*-Dimethyl-α-phenylbenzeneacetamide; Dimid; Diphenamide; Diphenylamide; 2,2-Diphenyl-*N*,*N*-dimethylacetamide; Dymid; Enide; Enide 50W; FDN; Fenam; L 34314; Lilly 34314; Rideon; U 4513; Zarur

CAS Registry Number: 957-51-7; *(alt.)* 73413-06-6

RTECS® Number: AB8050000

UN/NA & ERG Number: UN3077/171

EC Number: 213-482-4 [*Annex I Index No.:* 616-007-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R52/53; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diphenamid is a white crystalline solid in various forms. Molecular weight = 239.34; Freezing/Melting point = 135°C; Vapor pressure = 2.8×10^{-8} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Very slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. This material is used as a preemergent and selective herbicide for tomatoes, peanuts, alfalfa, soybeans, cotton, and other crops.

Incompatibilities: Reacts with strong oxidants, strong acids, and alkalies.

Permissible Exposure Limits in Air

No TEEL available.

Russia: STEL 5 mg/m^3, 1993.

Permissible Concentration in Water: Russia set a MAC of 1.2 mg/L in water bodies used for domestic purposes. A lifetime health advisory of 0.2 mg/L has been calculated by EPA. California[61] has set a guideline for diphenamid in drinking water of 40 μg/L.

Determination in Water: Fish Tox = 5.00495000 ppb (HIGH).

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 685 mg/kg (slightly toxic). Human Tox = 200.00000 ppb (VERY LOW).

Long Term Exposure: A slight increase in liver weights was observed in long-term animal feeding studies. Mutation data reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to diphenamid, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids, strong alkalies.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Diphenamid decomposes at 210°C forming toxic and corrosive gases, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be destroyed by alkaline hydrolysis. Admixture with alkali can be followed by soil burial.[22] Larger quantities can be disposed of by incineration in admixture with acetone or xylene and using effluent gas scrubbing.[22]

References

US Environmental Protection Agency. (August 1987). *Chemical Hazard Information Profile: Diphenamid.* Washington, DC: Office of Drinking Water

Diphenylamine D:1470

Molecular Formula: $C_{12}H_{11}N$

Common Formula: $(C_6H_5)_2NH$

Synonyms: Acetamide, 2-Biphenylyl-*N*-pyridyl-; AI3-00781; Aniline, *n*-phenyl-; Anilinobenzene; Benzenamine, *n*-phenyl-; Benzene, anilino-; Benzene, (phenylamino)-; Big Dipper; 2-Biphenylyl-*N*-pyridylacetamide; Caswell No. 398; C.I. 10355; Deccoscald 282; DFA; Difenilamina (Spanish); Diphenpyramide; *N,N*-Diphenylamine; DPA; EPA pesticide chemical code 038501; No scald DPA 283; NSC 215210; *n*-Phenylaniline; Phenylaniline; *n*-Phenylbenzenamine; *n*-Phenylbenzeneamine; Poly(diphenylamine); Pyridyl-biphenylyl-acetamide; Scaldip; Z-876

CAS Registry Number: 122-39-4

RTECS® Number: JJ7800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-539-4 [*Annex I Index No.:* 612-026-00-5]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE.

RCRA Hazardous Constituent Waste.[5]

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: DPA is a colorless to amber to brown crystalline solid or liquid with a pungent, floral odor. Contact with light causes a color change. Molecular weight = 169.24; Boiling point = 302°C; Freezing/Melting point = 53°C; Vapor pressure = 1 mmHg at 108°C; Flash point = 153°C (cc); Autoignition temperature = 634°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. DPA is used as a stabilizer for plastics including solid rocket propellants; antioxidant for polymers, greases, and industrial oils; in the manufacture of pharmaceuticals; pesticides, explosives, and dyes.

Incompatibilities: Dust may form an explosive mixture with air. Incompatible with strong acids, strong oxidizers, aldehydes, organic anhydrides, isocyanates, hexachloromelamine, trichloromelamine. Reacts with nitrogen oxides forming *n*-nitrosodiphenylamine and heat-, friction-, and shock-sensitive nitro products.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 100 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 10 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; the Netherlands: MAC-TGG 0.7 mg/m^3, 2003; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

The Czech Republic[35] TWA 5 mg/m^3; ceiling value 10 mg/m^3. Several states have set guidelines or standards for diphenylamine in ambient air[60] ranging from 0.68 μg/m^3 (Massachusetts) to 100.0 μg/m^3 (North Dakota) to 160.0 μg/m^3 (Virginia) to 200.0 μg/m^3 (Connecticut and Rhode Island) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method 78.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.05 mg/L in water bodies used for domestic purposes.

Determination in Water: No tests listed. Octanol–water coefficient: Log K_{ow} = 3.34.

Routes of Entry: Inhalation of dust, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: DFA irritates the eyes, skin, and respiratory tract. It may affect the blood (resulting in the formation of methemoglobin). Industrial poisoning has been encountered and was manifested clinically by bladder symptoms, tachycardia, hypertension, and skin trouble. Overexposure can damage the liver, kidneys (polycystic kidneys), and may cause bladder symptoms and blood in the urine.

Long Term Exposure: DFA may affect the liver, kidneys, and blood, forming methemoglobin. NIOSH warns that the carcinogen 4-aminodiphenyl may be present as an impurity in the commercial product. In animals: teratogenic effects.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, blood, bladder, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation of the kidneys and urinary system. Urine cytology (to look for abnormal cells). Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. If while wearing a filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect diphenylamine, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from light. Sources of ignition, such as smoking and open flames, are prohibited where diphenylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic solids, flammable, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Burn in admixture with flammable solvent in furnace equipped with afterburner and scrubber.[22]

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 63−66

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Diphenylamine*. Trenton, NJ

Diphenyl dichlorosilane D:1480

Molecular Formula: $C_{12}H_{10}Cl_2Si$

Common Formula: $(C_6H_5)_2SiCl_2$

Synonyms: Dichlorodiphenylsilane; Diphenylsilicon dichloride

CAS Registry Number: 80-10-4

RTECS® Number: VV3190000

UN/NA & ERG Number: UN1769/156

EC Number: 201-251-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Diphenyl dichlorosilane is a colorless liquid. It has a sharp, pungent, HCl-like odor. Molecular weight = 253.21; Specific gravity = 1.22 at 25°C; Boiling point = 305°C; Autoignition temperature = 633.6°C; Flash point = 142°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Reacts with water; insoluble.

Potential Exposure: This material is used in the synthesis of silicone lubricants.

Incompatibilities: Water, steam, strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.3 ppm

PAC-1: 0.9 ppm

PAC-2: 11 ppm

PAC-3: 50 ppm

Harmful Effects and Symptoms

Short Term Exposure: Vapors can irritate the eyes, nose, and throat. Higher levels could irritate the lungs and even lead to pulmonary edema, a medical emergency. This can cause death. This substance is a corrosive chemical and contact can cause severe skin burns and severe eye burns leading to permanent damage.

Long Term Exposure: Corrosive materials may affect the lungs, bronchitis with coughing and shortness of breath.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for

pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/ clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to diphenyl dichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Diphenyl dichlorosilane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), bases, alcohols, and acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames, are prohibited where diphenyl dichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Fire Extinguishing: Diphenyl dichlorosilane is a combustible liquid. Diphenyl dichlorosilane may burn but does not readily ignite. Poisonous gases are produced in fire, including hydrogen chloride and phosgene. Fire may restart after it has been extinguished. Using water or foam extinguishers may cause frothing. Water spray may be useful. Use dry chemical or CO_2 as extinguishing agents. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Diphenyl Dichlorosilane*. Trenton, NJ

1,2-Diphenylhydrazine D:1490

Molecular Formula: $C_{12}H_{12}N_2$
Common Formula: $C_6H_5NHNHC_6H_5$

Synonyms: Benzene, 1,1′-hydrazobis-; *N*,*N*′-Bianiline; *N*,*N*′-Difenilhidracina (Spanish); 1,2-Difenilhidracina (Spanish); *N*,*N*′-Diphenylhydrazine; *sym*-Diphenylhydrazine; DPH; Hydrazobenzene; Hydrazodibenzene; NCI-CO1854

CAS Registry Number: 122-66-7

RTECS® Number: MW2625000

UN/NA & ERG Number: UN3077/171

EC Number: 204-563-5 [*Annex I Index No.*: 007-021-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen. US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as diphenylhydrazine.

US EPA Hazardous Waste Number (RCRA No.): U109.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.087; Nonwastewater (mg/kg), N/A.

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; 50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: DPH is a white to yellow crystalline compound. Molecular weight = 184.26; Freezing/Melting point = 131°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. 1,2-Diphenylhydrazine (DPH) is a precursor in the manufacture of benzidine, an intermediate in the production of dyes. 1,2-Diphenylhydrazine is used in the synthesis of phenylbutazone, a potent anti-inflammatory (antiarthritic) drug. Manufacturers of dyes and pharmaceuticals are subject to occupational exposure. Groups working in the laboratory and forensic medicine may also be subject to 1,2-diphenylhydrazine exposure.

Incompatibilities: Not compatible with oxidizers, strong acids, acid chlorides, acid anhydrides, and mineral acids forming benzidine. Store under nitrogen.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 400 mg/m^3

DFG MAK: Carcinogen Category 2.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 270 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* no criterion developed due to insufficient data. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is presented by a concentration of 0.4 μg/L.[6] Two states have set guidelines for 1,2-diphenylhydrazine in drinking water both at the level of 0.45 μg/L.

Determination in Water: Gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = about 3.0.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract causing coughing and wheezing.

Long Term Exposure: This substance is possibly carcinogenic to humans. It has been shown to cause liver and breast cancer in animals. Diphenylhydrazine is a suspected carcinogen in humans because of its structural relationship to benzidine, which is an established human bladder carcinogen. Recent studies in rats and mice have shown that diphenylhydrazine produces both benign and malignant tumors when administered subcutaneously. Carcinogenicity in rats of both sexes and female mice has been established. In view of the relative paucity of data on the mutagenicity, teratogenicity, and long-term oral toxicity of diphenylhydrazine, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence according to NAS/NRC.[46] May cause skin allergy with itching and skin rash. Repeated exposure may cause anemia and may damage the liver.

Points of Attack: Liver, blood, skin.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist. Complete blood count (CBC).

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to 1,2-diphenylhydrazine, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store under nitrogen away from oxidizers, strong acids, acid chlorides, acid anhydrides. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Diphenylhydrazine: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *1,2-Diphenylhydrazine: Health and Environmental Effects Profile No. 96*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 68−70 (1982); 3, No. 2, 45−46 (1983); and 6, No. 1, 61−68 (1986)

Diphenyl oxide D:1500

Molecular Formula: $C_{12}H_{10}O$

Common Formula: $(C_6H_5)_2O$

Synonyms: Diphenyl ether; Dowtherm A (diphenyl/diphenyl oxide mixture); 1,1′-Oxybisbenzene; Oxydiphenyl; Phenoxy benzene; Phenoxybenzene; Phenyl ether; Phenyl oxide

CAS Registry Number: 101-84-8

RTECS® Number: KN8970000

UN/NA & ERG Number: UN3077/171

EC Number: 202-981-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Diphenyl oxide is a colorless solid or liquid with a highly disagreeable odor. The odor threshold is 0.1 ppm. Molecular weight = 170.22; Specific gravity (H_2O:1) = 1.08; Boiling point = 258.8°C; Freezing/Melting point = 27.8°C; Vapor pressure = 0.02 mmHg at 25°C; Flash point = 115°C (cc). Explosive limits: LEL = 0.7%; UEL = 6.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water. It is often used commercially in admixture with diphenyl also known as biphenyl. See also "Biphenyl" record.

Potential Exposure: Compound Description: Primary Irritant. This material is used as a heat transfer medium; as a chemical intermediate; in organic synthesis; in perfuming soaps.

Incompatibilities: Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.96 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/7 mg/m^3 TWA [vapor].

NIOSH REL: 1 ppm/7 mg/m^3 TWA [vapor].

ACGIH TLV®[1]: 1 ppm/7 mg/m^3 TWA; 2 ppm/14 mg/m^3 TWA STEL [vapor].

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 2 ppm

PAC-2: 20 ppm

PAC-3: 100 ppm

DFG MAK: 1 ppm/7.1 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

NIOSH IDLH: 100 ppm.

Australia: TWA 1 ppm (7 mg/m^3); STEL 2 ppm, 1999; Austria: MAK 1 ppm (7 mg/m^3), 1999; Belgium: TWA 1 ppm (7 mg/m^3); STEL 2 ppm (14 mg/m^3), 1993; Denmark: TWA 1 ppm (7 mg/m^3), 1999; Finland: TWA 1 ppm (7 mg/m^3); STEL 3 ppm (21 mg/m^3) [skin] 1999; France: VME 1 ppm (7 mg/m^3), 1999; Hungary: TWA 5 mg/m^3; STEL 10 mg/m^3 [skin] 1993; Norway: TWA 1 ppm (7 mg/m^3), 1999; the Philippines: TWA 1 ppm (7 mg/m^3), 1993; Poland: MAC (TWA) 7 mg/m^3, MAC (STEL) 14 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 1 ppm (7 mg/m^3), 1999; United Kingdom: LTEL 1 ppm (7 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2 ppm.

Russia[35,43] set a MAC of 0.03 mg/m^3 in ambient air of residential areas on a once-daily basis. Several states have set guidelines or standards for diphenyl oxide in ambient air ranging from 70−140 μg/m^3 (North Dakota) to 115 μg/m^3 (Virginia) to 140 μg/m^3 (Connecticut) to 168 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1617 or OSHA Analytical Method PV-2022.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{\text{ow}} = 4.21$.

Routes of Entry: Inhalation, eye and skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation may cause irritation of eyes, skin, and respiratory system. The odor can cause nausea.

Long Term Exposure: May cause dermatitis.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof goggles and face shield if working with the liquid or dust-proof chemical goggles and face shield if working with the crystalline material, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *50 ppm:* Any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with diphenyl oxide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of “CLASS 9.” It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen dry material with alcohol to avoid any dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Dry material:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

Dipropylamine D:1510

Molecular Formula: $C_6H_{15}N$

Synonyms: Di-*N*-propilamina (Spanish); *n*-Dipropylamine; Di-*N*-propylamine; 1-Propylamine, *n*-propyl; *n*-Propyl-1-propanamine

CAS Registry Number: 142-84-7

RTECS® Number: JL9200000

UN/NA & ERG Number: UN2383/132

EC Number: 205-565-9 [*Annex I Index No.:* 612-048-00-5]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): U110.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 5000 lb (2270 kg).
European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R20/21/22; R35; Safety phrases: S1/2; S16; S26; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dipropylamine is a colorless, water-white liquid with a strong ammonia-like odor. Molecular weight = 101.22; Boiling point = 110°C; Freezing/Melting point = −63°C; Vapor pressure = 29.8 mmHg at 25°C; Flash point = 17°C; Autoignition temperature = 299°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 1. Insoluble in water.

Potential Exposure: Used as a chemical intermediate and in the manufacture of herbicides.

Incompatibilities: Forms explosive mixture with air. Incompatible with acids, organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, mercury, phenols, cresols, caprolactum solution, strong oxidizers. Attacks aluminum, copper, lead, tin, zinc, and their alloys.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 400 mg/m^3

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = 1.7$.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Contact with the eyes and skin can cause severe irritation and burns. Inhaling the aerosol can irritate the respiratory tract and cause coughing, wheezing, and/or shortness of breath; headache, nausea, dizziness, anxiety, unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and polycarbonate are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with dipropylamine you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID, CORROSIVE.” It falls into Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and nitrogen oxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Dipropylamine*. Trenton, NJ

Dipropylene glycol methyl ether D:1520

Molecular Formula: $C_7H_{16}O_3$

Common Formula: $CH_3OCH_2CH(CH_3)OCH_2CH(CH_3)OH$

Synonyms: Arcosolv; 1,4-Dimethyl-3,6-dioxa-1heptanol; Dipropylene glycol monomethyl ether; Dowanol 50B®; Dowanol DPM®; DPGME; 2-Methoxymethyl-ethoxypropanol

CAS Registry Number: 34590-94-8; *(alt.)* 12002-25-4; 12002-35-6; *(alt.)* 83730-60-3; *(alt.)* 104512-57-4; *(alt.)* 112388-78-0

isomers: 13429-07-7; 20324-32-7; 13588-28-8; 55956-21-3

UN/NA & ERG Number: Not regulated

RTECS® Number: JV1575000

EC Number: 252-104-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DPGME is a colorless liquid with a weak odor. Molecular weight = 148.23; Specific gravity (H_2O:1) = 0.95; Boiling point = 180°C; Freezing/Melting point = − 80°C; Vapor pressure = 0.5 mmHg at 20°C; Flash point = 74.6°C (cc); Autoignition temperature = 270°C. Explosive limits: LEL = 1.3%; UEL = 10.4. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Highly soluble in water.

Potential Exposure: Compound Description: Primary Irritant. This material is used in antifreeze formulations, cosmetics, cleaning compounds, and heat transfer fluids; as a solvent for nitrocellulose and other synthetic resins.

Incompatibilities: Strong oxidizers. The substance can presumably form explosive peroxides in contact with air. Reacts violently with strong oxidants.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/600 mg/m^3 TWA [skin].

NIOSH REL: 100 ppm/600 mg/m^3 TWA; 150 ppm/900 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 100 ppm/606 mg/m^3 TWA; 150 ppm/909 mg/m^3 STEL [skin].

NIOSH IDLH: 600 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 150 ppm

PAC-2: 300 ppm

PAC-3: 600 ppm

DFG MAK: 50 ppm/310 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Australia: TWA 100 ppm (600 mg/m^3); STEL 150 ppm, [skin], 1993; Austria: MAK 50 ppm (300 mg/m^3), 1999; Belgium: TWA 100 ppm (606 mg/m^3); STEL 150 ppm, [skin], 1993; Denmark: TWA 50 ppm (300 mg/m^3), [skin], 1999; Finland: TWA 100 ppm (600 mg/m^3); STEL 150 ppm, [skin], 1999; France: VME 100 ppm (600 mg/m^3), 1999; the Netherlands: MAC-TGG 300 mg/m^3, 2003;

the Philippines: TWA 100 ppm (600 mg/m^3), [skin], 1993; Sweden: TWA 50 ppm (300 mg/m^3); STEL 75 ppm (450 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (300 mg/m^3); STEL 100 ppm (600 mg/m^3), 1999; Turkey: TWA 300 ppm (600 mg/m^3), [skin], 1993; United Kingdom: TWA 50 ppm (308 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 150 ppm [skin]. Several states have set guidelines or standards for ambient air ranging from 6.0−9.0 mg/m^3 (North Dakota) to 10 mg/m^3 (Virginia) to 12.0 mg/m^3 (Connecticut) to 14.3 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #S-69.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: DPGME can be absorbed through the skin, thereby increasing exposure. Exposure causes irritation of eyes and nose. Extremely high levels can cause dizziness, lightheadedness, headaches, unconsciousness.

Long Term Exposure: Repeated exposure to very high levels may affect the liver.

Points of Attack: Eyes, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 600 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire, including carbon monoxide. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dipropylene Glycol, Methyl Ether*. Trenton, NJ

Dipropyl ketone D:1530

Molecular Formula: $C_7H_{14}O$

Common Formula: $C_3H_7COC_3H_7$

Synonyms: Butyrone; Dipropil cetona (Spanish); DPK; GBL; 4-Heptanone; Heptan-4-one; Propyl ketone

CAS Registry Number: 123-19-3

RTECS® Number: MJ5600000

UN/NA & ERG Number: UN2710/128

EC Number: 204-608-9 [*Annex I Index No.:* 606-027-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn assigned; Risk phrases: R10; R20; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dipropyl ketone is a colorless liquid with a pleasant odor. Molecular weight = 114.21; Specific gravity (H_2O:1) = 0.82; Boiling point = 143.9°C; Melting point: −32.7°C; Vapor pressure = 5 mmHg at 20°C; Flash point = 49°C; Autoignition temperature = 429.7°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. This compound is used as a solvent for nitrocellulose and many other natural and synthetic resins. It is used in lacquer formulations and in food flavorings.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause a fire and explosion hazard. Incompatible with strong bases and strong reducing agents.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.67 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 50 ppm/235 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/233 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 350 ppm

PAC-2: 350 ppm

PAC-3: 350 ppm

Austria: MAK 50 ppm (230 mg/m^3), 1999; Denmark: TWA 50 ppm (230 mg/m^3), 1999; France: VME 50 ppm (235 mg/m^3), 1999; the Netherlands: MAC-TGG 235 mg/m^3, 2003; Norway: TWA 25 ppm (115 mg/m^3), 1999. States which have set guidelines or standards for dipropyl ketone in ambient air[60] include Connecticut at 4.7 mg/m^3 and Nevada at 5.595 mg/m^3.

Determination in Air: Use OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Dipropyl ketone can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. Dipropyl ketone is a central nervous system depressant; can cause depression, dizziness, somnolence (sleepiness, unnatural drowsiness), decreased breathing, unconsciousness.

Long Term Exposure: High or repeated exposures may damage the liver and kidney. Repeated contact can dry out the skin, causing irritation and rash.

Points of Attack: Eyes, skin, central nervous system, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Interview for brain effects, including memory, mood, concentration, headaches, malaise, and altered sleep patterns. Consider cerebellar, autonomic, and peripheral nervous system evaluation. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with dipropyl ketone you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dipropyl Ketone*. Trenton, NJ

Diquat D:1540

Molecular Formula: $C_{12}H_{12}N_2Br_2$

Note: Diquat is a cation ($C_{12}H_{12}N_2 + +$; 1,1′-Ethylene-2,2-bipyridyllium ion). Various diquat salts are commercially available.

Synonyms: Aquacide; Cleansweep; Deiquat; Dextrone; 9,10-Dihydro-8a,10,-diazoniaphenanthrene dibromide; 9,10-Dihydro-8a,10a-diazoniaphenanthrene(1,1′-ethylene-2,2′-bipyridylium)dibromide; 5,6-Dihydro-dipyrido (1,2a,2,1c) pyrazinium dibromide; 5,6-Dihydro-dipyrido (1,2-a: 2,1′-c) pyrazinium dibromide; 6,7-Dihydropyridol(1,2-a: 2′,1′-c) pyrazinedium dibromide; 6,7-Dihydropyrido(1,2-a: 2′,1′-c) pyrazinedium dibromide; Dipyrido(1,2-a: 2′,1′-c) pyrazinediium, 6,7-dihydro-, dibromide; *o*-Diquat; Diquat dibromide; 1,1′-Ethylene-2,2′-bipyridyliumdibromide; 1,1-Ethylene 2,2-dipyridylium dibromide; 1,1′-Ethylene-2,2′-

dipyridylium dibromide; Ethylene dipyridylium dibromide; Farmon PDQ; FB/2; Feglox; Groundhog soltair; Pathclear; Preeglone; Reglon; Reglone; Reglox; Weedol (ICI); Weedtrine-D

Diquat dibromide: 1,1′-Ethylene-2,2′-bipyridyllium dibromide

CAS Registry Number: 2764-72-9; 85-00-7 (Diquat dibromide)

RTECS® Number: JM5690000

UN/NA & ERG Number: UN1760 (diquat dibromide)/154

EC Number: 201-579-4 [*Annex I Index No.:* 613-089-00-1] (*85-00-7*)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Safe Drinking Water Act: MCL, 0.02 mg/L; MCLG, 0.02 mg/L; Regulated chemical (47FR9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations (*includes salts*): Hazard Symbol: T, N; Risk phrases: Risk phrases: R22; R26; R36/37/38; R43; R48/25; R50/53; Safety phrases: S1/2; S28; S36/37/39; S45; 60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Diquat forms a monohydrate which consists of colorless to yellow crystals. Dibromide salt (herbicide) is a yellow crystal. The commercial product may be found in a liquid concentrate or a solution. Molecular weight = 344.08; Boiling point = not determined (decomposes); Freezing/Melting point = 335°C; Vapor pressure = 0.0001 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Primary Irritant. Those involved in the manufacture, formulation, and application of this herbicide used to control a wide range of aquatic and terrestrial weeds.

Incompatibilities: Keep away from alkalis, UV light, basic solutions. Concentrated solutions of Diquat attack aluminum.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg/m^3 TWA, inhalable fraction, 0.1 mg/m^3 TWA, respirable fraction; not classifiable as a human carcinogen [skin].

No TEEL available.

Australia: TWA 0.5 mg/m^3, 1993; Belgium: TWA 0.5 mg/m^3, 1993; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, 1999; France: VME 0.5 mg/m^3, 1999; Hungary: STEL 0.1 mg/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Norway: TWA 0.5 mg/m^3, 1999; Switzerland: MAK-W 0.5 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 0.5 mg/m^3 TWA, inhalable fraction, 0.1 mg/m^3 TWA, respirable fraction; not classifiable as a human carcinogen [skin]. Russia set a MAC of 0.2 mg/m^3 in work-place air. Several states have set guidelines or standards for diquat in ambient air[60] ranging from 5 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Diquat can affect you when breathed in and by passing through your skin. Skin contact can cause burns. High exposure can cause nausea, diarrhea, lung, liver, and kidney damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. Irritation of eyes, skin, mucous membrane; respiratory system; rhinorrhea (discharge of thin mucus), epistaxis (nosebleed); skin burns; nausea, vomiting, diarrhea, malaise (vague feeling of discomfort); kidney, liver injury; cough, chest pain; dyspnea (breathing difficulty), pulmonary edema; tremor, convulsions; delayed healing of wounds.

Long Term Exposure: Long-term or repeated exposure may cause cataracts. Repeated contact causes dry, cracked skin and nail damage. Exposure can cause nosebleeds. Diquat may cause mutations. Handle with extreme caution. Diquat may damage the developing fetus. Lung damage may occur.

Points of Attack: Eyes, skin, respiratory system, kidneys, liver, central nervous system.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: lung function tests. Examination of the eyes. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **4 h** (at least 4 but <8 h of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over $0.5\ mg/m^3$, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air-purifying respirators. If while wearing filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect diquat, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a MSHA/NIODH approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diquat you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Diquat dibromide requires a Corrosive liquid, n.o.s. label. It falls in Hazard Class 8 and Packing Group III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Diquat is a combustible solid but does not readily ignite and burns with difficulty. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Diquat is inactivated by inert clay or by anionic surfactants. Therefore, an effective and environmentally safe disposal method would be to mix the product with ordinary household detergent and bury the mixture in clay soil.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Diquat Dibromide*. Trenton, NJ

Direct black 38 D:1550

Molecular Formula: $C_{34}H_{25}N_9O_7S_2 \cdot 2Na$
Synonyms: AHCO direct black GX; Airedale black ED; Aizen direct deep black EH; Aizen direct deep black GH; Aizen direct deep black RH; Amanil black GL; Amanil black WD; Apomine black GX; Atlantic black BD; Atlantic black C; Atlantic black E; Atlantic black EA; Atlantic black GAC; Atlantic black GG; Atlantic black GXCW; Atlantic black GXOO; Atlantic black SD; Atul black E; Azine deep black EW; Azine direct black E; Azocard black EW; Azomine black EWO; Belamine black GX; Bencidal black E; Benzanil black E; Benzo deep black E; Benzoform black BCN-CF; Benzo leather black E; Black 2EMBL; Black 4EMBL; Brasilamina black GN; Brilliant chrome leather black H; Calcomine black; Calcomine black EXL; Carbide black E; Chloramine black C; Chloramine black EC; Chloramine black ERT; Chloramine black EX; Chloramine black EXR; Chloramine black XO; Chloramine carbon black S; Chloramine carbon black SJ; Chloramine carbon black SN; Chlorazol black EA; Chlorazol black EN; Chlorazol Burl black E; Chlorazol leather black E; Chlorazol leather black EC; Chlorazol leather black EM; Chlorazol leather black ENP; Chlorazol silk black G; Chrome leather black E; Chrome leather black EC; Chrome leather black EM; Chrome leather black G; Chrome leather brilliant black ER; C.I. 30235; C.I. Direct black 38, disodium salt; Coir deep black F; Diacotton deep black; Diacotton deep black RX; Diamine deep black EC; Diamine direct black E; Diaphtamine black V; Diazine black E; Diazine direct black G; Diazol black 2V; Diphenyl deep black G; Direct black 38; Direct black A; Direct black BRN; Direct black CX; Direct black CXR; Direct black E; Direct black EW; Direct black EX; Direct black FR; Direct black GAC; Direct black GW; Direct black GX; Direct black GXR; Direct black jet; Direct black meta; Direct black methyl; Direct black N; Direct black RX; Direct black SD; Direct black WS; Direct black Z; Direct black ZSH; Direct deep black E; Direct deep black EAC; Direct deep black EA-CF; Direct deep black E-EX; Direct deep black E extra; Direct deep black EW; Direct deep black EX; Direct deep black WX; Erie black BF; Erie black GXOO; Erie black jet; Erie black NUG; Erie black RXOO; Erie brilliant black S; Erie fibre black VP; Fenamin black VF; Fixanol black E; Formaline black C; Formic black C; Formic black CW; Formic black EF; Formic black MTG; Formic black TG; Hispamin black EF; Interchem direct black Z; Kayaku direct deep black EX; Kayaku direct deep black GX; Kayaku direct deep black S; Kayaku direct special black AAX; Lurazol black BA; Meta black; Mitsui direct black EX; Mitsui direct black GX; 2,7-Naphthalenedisulfonic acid,4-amino-3-[{4′-[(2,4-diaminophenyl)azo](1,1′-biphenyl)-4-yl}azo]-5-hydroxy-6-(phenylazo)-, disodium salt; Nippon deep black; Nippon deep black GX; Paper black BA; Paper black T; Paper deep black C; Paramine black B; Paramine black E; Peermine black E; Peermine black GXOO; Phenamine black BCN-CF; Phenamine black clphenamine black E 200; Phenamine black E; Phenamine black EP; Pheno black EP; Pheno black SGN; Pontamine black E; Pontamine black EBN; Sandopel black EX; Seristan black B; Telon fast black E; Tertrodirect black EFD; Tetrazo deep black G; Union black EM; Vondacel black N
CAS Registry Number: 1937-37-7
RTECS$^{®}$ Number: QJ6160000
UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151
EC Number: 217-710-3 [*Annex I Index No.:* 611-025-00-7]
Regulatory Authority and Advisory Bodies
Carcinogenicity: NTP: 7th Report on Carcinogens, 1982; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence, mouse; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1998.
In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant level Goals (MRDG) for chloramines was set at 4 mg/L.
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer 1/1/88 [Direct Black 38 (technical grade)].
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R63; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Direct black 38 is a black powder. An AZO compound. Molecular weight = 781.78; Freezing/Melting point ≥ 400°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: Mutagen; Human Data. Direct black 38 is an azo compound and is used to dye fabric, leather, cotton, cellulosic materials, and paper; these are then used in consumer products. The chemical may be used by artists (CPSC, EPA). The FDA has indicated that although direct black 38 is identified in the literature as a hair-dye component, it is currently not used by the cosmetic industry. In view of a health hazard alert issued in December 1980 by OSHA, which cautioned workers and employers of the

carcinogenic effect of benzidine-derived direct black 38, new nonbenzidine direct black dyes have been developed and used successfully in commercial applications by the paper and leather industry. These nonbenzidine dyes were developed with the hope of replacing benzidine-based dyes throughout industry.

Incompatibilities: Azo dyes can form explosive mixtures in air, especially if sensitized with metal salts and/or strong acids. Contact with alkali metals forms explosive gases. Contact with oxidizers and reducing agents forms toxic fumes and gases; also with acids, acryl halides, aldehydes, amides, carbamates, cyanides, epoxides, fluorides (inorganic), halogenated organic materials, isocyanates, ketones, metals, nitrides, peroxides, phenols. May form explosive mixtures with oxidizers, metal salts, peroxides, and sulfides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 25 mg/m^3
PAC-1: 75 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

North Dakota[60] has set a guideline for Direct black 38 in ambient air of zero.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Permissible Concentration in Water: In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant Level Goals (MRDG) for chloramines was set at 4 mg/L.

Routes of Entry: Human exposure to Direct black 38 may occur through inhalation, skin absorption, and unintentional ingestion. Consumer exposure to Direct black 38 depends upon the ability of the dye to migrate out of consumer products and either penetrate the skin or degrade prior to penetrating the skin. No additional data quantifying the rate of migration or degradation of this dye are currently available.

Harmful Effects and Symptoms

Short Term Exposure: Causes eye irritation. Toxic if inhaled or ingested.

Long Term Exposure: There is sufficient evidence that commercial Direct black 38 is carcinogenic to experimental animals. In an occupational hazard review, it was concluded that all benzidine-based dyes, including Direct black 38, regardless of their physical state or proportion in the mixture, should be recognized as potential human carcinogens. Mutation data reported.

First Aid: *Skin Contact*[52]*:* Flood all areas of the body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to direct black 38, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: *Dry material*: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen dry material with water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

National Institute for Occupational Safety and Health. (1980). *Special Occupational Hazard Review for Benzidine-Based Dyes*. Washington, DC: US Government Printing Office

Direct blue 6 D:1560

Molecular Formula: $C_{32}H_{24}N_6O_{14}S_4 \cdot 4Na$

Synonyms: Airedale blue 2BD; Aizen direct blue 2BH; Amanil blue 2BX; Atlantic blue 2B; Atul direct blue; Azocard blue 2B; Azomine blue 2B; Belamine blue 2B; Bencidal blue 2B; Benzanil blue 2B; Benzo blue GS; Blue 2B; Brasilamina blue 2B; Calcomine blue 2B; Chloramine blue 2B; Chlorazol blue B; Chrome leather blue 2B; C.I. Direct blue 6; C.I. Direct blue 6, tetrasodium salt; Cresotine blue 2B; Diacotton blue B; Diamine blue 2B; Diaphtamine blue BB; Diazine blue 2B; Diazol blue 2B; Diphenyl blue 2B; Enianil blue 2B; Fixanol blue 2B; Hispamin blue 2B; Indigo blue 2B; Kayaku direct; Mitsui direct blue 2BN; Naphtamine blue 2B; 2,7-Naphthalenedisulfonic acid, 3,3′-[(4,4′-biphenylene)-biphenylene)bis-(azo)]bis(5-amino-4-hydroxy-), tetrasodium salt; NB2B; NCI-C54579; Nfenamin blue 2B; Niagara blue 2; Nippon blue BB; Paramine blue 2B; Phenamine blue BB; Pheno blue 2B; Pontamine blue BB; Sodium diphenyl-4,4′-bis-azo-2″-8″-amino-1″-naphthol-3″,6″ disulphonate; Tertrodirect blue 2B; Vondacel blue 2B

CAS Registry Number: 2602-46-2

RTECS® Number: QJ6400000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

EC Number: 220-012-1 [*Annex I Index No.:* 611-026-00-2]

Regulatory Authority and Advisory Bodies

Carcinogen: IARC: (Direct Blue 6, technical grade) Animal Sufficient Evidence (rats); Human Sufficient Evidence*, carcinogenic to humans*, Group 1, 1999; NTP: 7th Report on Carcinogens, 1982; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence, mouse.

In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant level Goals (MRDG) for chloramines was set at 4 mg/L.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88 [Direct Blue 6 (technical grade)].

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R63; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Direct blue 6 is a benzidine-based dyestuff somewhat analogous to Direct black 38 (which see). It is a dark blue powder. Molecular weight = 932.78; Freezing/Melting point ≥ 400°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: Mutagen; Human Data. Direct Blue 6 may be used by artists. It is potentially used to dye fabric, leather, cotton, cellulosic materials, and paper; these are then used in consumer products (CPSC, EPA). The FDA has indicated that although Direct Blue 6 has been identified in the literature as a hair dye component, it is not presently used by the cosmetic industry. The primary source for exposure to Direct Blue 6 is at the production site. The initial production step is in a closed system. However, other production operations, such as filter press, drying, and blending, may be performed in the open and, therefore, may afford a greater potential for worker exposure. The general population may be exposed to Direct Blue 6 through the use of retail packaged dyes containing this benzidine-based dye.

Permissible Exposure Limits in Air

No TEEL available.

The state of North Dakota[60] has set a guideline for Direct Blue 6 in ambient air of zero.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Permissible Concentration in Water: In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant Level Goals (MRDG) for chloramines was set at 4 mg/L.

Routes of Entry: Human exposure to direct blue 6 may occur through inhalation, skin absorption; and to a lesser extent, unintentional ingestion; when the dye is in the press cake or dry powder form.

Harmful Effects and Symptoms

Long Term Exposure: There is sufficient evidence for the carcinogenicity of direct blue 6 (technical grade) in experimental animals. In an occupational hazard review, it was concluded that all benzidine-based dyes, including direct blue 6, regardless of their physical state or proportion in the mixture should be recognized as potential human carcinogens. Mutation data reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to direct blue 6, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with direct blue 6 you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

National Institute for Occupational Safety and Health. (1980). *Special Occupational Hazard Review for Benzidine-Based Dyes*. Washington, DC: US Government Printing Office

Disulfiram D:1570

Molecular Formula: $C_{10}H_{20}N_2S_4$

Synonyms: Abstensil; Abstinyl; Alcophobin; Alk-Aubs; Antabus®; Antabuse®; Antadix; Antaenyl; Antaethan; Antaethyl; Antaetil; Antalcol; Antetan; Antethyl; Antetil; Anteyl; Antiaethan; Antietanol; Anti-ethyl; Antietil; Antikol; Antivitium; Aversan; Averzan; [Bis(diethylamino) thioxomethyl] disulphide; Bis(*N*,*N*-diethylthiocarbamoyl) disulfide; Bis(diethylthiocarbamoyl) disulfide; Bis(*N*,*N*-diethylthiocarbamoyl) disulphide; Bonibal; Contralin; Contrapot; Cronetal®; Dicupral; Disetil; Disulfan; Disulfuram; Disulphuram; 1,1′-Dithiobis(*N*,*N*-diethylthioformamide); Ekagom teds; Ephorran; Espenal; Esperal (France); Etabus; Ethyldithiourame; Ethyldithiurame; Ethyl thiram; Ethyl thiudad; Ethyl thiurad; Ethyl tuads; Ethyl tuex; Exhoran; Exhorran; HOCA; Krotenal; NCI-C02959; Nocbin; Noxal; Refusal (Netherlands); Ro-Sulfiram®; Stopaethyl; Stopethyl; Stopetyl; TATD; Tenurid; Tenutex; TETD; Tetidis; Tetradin; Tetradine; Tetraethylthioperoxydi-carbonic diamide; Tetraethylthiram disulphide; Tetraethylthiuram; Tetraethylthiuram disulfide; *N*,*N*,*N*′,*N*′-Tetraethylthiuram disulphide; Tetraethylthiuram disulphide; Tetraetil; Teturam; Teturamin; Thiosan; Thioscabin; Thireranide; Thiuram E; Thiuranide; Tillram; Tiuram; TTD; TTS

CAS Registry Number: 97-77-8

RTECS® Number: JO1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-607-8 [*Annex I Index No.:* 006-079-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; IARC: Human No Adequate Evidence; Animal, Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Hazard Symbol: Xn, N; Risk phrases: R22; R43; R48/22; R50/53; Safety phrases: S2; S24; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Disulfiram is a white to off-white or light-gray powder with a slight odor. Molecular weight = 296.56; Boiling point = 117°C at 17 mmHg; Freezing/Melting point = 70°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Very slightly soluble in water; solubility = 0.2%.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Some thiurams have been used as rubber components. Disulfiram is used as an accelerator in compounding natural, styrene-butadiene, and Neoprene™ rubbers as a rubber accelerator and vulcanizer; as a seed disinfectant and fungicide; in therapy; as an alcohol deterrent; in adhesives.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2 mg/m^3 TWA [Precautions should be taken to avoid concurrent exposure to ethylene dibromide.]

ACGIH TLV®[1]: 2 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 125 mg/m^3

DFG MAK: 2 mg/m^3 measured as the inhalable fraction TWA; Peak Limitation Category II(8), [skin] danger of skin sensitization; Pregnancy Risk Group D.

Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3; STEL 6 mg/m^3, 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Sweden: TWA 1 mg/m^3; STEL 2 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: No method available.

Permissible Concentration in Water: Zero, according to USSR-UNEP/IRPTC joint project.[43]

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{\mathrm{ow}} = 3.9$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory system. Eye contact can lead to damage. Disulfiram can affect you when breathed in and by passing through your skin. Exposure to disulfiram and alcohol within 1−2 days of each other can cause a reaction with flushing of the face and neck, rapid heartbeat, and vomiting. This could be fatal. If working with disulfiram, you should never be exposed to ethylene dibromide because of possible severe reaction. Symptoms of exposure include lassitude (weakness, exhaustion), fatigue, tremor, restlessness, headache, dizziness, metallic taste, vomiting, peripheral neuropathy.

Long Term Exposure: May cause liver and kidney damage. It may damage the developing fetus. Damage to vision, nervous system with numbness, "pins and needles," weakness and poor coordination can result from repeated exposure. May cause personality changes of depression, anxiety, or irritability. Can cause skin sensitization dermatitis. Enlarged thyroid and skin rash can also occur.

Points of Attack: Eyes, skin, respiratory system, central nervous system, peripheral nervous system, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver, kidney, and thyroid function tests. Skin testing with dilute Disulfiram may help diagnose allergy, if done by a qualified allergist. Examination of the nervous system, eyes, and vision. Evaluate for brain effects. Alcohol use may increase liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note: For alcohol/disulfiram or ethylene dibromide/disulfiram reaction, remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 mg/m^3*, use an NIOSH/MSHA- or European Standard EN 149-approved full face-piece respirator with a pesticide cartridge. Increased protection is obtained from full face-piece air-purifying respirators. If while wearing a filter, cartridge, or canister respirator, you can smell, taste, or otherwise detect Disulfiram, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: Toxic solids, flammable, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall into Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Disulfiram itself does not burn readily. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disulfiram can be dissolved in alcohol or other flammable solvent and burned in an incinerator equipped with afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 40

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Disulfiram*. Trenton, NJ

Disulfoton D:1580

Molecular Formula: $C_8H_{19}O_2PS_3$

Synonyms: Bay 19639; Bayer 19639; *O,O*-Diaethyl-*S*-(2-aethylthio-aethyl)-dithiophosphat (German); *O,O*-Diaethyl-*S*-(3-thia-pentyl)-dithiophosphat (German); *O,O*-Diethyl *S*-(2-eththioethyl) phosphorodithioate; *O,O*-Diethyl *S*-(2-eththioethyl) thiothionophosphate; *O,O*-Diethyl *S*-(2-ethylmercaptoethyl)dithiophosphate; *O,O*-Diethyl 2-ethylthioethylphosphorodithioate; *O,O*-Diethyl *S*-2-(ethylthio)ethyl phosphorodithioate; Dimaz; Disulfaton; Di-Syston; Disystox; Dithiodemeton; Dithiophosphate de *O,O*-diethyle ETDE *S*-(2-ethylthio-ethyle) (French); Dithiosystox; ENT 23,437; *O,O*-Ethyl *S*-2(ethylthio)ethyl phosphorodithioate; Ethylthiodemeton; *S*-2-(Ethylthio)ethyl *O,O*-diethyl ester of phosphorodithioic acid; Frumin-Al®; Frumin G®; M-74; Phosphorodithionic acid, *O,O*-diethyl *S*-2-[(ethylthio)ethyl] ester; Phosphorodithionic acid, *S*-2-(ethylthio)ethyl *O,O*-diethyl ester; S 276; Solvirex®; Thiodemeton®; Thiodemetron®

CAS Registry Number: 298-04-4

RTECS® Number: TD9275000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid toxic)/152

EC Number: 206-054-3 [*Annex I Index No.:* 015-060-00-3]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Various Countries) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Supported, 1998.

US EPA Gene-Tox Program, Weakly Positive: *In vitro* UDS—human fibroblast; Negative: Histidine reversion—Ames test; Negative: *D. melanogaster* sex-linked lethal; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P039.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 6.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8140 (2).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Disulfoton is a combustible, colorless to yellowish oil with a characteristic odor. Technical product is a brown liquid. Molecular weight = 274.42; Boiling point = 132−133°C at 1.5 mm pressure; Freezing/Melting point ≥ −25°C; Vapor pressure = 0.0002 mmHg at 20°C; Flash point ≥82°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.003% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Human Data. Those involved in the manufacture, formulation, and application of this systemic insecticide and acaricide.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI$_A$ issued for acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 75 mg/m^3

Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2000; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, 1999; United Kingdom: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Several states have set guidelines or standards for disulfoton in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: A long-term health advisory for an adult has been calculated by EPA as 0.009 mg/L (9 μg/L) and a lifetime health advisory of 0.3 μg/L.

Determination in Water: Extraction with methylene chloride followed by measurement by gas chromatography using a nitrogen-phosphorus detector. Fish Tox = 2.90001000 pbb (HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause burns to skin and eyes. Symptoms include pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) and chest pain may be noted. Hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Probable oral lethal dose in humans is less that 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150-lb) person. It is poisonous and may be fatal if inhaled, swallowed, or absorbed through the skin. Human Tox = 0.30000 pbb (EXTRA HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure; resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended following acute overexposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with disulfoton you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalies. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Disulfoton in Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spill material. Exposure by skin contact is likely to be more significant than inhalation. *Small spills:* take up with sand or other noncombustible absorbent materials and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: A combustible liquid, but will not ignite easily. Poisonous gases may be generated from the fire, including sulfur oxides and phosphorus oxides. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added flammable solvent in a furnace with alkali scrubber. Acid or alkaline hydrolysis may also be used.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with

EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Disulfoton: Health and Environmental Effects Profile No. 97*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Disulfoton*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (August 1987). *Health Advisory: Disulfoton*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Disulfoton*. Trenton, NJ

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 5, 74−85

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Dithiazanine iodide D:1590

Molecular Formula: $C_{23}H_{24}IN_2S_2$

Common Formula: $C_{23}H_{24}N_2S_2I$

Synonyms: Abminthic; Anelmid; Anguifugan; Compound 01748; DEJO; Delvex; 3,3′-Diethylthiadicarbocyanine iodide; Diethylthiadicarbocyanine iodide; Dilombrin; Dithiazanine iodide; Dithiazanin iodide; Dithiazinine; Eastman 7663; 3-Ethyl-2-[5-(3-ethyl-2-benzothiazolinylidene)-1,3-pentadienyl]benzothiazolium iodide; L-01748; Netocyd; NK 136; Omnipassin; Partel; Telmicid; Telmid; Telmide; Vercidon

CAS Registry Number: 514-73-8

RTECS® Number: DL7060000

UN/NA & ERG Number: UN2811(toxic, solid, organic, n.o.s.)/154

EC Number: 208-186-7

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dithiazanine iodide is a green, needle-like crystalline solid which decomposes at 248°C. Sulfur-like odor. Molecular weight = 519.51. Melting point = −25°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Insoluble in water.

Incompatibilities: Stable under normal conditions of temperature and pressure. Keep away from alkalies, strong oxidizers.

Potential Exposure: This material is used as a veterinary anthelmintic and for insecticides. Not registered as a pesticide in the United States. It is also used as a sensitizer for photographic emulsions.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if swallowed, or if dust is inhaled. LD_{50} = (oral-rat) 20 mg/kg (highly toxic).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Pesticides, solid, toxic, n.o.s. have a label requirement of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and this material in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Poisonous gases, including sulfur oxides, iodine, and nitrogen oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear self-contained, positive-pressure if available, breathing apparatus and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dithiazanine Iodine*. Washington, DC: Chemical Emergency Preparedness Program

Dithiobiuret D:1600

Molecular Formula: $C_2H_5N_3S_2$

Common Formula: $H_2NCSNHCSNH_2$

Synonyms: AI3-14762; Biuret, 2,4-dithio-; Biuret, dithio-; 2,4-Dithiobiuret; Dithiobiuret; 2,4-Ditiobiuret (Spanish); DTB; Imidodicarbonimidothioic diamide; Imidodicarbonodithioic diamide; Thioimidodicarbonic diamide; Thio-1-(thiocarbamoyl)urea; Urea, 2-thio-1-(thiocarbamoyl)-

CAS Registry Number: 541-53-7

RTECS® Number: EC1575000

UN/NA & ERG Number: UN2811(toxic, solid, organic, n.o.s.)/154

EC Number: 208-784-8

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P049.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Dithiobiuret is a colorless, crystalline solid. Molecular weight = 135.22; Freezing/Melting point = (decomposition) 189°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solubility = 0.25 g/110 mL at 25°C.

Potential Exposure: This material is used as a plasticizer, as a rubber accelerator; and as an intermediate in manufacturing of pesticides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 5 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes on contact. May cause muscular weakness and/or paralysis leading to difficulty in breathing. This may be fatal. Can cause nausea, watery diarrhea, dehydration, and weight loss. The material is highly toxic. It may cause respiratory failure. Symptoms include respiratory paralysis. LD_{50} = (oral-rat) 5 mg/kg (extremely toxic).

Long Term Exposure: May affect the nervous system.

Points of Attack: Nervous system, eyes.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dithiobiuret you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Pesticides, solid, toxic, n.o.s. have a label requirement of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and this material in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Avoid breathing dusts and fumes from burning material. Keep upwind; avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Use a vacuum or wet method to reduce dust during cleanup. *Do not* dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire. (Material itself does not burn or burns with difficulty.) Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide, or dry chemical. Poisonous gases are produced in fire, including sulfur oxides and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Dithiobiuret*. Washington, DC: Chemical Emergency Preparedness Program

Diuron D:1610

Molecular Formula: $C_9H_{10}Cl_2N_2O$

Common Formula: $Cl_2C_6H_3NHCON(CH_3)_2$

Synonyms: 330541; AF 101; AI3-61438; Caswell No. 410; Cekiuron; Crisuron; Dailon; DCMU (in Japan); Diater;

Dichlorfenidim; 3-(3,4-Dichlorophenol)-1,1-dimethylurea; 3-(3,4-Dichlorophenyl)-1,1-demethylurea; *N*′-(3,4-Dichlorophenyl)-*N*,*N*-dimethylurea*;* *n*-(3,4-Dichlorophenyl)-*N*′,*N*′-dimethylurea; 1-(3,4-Dichlorophenyl)-3,3-dimethylurea; 1 (3,4-Dichlorophenyl)-3,3-dimethyluree (French); 3-(3,4-Dichlor-phenyl)-1,1-dimethylharnstoff (German); 3-(3,4-Diclorofenil)-1,1-dimetilurea (Spanish); 1,1-Dimethyl-3-(3,4-dichlorophenyl)urea; Di-On; Diurex; Diurol; Diuron 4L; DMU; Drexel; Drexel diuron 4L; Duran; Dynex; EPA pesticide chemical code 035505; Farmco diuron; HW 920; Karmex; Karmex diuron herbicide; Karmex DW; Marmer; STCC 4962622; Sup'r flo; Telvar; Telvar diuron weed killer; Tigrex; Urea, *N*′-(3,4-dichlorophenyl)-*N*,*N*-dimethyl-; Urea, 3-(3,4-dichlorophenyl)-1,1-dimethyl-; Urox D; Vonduron

CAS Registry Number: 330-54-1

RTECS® Number: YS8925000

UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151; UN2588/155

EC Number: 206-354-4 [*Annex I Index No.:* 006-015-00-9]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *S. cerevisiae* gene conversion.

US EPA, FIFRA 1998 Status of Pesticides: Supported, 1998.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 5/31/02.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R48/22; R50/53; Safety phrases: S2; S13; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Diuron is a white, odorless crystalline solid. Molecular weight = 233.11; Boiling point = 180°C (decomposes); Freezing/Melting point = 157.8°C; Vapor pressure = 2×10^{-9} mmHg; 6.9×10^{-8} mmHg at 20°C. Flash point = >200°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.004%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those involved in the manufacture, formulation, and application of this herbicide for control of germinating broadleaf and grass weeds in crops.

Incompatibilities: Strong acids.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.

No TEEL available.

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia set a MAC of 0.5 mg/m^3 in ambient air of residential areas either on a momentary or a daily average basis.[35,43] Several states have set guidelines or standards for diuron in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5601or OSHA Analytical Method PV-2097.

Permissible Concentration in Water: Russia[35,43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes and a MAC of 1.5 μg/L in water bodies used for fishery purposes. A long-term health advisory of 0.875 mg/L has been calculated by EPA and a lifetime health advisory of 0.014 mg/L (14 μg/L).

Determination in Water: High-performance liquid chromatography may be used after extraction with methylene chloride. Measurement is made using an ultraviolet detector. Fish Tox = 40.39243000 pbb (INTERMEDIATE). Moderately toxic to fish; highly toxic to aquatic invertebrates.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure may irritate the skin, eyes, and throat. Human Tox = 18.32460 pbb (INTERMEDIATE).

Long Term Exposure: May damage the developing fetus. In animals: anemia, methemoglobinemia.

Points of Attack: Eyes, skin, respiratory system, blood.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved respirator with a pesticide cartridge. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. If while wearing a filter, cartridge, or canister respirator, you can detect diuron, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Phenyl urea pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Diuron may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gas is produced in fire: toxic gases dimethylamine and 3,4-dichlorophenyl isocyanate are produced at temperatures exceeding 180°C/355°F. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Diuron, stable under normal conditions, decomposes on heating to 180−190°C giving dimethylamine and 3,4-dichlorophenyl isocyanate. Treatment at elevated temperatures by acid or base yields dimethylamine and 3,4-dichloroaniline. Hydrolysis is not recommended as a disposal procedure because of the generation of the toxic products, 3,4-dichloroaniline and dimethylamine.[22] Incineration is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 5, 49−55

US Environmental Protection Agency. (August 1987). *Health Advisory: Diuron*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Diuron*. Trenton, NJ

Divinyl benzene D:1620

Molecular Formula: $C_{10}H_{10}$

Common Formula: $C_6H_4(CH{=}CH_2)_2$

Synonyms: Benzene, divinyl-; Diethenylbenzene; Diethyl benzene; 1,4-Divinyl benzene; DVB; DVB-22; DVB-27; DVB-55; Vinylstyrene

CAS Registry Number: 1321-74-0 (*all isomers*); 108-57-6 (*m*-isomer)

RTECS® Number: CZ9370000 (*mixed isomers*); CZ9400000 (*m*-isomer)

UN/NA & ERG Number: UN2049/130

EC Number: 215-325-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*m*-isomer).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Water polluting (CAS: 1321-74-0).

Description: DVB exists as *o*-, *m*-, and *p*-isomers. The commercial product contains all 3 isomers, but *m*-isomer predominates. Usually contains an inhibitor to prevent polymerization. The CAS number for the mixed isomers appears on most regulatory lists.

DVB is a pale, straw-colored liquid. Molecular weight = 130.20; Specific gravity (H_2O:1) = 0.93; Boiling point = 195−200°C; Freezing/Melting point = −66.7 to −52°C; Vapor pressure = 0.7 mmHg at 20°C; Flash point = 62°C (cc); 76°C (oc); Autoignition temperature = 469°C. Explosive limits: LEL = 0.7%; UEL = 6.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. This compound is used as a monomer for the preparation of special synthetic rubbers, drying oils, ion-exchange resins and casting resins, and in polyester resin manufacture.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers, metallic salts. Able to polymerize; add inhibitor and monitor to insure effective levels are maintained at all times. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.33 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 10 ppm/50 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/53 mg/m^3 TWA.

Protective Action Criteria (PAC)

m-isomer and mixed isomers

TEEL-0: 10 ppm

PAC-1: 10 ppm

PAC-2: 75 ppm

PAC-3: 350 ppm

DFG MAK: No numerical value established. Data may be available.

Denmark: TWA 10 ppm (50 mg/m^3), 1999; United Kingdom: TWA 10 ppm (54 mg/m^3), 2000. Several states have set guidelines or standards for divinyl benzene in ambient air[60] ranging from 500 μg/m^3 (North Dakota) to 800 μg/m^3 (Virginia) to 1000 μg/m^3 (Connecticut) to 1190 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #89.

Determination in Water: No test listed. Octanol−water coefficient: Log K_{ow} = 3.6 (estimated).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin, eye, and respiratory system irritation. Divinyl benzene can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Prolonged skin contact can cause burns and rash. Exposure can irritate the nose and throat. A central nervous system depressant; higher exposure can cause dizziness, drowsiness, and passing out.

Long Term Exposure: Repeated or prolonged contact may cause skin dryness, burns, and rash.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. NIOSH recommends: **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton™ gloves, suits Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with DVB you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from metallic salts (such as ferric and aluminum chlorides) and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Diethylbenzene requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a furnace equipped with afterburner and scrubber.

Reference

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Divinyl Benzene.* Trenton, NJ

Dodecylbenzenesulfonic acid D:1630

Molecular Formula: $C_{18}H_{30}O_3S$

Synonyms: Acido dodecilbencenosulfonico (Spanish); Benzenesulfonic acid, dodecyl-; Benzene sulfonic acid, dodecyl ester; Benzenesulphonic acid, dodecyl-; Benzene sulphonic acid, dodecyl ester; Calsoft LAS 99; DDBSA; Dodanic acid 83; Dodecyl benzenesulfonate; *N*-Dodecyl benzenesulfonic acid; Dodecyl benzenesulphonate; *N*-Dodecyl benzenesulphonic acid; Dodecylbenzenesulphonic acid; E 7256; Elfan WA sulphonic acid; Lauryl benzenesulfonate; Laurylbenzenesulfonic acid; Lauryl benzenesulphonate; Laurylbenzenesulphonic acid; Nacconol 98 SA; Nansa SSA; Pentine acid 5431; Rhodacal ABSA; Richonic acid; Sulframin acid 1298

CAS Registry Number: 27176-87-0; *(alt.)* 1886-81-3

UN/NA & ERG Number: UN2584 (Alkyl sulfonic acids, liquid or Aryl sulfonic acids, liquid with more than 5 percent free sulfuric acid)/153; UN2586 (liquid, with>5% free H_2SO_4)/153

EC Number: 248-289-4

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Supported, 1998.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

NIOSH Profile, "Sulfonic Acids and Salts," ARYL, SRC, 12/79.

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dodecylbenzenesulfonic acid is a light yellow to brown liquid with a slight SO_2 odor. Molecular weight = 326.54; Boiling point = 315°C; Freezing/Melting point = 10°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Soluble in water.

Potential Exposure: Used as a laboratory chemical. Used for cleaning electronic components; emulsifier for agricultural herbicides; in polymerization; in pickling baths; as a wetting agent in various industrial applications Used in the production of biologically soft detergents, including household detergents (laundry liquids and powders, dishwashing liquids, and various other cleaners).

Incompatibilities: May attack metals, forming flammable hydrogen gas. Keep away from combustible materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 2.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: A corrosive. Contact with the eyes and skin can cause severe irritation and burns. Inhalation can irritate the respiratory tract. LD_{50} (oral-rat) = 650 mg/kg.

Long Term Exposure: Repeated skin contact may cause dermatitis. Corrosive materials may affect the lungs or cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with DDBSA you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Dodecylbenzenesulfonic acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II. The symbol "D" identifies proper shipping names which are appropriate for describing materials for domestic transportation but may be inappropriate for international transportation under the provisions of international regulations (e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Poisonous gases, including sulfur oxides and hydrogen sulfide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators

recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Dodecylbenzenesulfonic Acid*. Trenton, NJ

Dodecyl trichlorosilane D:1640

Molecular Formula: $C_{12}H_{25}Cl_3Si$

Synonyms: Dodeciltriclorosilano (Spanish); Dodecyl trichlorosilane; Silane, dodecyltrichloro-; Silane, trichlorododecyl-; Trichlorododecylsilane

CAS Registry Number: 4484-72-4

RTECS$^{®}$ Number: VV3940000

UN/NA & ERG Number: UN1771/156

EC Number: 224-769-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Dodecyl trichlorosilane is a colorless to yellow liquid with a pungent odor. Molecular weight = 303.81; Boiling point ≥ 149°C; Flash point ≥ 65°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩ (water reactive).

Potential Exposure: This material is used in silicone polymer manufacture.

Incompatibilities: Forms explosive mixture with air. Reacts with strong bases and oxidizers. Hydrolyzes with moist air, water, or steam, forming corrosive and toxic chloride gases, including hydrogen chloride. Corrosive to common metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.60** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Dodecyl trichlorosilane can affect you when breathed in. This substance can cause severe eye burns leading to permanent damage. Dodecyl trichlorosilane is a corrosive chemical and contact can cause severe skin burns. Breathing Dodecyl trichlorosilane can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. Exposure can irritate the eyes, nose, and throat.

Short Term Exposure: Dodecyl trichlorosilane can affect you when breathed in. This substance can cause severe eye burns leading to permanent damage. Dodecyl trichlorosilane is a corrosive chemical and contact can cause severe skin burns. Breathing dodecyl trichlorosilane can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dodecyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied/air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where dodecyl trichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Dodecyl trichlorosilane requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, crushed limestone, soda ash, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.9/1.5

Fire Extinguishing: This chemical is a combustible liquid but does not easily ignite. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Use dry chemical, carbon dioxide, or alcohol-resistant foam extinguishers. *Do not use water*; may react violently. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Dodecyl Trichlorosilane*. Trenton, NJ

E

Emetine dihydrochloride E:0050

Molecular Formula: $C_{29}H_{42}Cl_2N_2O_4$
Common Formula: $C_{29}H_{40}N_2O_4 \cdot 2HCl$
Synonyms: Amebicide; (−)Emetine, dihydrochloride; 1-Emetine, dihydrochloride; Emetine, hydrochloride; NSC-33669
CAS Registry Number: 316-42-7
RTECS® Number: JY5250000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 206-259-8
Regulatory Authority and Advisory Bodies
Banned or Severely Restricted (Mauritius) (UN).[13]
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1/10,000 lb (0.454/4540 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Emetine dihydrochloride is a colorless, combustible powder which turns yellow on exposure to heat or light. Molecular weight = 553.63; Boiling point = 600°C; Freezing/Melting point = 235−250°C (decomposes); Flash point = >310°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Primary Irritant. Emetine dihydrochloride is an injectable form of emetine. It is an antiamebic. Emetine is the active ingredient of Ipecac. Emetine dihydrochloride is used as a chemical reagent, organic intermediate; in pharmaceutical R&D.
Incompatibilities: Keep away from strong oxidizers.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.05 mg/m^3
PAC-1: 0.15 mg/m^3
PAC-2: 0.4 mg/m^3
PAC-3: 0.4 mg/m^3
Routes of Entry: Inhalation, ingestion, eye and/or skin contact.
Harmful Effects and Symptoms
Symptoms include nausea, vomiting, diarrhea, muscle weakness, pain, tenderness, hypotension, precordial pain, and rapid heartbeat. This material is highly toxic when administered orally. It is an eye irritant. Probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 1 teaspoon for a 150-lb person. LD_{50} = (oral-rat) 0.012 mg/kg (12 μg/kg) (extremely toxic).
Short Term Exposure: Irritates the eyes. Symptoms include nausea, vomiting, diarrhea, muscle weakness, pain, tenderness, hypotension, precordial pain, and rapid heartbeat, diarrhea, dyspnea, hallucinations, nausea, or vomiting. This material is highly toxic when administered orally. Probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 1 teaspoon for a 150-lb person. LD_{50} = (oral-rat) 0.012 mg/kg (12 μg/kg) (extremely toxic).
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Emetine is an alkaloid. Procedures for alkaloid salts are as follows. Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00005-9

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from light.

Shipping: Emetine may be classified as Toxic solids, organic, n.o.s. and falls in Hazard Class 6.1 and Packing Group I. It requires a "POISONOUS/TOXIC MATERIALS" label.

Spill Handling: The following procedures should be used for alkaloid salts. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguishing methods for alkaloid salts are as follows. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Procedures for alkaloid salts include the following. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including chlorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Emetine Dihydrochloride*. Washington, DC: Chemical Emergency Preparedness Program

Endosulfan E:0100

Molecular Formula: $C_9H_6Cl_6O_3S$

Synonyms: Benzoepin (in Japan); Beosit; Bio 5462; Chlorthiepin; Crisufan; Cyclodan; Devisulphan; Endocel; Endosol; Endosulfan chlorinated hydrocarbon insecticide; Endosulphan; Endox; Ensodulfan (Spanish); Ensure; ENT 23,979; FMC5462; α,β-1,2,3,4,7,7-1,2,3,4,7,7-Hexachlorobiclo(2,2,1)hepten-5,6-bioxymethylenesulfite; Hexachlorohexahydromethano 2,4,3-benzotrinorborn-5-en-2,3-ylene) (dimethylsulphite)6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide; 6,7,8,9,10,10-Hezachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide; 1,4,5,6,7,7-Hezachloro-5-norborene-2,3-dimethanol cyclic sulfite; Hildan, HOE 2671; Insecto; Insectophene; Kop-Thiodan; Malix; Maux; 6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, NCI-C00566; MOS-570; NIA 5462; Niagra 5462; OMS570; Rasayansulfan; Sulfurous acid cyclic ester with 1,4,5,6,7,7-hexachloro-5-norborene-2,3-dimethanol; Thidan; Thifor; Thimul; Thiodan (in Russia); Thiodan®; Thiodan 35; Thiofor; Thiomul; Thionex; Thiosulfan; Thiosulfan thionel; Tiovel

CAS Registry Number: 115-29-7; 959-98-8 (*alpha*-); 33213-65-9 (*beta*-); *(alt.)* 6994-04-3; *(alt.)* 8003-45-0

RTECS® Number: RB9275000; RB9875200 (beta)

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 204-079-4 [*Annex I Index No.:* 602-052-00-5]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (many countries) (UN).[13]

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

US EPA, FIFRA 1998 Status of Pesticides: Supported, 1998.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): P050.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant.

List of Stockholm Convention POPs: proposed addition.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R26/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61; S63. (115-29-7).

alpha-:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant; as endosulfan.

beta-:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.029; Nonwastewater (mg/kg), 0.13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant.

WGK (German Aquatic Hazard Class): 3—Highly water polluting (CAS: 115-29-7).

Description: Endosulfan is a chlorinated cyclodiene insecticide. The pure product is a colorless crystalline solid. The technical product is a light to dark brown waxy solid. It has a rotten egg or sulfur odor. Molecular weight = 406.90; Melting point = 406.91; Boiling point = decomposes; Freezing/Melting point = 70−100°C (technical); 106.1°C (pure); 106°C (a); 212°C (b); Vapor pressure = 1.7×10^{-7} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water; solubility = 0.00001%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those engaged in the manufacture, formulation, and application of this material.

Incompatibilities: Strong acids, strong bases. Hydrolyzed by acids. Contact with alkalis forms toxic sulfur dioxide fumes. Corrosive to iron in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.006 ppm/0.1 mg/m^3 TWA measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen.

115-29-7

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 8 mg/m^3

PAC-3: 200 mg/m^3

Australia: TWA 0.1 mg/m^3, [skin], 1993; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; India: TWA 0.1 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; United Kingdom: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[35,43] set a MAC of 0.1 mg/m^3 in work-place air as well as a MAC in ambient air of residential areas of 0.005 mg/m^3 on a momentary basis and 0.001 mg/m^3 on a daily average basis. Several states have set guidelines or standards for endosulfan in ambient air[60] ranging from 0.238 μg/m^3 (Kansas) to 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada) to 2.4 μg/m^3 (Pennsylvania).

Determination in Air: Use OSHA Analytical Method PV-2023.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.056 μg/L as a 24-h average, never to exceed 0.22 μg/L. *To protect saltwater aquatic life:* 0.0087 μg/L as a 24-h average, never to exceed 0.034 μg/L. *To protect human health:* 74.0 μg/L.[6] Mexico[35] set a MAC of 2 μg/L in estuaries and 0.2 μg/L in coastal waters. Kansas[61] has set a guideline of 74.0 μg/L for endosulfan in drinking water.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 3.6$. Fish Tox = 0.00446000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Endosulfan may affect the central nervous system, blood, resulting in irritability, convulsions, and renal failure. High-level exposure may result in death. The effects may be delayed. Ingestion of endosulfan may result in nausea, vomiting, and diarrhea. Dizziness, agitation, nervousness, tremor, a lack of coordination, and convulsions may also occur. Central nervous system depression may terminate in respiratory failure. Contact with endosulfan may irritate or burn the skin, eyes, and mucous membranes. Human Tox = 42.00000 ppb (INTERMEDIATE). The probable oral lethal dose is 50−500 mg/kg or between 1 teaspoonful and 1 oz for a 150-lb person. LD_{50} = (oral-rat) 18 mg/kg (highly toxic). Death has occurred within 2 h of heavy dust exposure during bagging operations.

Long Term Exposure: Repeated exposure may cause brain damage, causing convulsions, loss of coordination, and memory loss. May cause liver and kidney damage. May damage the testes.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver and kidney function tests. Examination of the nervous system. EEG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Consult hospital or poison control center on use of antidotes. Transport to health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton or Neoprene™ materials are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If used out of doors adequate emergency water should be available.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode. A dust respirator approved for pesticide use may be worn. An organic vapor respirator may be necessary if exposure to the solvent is significant.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated area, free of alkalis, acids, and acid fumes. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organochlorine pesticides, solid, toxic, require "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and Endosulfan in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. In case of spills, stay upwind; stay out of low areas. Use water spray to reduce vapors. Do not dry sweep. Do not touch spilled material; stop leak if you can do it without risk. *Small wet spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire, including sulfur oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A recommended method for disposal is burial 18 in. deep in noncropland, away from water supplies, but bags can be burned.[22] Large quantities should be incinerated at high temperature in a unit with effluent gas scrubbing. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (1980). *Endosulfan: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Endosulfan: Health and Environmental Effects Profile No. 98*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Endosulfan*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Endosulfan*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Endosulfan*. Trenton, NJ

Endothall E:0110

Molecular Formula: $C_8H_{10}NO_5PS$

Synonyms: Accelerate; Aquathol; Des-I-Cate; 1,2-Dicarboxy 3,6-endoxocyclohexane; 3,6-Endo-epoxy-1,2-cyclohexanedicarboxylic acid; 3,6-Endooxohexahydrophthalic acid; Endothal chlorophenoxy herbicide; Endothall technical; 3,6-Endoxohexahydrophthalic acid; 3,6-Epoxycyclohexane-1,2-dicarboxylic acid; Hexahydro-3,6-endooxyphthalic acid; Hydout; Hydrothal-47; Hydrothol; 7-Oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid; Tri-endothal

CAS Registry Number: 145-73-3; 129-67-9 (disodium salt)

RTECS® Number: RN7875000; RN8225000 (disodium salt)

UN/NA & ERG Number: UN2588/151

EC Number: 205-660-5 [*Annex I Index No.:* 607-150-00-1] (*145-73-3*); 204-959-8 [*Annex I Index No.:* 607-055–00-5] (*129-67-9*)

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): P088.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations (*145-73-3; 129-67-9*): Hazard Symbol: T; Risk phrases: R21; R25; R36/37/38; Safety phrases: S1/2; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Endothall, when pure, is a white crystalline solid. The technical grade is a light brown liquid. Molecular weight = 186.18; Freezing/Melting point = 144°C with conversion to the anhydride. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility = 100% at 20°C.

Potential Exposure: Endothall is used as a defoliant and as an herbicide on both terrestrial and aquatic weeds.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Disodium salt

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 20 mg/m^3

Permissible Concentration in Water: A no-observed-adverse-effects-level (NOAEL) of 2 mg/kg/day has been determined by EPA. This gives a reference dose (or acceptable daily intake) of 0.02 mg/kg/day on the basis of which a lifetime health advisory of 0.14 mg/L (140 μg/L) was calculated. Drinking Water Standards: MCLG: 0.1 ppm; MCL: 0.1 ppm.

Determination in Water: No test listed. Fish Tox = 240.32545000 ppb (LOW).

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, and respiratory tract. Poisonous: approximate lethal dose (human) is about 2.5 teaspoonfuls. Little information was found in the available literature on the health effects of endothall in humans except for one case history of a young male suicide victim who ingested an estimated 7−8 g of disodium endothall in solution (approximately 100 mg endothall ion/kg). Repeated vomiting was evident. Autopsy revealed focal hemorrhages and edema in the lungs and gross hemorrhage of the gastrointestinal (GI) tract. LD50 = (oral-rat) 18 mg/kg. Human Tox = 100.00000 ppb MCL (VERY LOW).

Long Term Exposure: May be mutagenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear rubber gloves for all handling. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear hats, protective suits, and boots for all handling.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with endothall you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Pesticides, solid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and endothall in Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not dry sweep. Use industrial vacuum. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be disposed of by burial in soil which is rich in organic matter. Large quantities are best disposed of by incineration.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (=100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 6, 51−56

US Environmental Protection Agency. (August 1987). *Health Advisory: Endothall*. Washington, DC: Office of Drinking Water

Endothion E:0120

Molecular Formula: $C_9H_{13}O_6PS$

Synonyms: AC-18,737; *O*,*O*-Dimethyl *S*-(5-methoxy-4-oxo-4H-pyran-2-yl) phosphorothioate; *O*,*O*-Dimethyl-S-[(5-methoxy-pyron-2-yl)-methyl]-thiolphosphat (German); *O*, *O*-Dimethyl *S*-(5-methoxypyronyl-2-methyl) thiolphosphate; Endocid; Endocide; Endotiona (Spanish); ENT 24,653; Exothion; 5-Methoxy-2-(dimethoxyphosphinylthiomethyl)pyrone-4; *S*-5-Methoxy-4-oxopyran-2-ylmethyl dimethyl phosphorothioate; *S*-[(5-Methoxy-4H-pyron-2-yl)-methyl]-*O*,*O*-dimethyl-monothiophosphat (German); *S*-(5-Methoxy-4-pyron-2-ylmethyl) dimethyl phosphorothiolate; NIA-5767; Niagra 5767; Phosphate 100; Phosphopyron; Phosphopyrone; Phosphorothioate;

Thiophosphate de *O*,*O*-dimethyle et de *S*-[(5-methoxy-4-pyronyl)-methyle] (French)

CAS Registry Number: 2778-04-3

RTECS® Number: IF8225000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 220-472-3 [*Annex I Index No.:* 015-049-00-3]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T; Risk phrases: R24/25; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Endothion is a white crystalline solid with a slight odor. Molecular weight = 280.25; Freezing/Melting point = 96°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is a systemic insecticide. It is not sold in the United States or Canada.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 17 mg/m^3

PAC-3: 17 mg/m^3

Routes of Entry: Inhalation, ingestion, skin contact.

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Exposure may cause psychotic behavior, loss of coordination, unconsciousness, and rarely convulsions. This material is poisonous to humans. Its toxic effects are most likely related to action on the nervous system; LD_{50} = (oral-rat) 23 mg/kg (highly toxic).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Endothion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Endothion in Packing Group II.

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry containers and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including phosphorus oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Endothion*. Washington, DC: Chemical Emergency Preparedness Program

Endoxan E:0130

Molecular Formula: $C_7H_{15}C_{12}N_2O_2P$

Synonyms: *N*,*N*-Bis-(β-chloraethyl)-*N*′,*O*-propylen-phosphorsaeure-ester-diamid (German); 2-[Bis(2-chloroethyl) amino]-1-oxa-3-aza-2-phosphocyclohexane 2-oxide monohydrate; 2-[Bis(2-chloroethyl)amino]-2H-1,3, 2-oxazaphosphorine 2-oxide; 1-Bis(2-chloroethyl)amino-1-oxo-2-aza-5-oxaphosphoridine monohydrate; [Bis(chloro-2-ethyl) amino]-2-tetrahydro-3,4,5,6-oxazaphosphorine-1,3, 2-oxide-2 hydrate; 2-[Bis(2-chloroethyl)amino]tetrahydro(2H)-1,3,2-oxazaphosphorine 2-oxide monohydrate; *N*,*N*-Bis(2-chloroethyl)-*N*′-(3-hydroxypropyl)phosphorodiamidic acid intramol ester hydrate; Bis(2-chloroethyl)phosphoramide-cyclic propanolamide ester; Bis(2-chloroethyl) phosphoramide cyclic propanolamide ester monohydrate; *N*,*N*-Bis (β-chloroethyl)-*N*′,*O*-propylenephosphoric acid ester; *N*,*N*-Bis(2-chloroethyl)-*N*′,*O*-propylenephosphoric acid ester diamide; Cyclophosphamide; Cyclophosphamidum; Cyclophosphan; Cyclostin; Cytophosphan; Cytoxan; *N*,*N*-Di (2-chloroethyl)-*N*,*O*-propylenephosphoric acid ester diamide; Endoxanal; Genoxal; Hexadrin; Mitoxan; NCI-C04900; Neosar; NSC-26271; 2-H-1,3,2-Oxazaphosphorinane; Procytox; Semdoxan; Senduxan; SK 20501; Zyklophosphamid (German)

CAS Registry Number: 50-18-0

RTECS® Number: RP5950000

UN/NA & ERG Number: UN1851 (Medicine, liquid, toxic, n.o.s.)/151; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-015-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP (*50-18-0*): 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987.

US EPA Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: *In vitro* cytogenetics—human; Positive: *In vivo* cytogenetics—human bone marrow; Positive: *In vivo* cytogenetics—human lymphocyte; Positive: Cytogenetics—male germ cell; Host-mediated assay; Positive: Rodent heritable translocation; Positive: L5178Y cells *In vitro*—TK test; Mammalian micronucleus; Positive: Mouse spot test; *E. coli* polA with S9; Positive: Histidine reversion—Ames test; Mouse specific locus; Positive: Sperm morphology—rat; Sperm morphology—mouse F1; Positive: Sperm morphology—human; Sperm morphology—mouse; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Positive: TRP reversion; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—forward mutation; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; Positive/dose response: Cell transform. —C3H/10T1/2; Positive/dose response: *In vivo* cytogenetics—nonhuman bone marrow; Positive/dose response: *In vivo* cytogenetics—mammalian oocyte; Positive/dose response: *In vitro* cytogenetics—human lymphocyte; Positive/dose response: Rodent dominant lethal; Positive/dose response: *In vitro* SCE—nonhuman; *In vivo* SCE—nonhuman; Negative: Cell transform.—BALB/c-3T3; Inconclusive: *In vitro* SCE—human lymphocytes; Inconclusive: Sperm morphology—rabbit; *In vitro* UDS—human fibroblast; Positive: CHO gene mutation.

US EPA Hazardous Waste Number (RCRA No.): U058.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 1/1/89.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Endoxan is a white crystalline powder (monohydrate). It may be used or shipped in solution. Darkens on exposure to light. Odorless. Molecular weight = 261.11; Freezing/Melting point = 41−45°C; Flash point = 112°C. Soluble in water; solubility = 4%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Natural Product. Exodan is used as an immunosuppressive agent in nonmalignant diseases and in the treatment of malignant lymphoma, multiple myeloma, leukemias, and other malignant diseases. Exodan has been tested as an insect chemosterilant and for use in the chemical shearing of sheep. Exodan is not produced in the United States. It is produced in Germany and exported to the United States where one company has formulated and marketed the drug since 1959. The FDA estimates that 200,000−300,000 patients per year are treated with exodan. It is administered orally and through injection. The adult dosage is usually 1−5 mg/kg of body weight daily or 10−15 mg/kg administered intravenous every 7−10 days.

Incompatibilities: Should be protected from exposure to temperatures above 30°C/86°F.

Permissible Exposure Limits in Air

No standard or TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Exodan irritates the eyes, skin, and respiratory tract. Eye contact can cause severe damage with possible loss of vision. This chemical can be absorbed through the skin, thereby increasing exposure. Exodan may affect the blood, bladder, central nervous system, and heart. Symptoms of exodan exposure include GI disturbance, leukopenia, nausea, dizziness, liver dysfunction, and hair loss. When used as a medical drug it can cause nausea, vomiting, and may interfere with the body's manufacture of blood cells (anemia). It is not known if this also occurs in workplace exposures. Contact may cause eye damage.

Long Term Exposure: Exodan is a carcinogen and probable teratogen in humans. It causes bladder and skin cancer. There is limited evidence that this chemical causes sterility in males and females. Repeated exposure may interfere with the body's ability to produce blood cells (anemia). May cause liver damage. The substance may have effects on the blood, bladder, lungs, and bone marrow, resulting in leucopenia, cystitis, pulmonary fibrosis. There is sufficient evidence for the carcinogenicity of exodan both in humans and in experimental animals. Exodan was carcinogenic in rats following administration in drinking water and intravenous injection and in mice following subcutaneous injection. Dosages were comparable to those used in clinical practice. The chemical produced benign and malignant tumors at various sites including bladder tumors in the rats. Epidemiological studies are available in which persons treated with Exodan for a variety of medical conditions were compared with similarly affected controls. These studies consistently demonstrate an excess of various neoplasms and leukemias in the treated groups; although the number in all five studies was small. LD_{50} = (oral-mouse) 137 mg/kg (MODERATELY TOXIC).

Points of Attack: Blood, lungs, bladder, skin, liver.

Medical Surveillance: Complete blood count. Lung function tests. Kidney function tests. GI tests. Tests for blood in urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If you are required to work in a "sterile" environment, you require special training.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store at below 25°C. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a "POISONOUS/TOXIC MATERIALS" label. Medicine, solid, toxic, n.o.s. falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chlorine, nitrogen oxides, phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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Endrin E:0140

Molecular Formula: $C_{12}H_8Cl_6O$

Synonyms: Compound 269; 2,7: 3,5-Dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (aa,2.b,2ab,2ab,3a,6a,6ab,7b,7aa)-; Endrex; Endrina (Spanish); Endrin chlorinated hydrocarbon insecticide; Endrine (French); ENT 17,251; Hexachloroepoxyoctahydro-endo, endo-dimethanonapthalene; (1r, 4s, 4as, ss, 7r, 8r, 8ar)-1,2,3,4,10-Hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4: 5,8-dimethano naphthalene; Hexadrin; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-1,4,5,8-dimethanonaphthalene; Mendrin; NCI-C00157; Nendrin

CAS Registry Number: 72-20-8

RTECS® Number: IO1575000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 200-775-7 [*Annex I Index No.:* 602-051-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; IARC: Human No Adequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Negative/limited: Carcinogenicity—mouse/rat; Inconclusive: *D. melanogaster* sex-linked lethal.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): P051; D012.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.02 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0028; Nonwastewater (mg/kg), 0.13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10).

Safe Drinking Water Act: MCL, 0.002 mg/L; MCLG, 0.002 mg/L; Regulated chemical (47 FR 9352).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Mexico, Drinking Water Criteria, 0.07 mg/L.

California Proposition 65 Chemical: Developmental/Reproductive toxin 5/15/98.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases R24; R28; R50/53; Safety phrases: S1/2; S21; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Endrin is the common name of one member of the cyclodiene group of pesticides. It is a cyclic hydrocarbon having a chlorine-substituted, methano-bridge structure. Endrin is a white, crystalline solid. Molecular weight = 380.90; Boiling point = (decomposes) below 245°C; Freezing/Melting point = (decomposes) 200°C/392°F; Vapor pressure = $2x10^{-7}$ mmHg at 20°C. *Mixture in xylene:* Flash point = 27°C. Explosive limits: LEL = 1.1%; UEL = 7.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those involved in manufacture, formulation, and field application of this insecticide, avicide, and rodenticide.

Incompatibilities: Parathion, strong acids (forms explosive vapors), strong oxidizers. Slightly corrosive to metals.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg/m^3 TWA[skin].

NIOSH REL: 0.1 mg/m^3 TWA[skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA[skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 2 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 2 mg/m^3

DFG MAK: 0.1 mg/m^3, measured as the, inhalable fraction TWA; Peak Limitation Category II(8); [skin]; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 mg/m^3, [skin], 1993; Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Norway: TWA 0.1 mg/m^3, 1999; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; Thailand: TWA 0.1 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for Endrin in ambient air[60] ranging from 0.07 μg/m^3 (Pennsylvania) to 0.238 μg/m^3 (Kansas) to 1.0 μg/L (North Dakota) to 1.6 μg/L (Virginia) to 2.0 μg/L (Connecticut and Nevada).

Determination in Air: Use NIOSH (IV), Method #5519.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0023 μg/L as a 24-h average, never to exceed 0.18 μg/L. *To protect saltwater aquatic life:* 0.0023 μg/L as a 24-h average, never to exceed 0.037 μg/L. *To protect human health:* 1.0 μg/L[6]. According to a UN publication,[35] the limit on endrin in drinking water delivered at the tap is 0.2 μg/L. Mexico has imposed limits on endrin in water[35] as follows: 2 μg/L in estuaries; 1 μg/L in receiving waters used for drinking water supply and 0.2 μg/L in coastal waters. The EPA has derived a no-observed-adverse-effects-level (NOAEL) of 0.045 mg/kg/day on the basis of which they have arrived at a long-term health advisory of 16 μg/L and a lifetime health advisory of 0.32 μg/L. Massachusetts has set a standards of 0.2 μg/L and Maine has set a guideline of 0.2 μg/L for endrin in drinking water.[61] Mexico's drinking water criteria is 0.07 mg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 5.3. Fish Tox = 0.00440000 pbb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Quickly passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin and eyes and may affect vision. Inhalation can cause irritation of the respiratory tract. Exposure can cause headache, nausea, vomiting, diarrhea, loss of appetite, sweating and weakness, lightheadedness, dizziness, convulsions, and unconciousness. Lower exposure can affect concentration, memory, and muscle coordination. Endrin can cause death by respiratory arrest. Symptoms include headache, nausea, vomiting, dizziness, tremors, convulsions, loss of consciousness, rise in blood pressure, fever, frothing of the mouth, deafness, coma, and death. This material is extremely toxic. It is rapidly absorbed through the skin. Symptoms appear between 20 min and 12 h after exposure. Doses of 1 mg/kg can cause symptoms. Also, it is a central nervous system depressant and hepatotoxin. Inhalation may cause irritation to nose and throat; and sudden convulsions, which may occur from 30 min to 10 h after exposure. Recovery is usually rapid, but headache, dizziness, lethargy, weakness, and weight loss may persist to 2−4 weeks. Prolonged breathing or ingestion can result in an onset of symptoms in 3 h at a dose of 1 mg per kg of body weight. Ingestion of 12 g has caused death. Pregnant women are considered to be at special risk. A rebuttable presumption notice against pesticide registration was issued on July 27, 1976 by EPA on the basis of oncogenicity, teratogenicity, and reductions in endangered species and nontarget species. Human Tox = 2.00000 ppb MCL (HIGH).

Long Term Exposure: May damage the developing fetus. May damage the nervous system causing numbness and weakness in the extremities. Repeated exposure may cause personality changes of depression, anxiety, and/or irritability. May cause anorexia. High or repeated exposure may cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Examination of the nervous system. Electroencephalogram (a test for abnormal seizure activity). Blood endrin level. Liver and kidney function tests. NIOSH lists the following tests: whole blood (chemical/metabolite), end-of-shift; blood plasma, blood serum; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m^3*: Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator); *2 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter) or CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with endrin you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organochlorine pesticides, solid toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and endrin in Packing Group I.

Spill Handling: For leaks or spills, use water spray to disperse vapor and to flush spills. Liquid containing this material should be absorbed in vermiculite, dry sand, or earth. Do not touch spilled material; stop leak if you can do it without risk. Establish forced ventilation to keep levels below explosive limit. *Small dry spills:* collect powdered material in the most convenient and safe manner and deposit in sealed containers; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Endrin itself does not burn but it may be dissolved in a flammable liquid. Poisonous gases are produced in fire, including phosgene and hydrogen chloride. Use dry chemical, foam, carbon dioxide, water spray for solution. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Use water to keep fire-exposed containers cool. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind: keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A disposal procedure recommended by the manufacturer consists of absorption, if necessary, and burial at least 18 in. deep; preferably in sandy soil in a flat or depressed location away from wells, livestock, children, wildlife, etc. Incineration is the recommended method.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

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Enflurane E:0150

Molecular Formula: $C_3H_2ClF_5O$

Common Formula: CHF_2OCF_2CHFCl

Synonyms: 2-Chloro-1-(difluoromethoxy)-1,1,2-trifluoroethane; 2-Chloro-1,1,2-trifluoroethyl difluoromethyl ether; Ethrane®; Ethrane methylflurether

CAS Registry Number: 13838-16-9; *(alt.)* 22194-21-4; *(alt.)* 22194-22-5
RTECS® Number: KN6800000
UN/NA & ERG Number: Not regulated.
EC Number: 237-553-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Negative: V79 cell culture-gene mutation; Inconclusive: Histidine reversion—Ames test; Sperm morphology—mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Enflurane is a clear, colorless liquid with a mild, sweet odor, which easily turns into a nonflammable gas. Molecular weight = 184.50; Specific gravity (H_2O:1) = 1.52; Boiling point = 56.7°C; Vapor pressure = 175 mmHg; Relative vapor density (air = 1) = 1.92. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Very slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. FDA—proprietary drug, used as an anesthetic (gas). Axphyxiant.

Incompatibilities: May be able to form unstable peroxides. Decomposes on heating, forming toxic and corrosive fumes of hydrogen chloride, hydrogen fluoride, phosgene.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL*: 2 ppm/15.1 mg/m^3 [60-min] Ceiling Concentration [**Note*: REL for exposure to waste anesthetic gas.]

ACGIH TLV®[1]: 75 ppm; not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: 20 ppm/150 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group C.

Australia: TWA 0.5 ppm (3.8 mg/m^3), 1993; Belgium: TWA 75 ppm (566 mg/m^3), 1993; Denmark: TWA 2 ppm (15 mg/m^3), 1999; the Netherlands: MAC-TGG 153 mg/m^3, 2003; Norway: TWA 2 ppm (15 mg/m^3), 1999; Sweden: NGV 10 ppm (80 mg/m^3), KTV 20 ppm (150 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (80 mg/m^3), KZG-W 20 ppm (160 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use OSHA Analytical Methods 29 and 103.

Permissible Concentration in Water:

No standards or TEEL available.

Routes of Entry: Inhalation of vapors.

Harmful Effects and Symptoms

Short Term Exposure: Enflurane can affect you when breathed in. There is an association between exposure to anesthetic vapors and increased cancers, miscarriages, and birth defects. Enflurane's role in these increased risks is unclear. Medical patients receiving enflurane as surgical anesthesia have had rare cases of seizures (fits) and liver damage. It is not known whether this happens with workplace exposures. Exposure can cause you to become dizzy, lightheaded and to pass out. LD_{50} = (oral-rat) 5450 mg/kg (insignificantly toxic).

Long Term Exposure: There is limited evidence that enflurane causes lung and liver cancer in animals. It may damage the developing fetus. Exposure to high levels may cause seizures and affect the liver.

Points of Attack: Eyes, central nervous system, liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Prior to working with enflurane you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Check oxygen content before entering confined spaces. Where possible, automatically pump liquid from drums or other storage containers to process containers. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. If the gas is leaking from a vaporizer or other equipment, stop the flow of gas if it can be done safely. Ventilate area of spill or leak to disperse gas. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid or gas. Poisonous gases, including hydrogen chloride, hydrogen fluoride, phosgene, are produced in fire. Use any extinguisher suitable for surrounding fires. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors*, NIOSH Document No. 77-140

New Jersey Department of Health and Senior Services. (April, 1997). *Hazardous Substances Fact Sheet: Enflurane*. Trenton, NJ

Epichlorohydrin E:0160

Molecular Formula: C_3H_5ClO

Synonyms: 1-Chlor-2,3-epoxy-propan (German); 1-Chloro-2,3-epoxypropane; 3-Chloro-1,2-epoxypropane; (Chloromethyl)ethylene oxide; (Chloromethyl)oxirane; 2-(Chloromethyl)oxirane; Chloromethyloxirane; 3-Chloropropene-1,2-oxide; γ-Chloropropylene oxide; 3-Chloropropylene oxide; 3-Chloro-1,2-propylene oxide; Chloropropylene oxide; Epichlorhydrin (German); Epichlorhydrine (French); α-Epichlorohydrin; (dl)-α-Epichlorohydrin; EPI-chlorohydrin; Epiclorhidrina (Spanish); 1,2-Epoxy-3-chloropropane; 2,3-Epoxypropyl chloride; Epoxy resin component; Glycerol epichlorohydrin; Glycidyl chloride; Oxirane, (chloromethyl)-; Phenoxy resin component; Propane, 1-chloro-2,3-epoxy-; Skekhg

CAS Registry Number: 106-89-8

RTECS$^{®}$ Number: TX4900000

UN/NA & ERG Number: UN2023

EC Number: 203-439-8 [*Annex I Index No.:* 603-026-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000.

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *In vitro* cytogenetics—human lymphocyte; Positive: *In vivo* cytogenetics—human lymphocyte; Positive: *N. crassa*—forward mutation; *N. crassa*—reversion; Positive: *E. coli* polA without S9; Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; *S. pombe*—forward mutation; Positive: *S. pombe*—reversion; Negative: Sperm morphology—human; Sperm morphology—mouse; Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9,080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U041.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87; male 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R10; R23/24/25; R34; R43; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Epichlorohydrin is a colorless liquid with a slightly irritating, chloroform-like odor. Molecular weight = 92.53; Boiling point = 116.7°C; Freezing/Melting point = −48°C; Vapor pressure = 13 mmHg at 20°C; Flash point = 31°C; Autoignition temperature = 411°C. Explosive limits: LEL = 3.8%; UEL = 21.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Soluble in water; solubility = 7%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Epichlorohydrin is used in the manufacture of many glycerol and glycidol derivatives and epoxy resins; as a stabilizer in chlorine-containing materials; as an intermediate in the preparation of cellulose esters and ethers, paints, varnishes, nail enamels, and lacquers; as a cement for celluloid. It is used as an intermediate in the manufacture of various drugs.

Incompatibilities: Forms explosive mixture with air. Slowly decomposes on contact with water. Heat or strong acids, alkalies, metallic halides, or contaminants can cause explosive polymerization. Violent reaction with strong oxidizers, aliphatic amines, alkanolamines, amines (especially aniline), alkaline earths, chemically active metals (chlorides of aluminum, iron zinc), powdered metals (aluminum, zinc), alcohols, phenols, organic acids, causing fire and explosion hazard. Will pit steel in the presence of water. Decomposition forms highly toxic phosgene gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 5 ppm/19 mg/m^3 TWA [skin].

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.5 ppm TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 75 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.5 ppm

PAC-1: **5.7** ppm

PAC-2: **24** ppm

PAC-3: **72** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Group: 3B.

Arab Republic of Egypt: TWA 2 ppm (10 mg/m^3), [skin], 1993; Australia: TWA 2 ppm (10 mg/m^3), [skin], 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 2 ppm (7.6 mg/m^3), [skin], 1993; Finland: TWA 0.5 ppm (1.9 mg/m^3), [skin], carcinogen, 1999; France: VLE 2 ppm (10 mg/m^3), carcinogen, 1999; Hungary: STEL 1 mg/m^3, [skin], carcinogen, 1999; the Netherlands: MAC-TGG 1.9 mg/m^3, 2003; Norway: TWA 0.5 ppm (1.9 mg/m^3), 1999; the Philippines: TWA 5 ppm (19 mg/m^3), [skin], 1993; Poland: MAC (TWA) 1 mg/m^3; STEL 8 mg/m^3, 1999; Sweden: NGV 0.5 ppm (1.9 mg/m^3), KTV 1 ppm (4 mg/m^3), [skin], 1999; Switzerland: MAK-W 2 ppm (8 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 5 ppm (19 mg/m^3), [skin], 1993; United Kingdom: TWA 0.5 ppm (1.9 mg/m^3); STEL 1.5 ppm, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Russia set a MAC value of 0.2 mg/m^3 (200 μg/m^3) in the ambient air in residential areas[35,43] on either a momentary or a daily average basis. Several states have set guidelines or standards for epichlorohydrin in ambient air[60] ranging from 2.7 μg/m^3 (Massachusetts) to 8.3 μg/m^3 (North Carolina) to 12.0 μg/m^3 (Pennsylvania) to 20.0 μg/m^3 (Connecticut) to 33.3 μg/m^3 (New York) to 50.0 μg/m^3 (Indiana, South Carolina) to 0−100.0 μg/m^3 (North Dakota) to 0.8−200.0 μg/m^3 (Rhode Island) to 160.0 μg/m^3 (Virginia) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #1010 or OSHA Analytical Method 7.

Permissible Concentration in Water: EPA has suggested a permissible ambient goal of 276 μg/L based on health effects. The EPA more recently calculated[48] a no-observed-adverse-effects-level (NOAEL) of 2 mg/kg/day on the basis of which they have calculated a lifetime health advisory of 70 μg/L. Russia[43] set a MAC of 10 μg/L in water bodies used for drinking purposes. Several states have set guidelines for epichlorohydrin in drinking water[61] ranging from 3.5 μg/L (Arizona) to 35.4 μg/L (Minnesota) to 150 μg/L (Maine).

Determination in Water: A purge-and-trap gas chromatographic/mass spectrometric procedure for the determination of volatile organic compounds may be used for epichlorohydrin according to EPA.[48]

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Epichlorohydrin is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the nervous system. Exposure may result in unconsciousness. Acute exposure to epichlorohydrin may result in nausea, vomiting, and abdominal pain. Liver and kidney effects may be observed. The respiratory tract may become irritated; dyspnea (shortness of breath) may occur; and in acute cases, respiratory paralysis has been observed. Central nervous system and respiratory depression have been noted. *Inhalation:* Levels below 0.05 ppm have not caused adverse effects. Levels above 20 ppm may cause fatigue, stomach pains, nausea, vomiting, slowed breathing, loss of muscle strength, and blue coloration of the skin. *Skin:* May cause severe blistering, burns, and severe pain which may be delayed. Skin absorption may cause or increase the severity of symptoms listed above.

Eyes: Levels above 5 ppm may cause severe irritation or burns. Direct contact of the liquid may cause clouding of the cornea and tissue death. *Ingestion:* May cause nausea and stomach pain. Animal studies indicate that the probable lethal dose for an adult is 14 g (1/2 oz).

Long Term Exposure: Repeated or prolonged contact to epichlorohydrin may cause skin allergy to develop. Repeated or prolonged inhalation exposure may cause asthma. May decrease fertility in males. Repeated overexposure may cause changes in the eyes and lungs, kidney and liver damage, and chronic asthmatic bronchitis. Epichlorohydrin causes cancer and changes in the genetic material of laboratory animals and has also been linked to cancers and change in the genetic material of occupationally exposed humans. There is some evidence of lung cancer in humans.

Points of Attack: Eyes, skin, respiratory system, kidneys, liver, reproductive system. *Cancer site* (in animals): nasal cavity.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Epichlorohydrin slowly penetrates rubber, so all contaminated clothing should be thoroughly washed. **8 h:** Barricade® coated suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h:** 4H™ and Silver Shield™ gloves, Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor and acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Epichlorohydrin must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), and chemically active metals (such as aluminum, caustics, chlorides of iron, and aluminum and zinc) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where epichlorohydrin is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of epichlorohydrin should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Where possible, automatically pump liquid from drums or other storage containers to process containers. Use only nonsparking tools and equipment, especially when opening and closing containers of epichlorohydrin. Wherever epichlorohydrin is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Use water spray, dry chemical, foam or carbon dioxide. Water spray may be used to dilute spills to nonflammable mixtures. If leak or spill has not ignited, use water spray to disperse the vapors. Evacuate for a radius of 1500 feet. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Epichlorohydrin may react violently with water. Poisonous gases, including hydrogen chloride and carbon monoxide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standards: Occupational Exposure to Epichlorohydrin*, NIOSH Document No. 76-206. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Epichlorohydrin: Health and Environmental Effects Profile No. 100*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.) (1986). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 57−59 (1981) and 3, 68−71 (1983) and 6, No. 5, 50−51

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Epichlorohydrin*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Epichlorohydrin*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Epichlorohydrin*. Trenton, NJ

EPN E:0170

Molecular Formula: $C_{14}H_{14}NO_4PS$

Synonyms: *O*-Aethyl-*O*-*N*(4-nitrophenyl)-phenylmonothiophosphonat (German); ENT 17,798; *O*-Ester of *p*-nitrophenol with *O*-ethylphenyl phosphonothioate; Ethoxy-4-nitrophenoxyphenylphosphine sulfide; Ethyl *p*-nitrophenyl benzenethionophosphate; *O*-Ethyl *O*-(4-nitrophenyl) benzenethionophosphonate; Ethyl *p*-nitrophenyl benzenethionophosphonate; Ethyl *p*-nitrophenyl benzenethiophosphonate; *O*-Ethyl *O*-(4-nitrophenyl) phenyl phosphonothioate; *O*-Ethyl *O*,*p*-nitrophenyl phenyl phosphonothioate; Ethyl *p*-nitrophenyl phenylphosphonothioate; Ethyl *p*-nitrophenyl thionobenzenephosphate; *O*-Ethyl phenyl-*p*-nitrophenyl thiophosphonate; Pin; Santox; Thionobenzenephosphonic acid ethyl *p*-nitrophenyl ester

CAS Registry Number: 2104-64-5

RTECS® Number: TB1925000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 218-276-8 [*Annex I Index No.:* 015-036-00-2]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Water Pollution Standard Proposed (Japan).[35]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: EPN is a light yellow crystalline solid with an aromatic odor (as a pesticide) or a brown liquid above 36°C. Molecular weight = 323.32; Freezing/Melting point = 36°C; Vapor pressure = 3.4×10^{-7} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug; Reproductive Effector; Primary Irritant. EPN is used in the preparation of emulsifiable, granular or wettable powder insecticides for cotton. Those involved in the manufacture, formulation, and application of this material.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Contact with alkalies causes decomposition (hydrolysis) producing *p*-nitrophenol.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA inhalable fraction [skin]; not classifiable as a human carcinogen (2000); BEI_A issued as Acetylcholinesterase inhibiting pesticides.

NIOSH IDLH: 5 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK: 0.5 mg/m^3 measured as the inhalable fraction TWA; Peak Limitation Category II(2) [skin].

Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: MAK 0.5 mg/m^3, [skin], 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Norway: TWA 0.5 mg/m^3, 1999; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for EPN in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #5012.

Permissible Concentration in Water: Japan[35] has set a effluent maximum of 1 mg/L and an environmental water quality standard of zero.

Determination in Water: Fish Tox = 1.51635000 ppb MATC (HIGH). Octanol−water coefficient: Log K_{ow} = >5.0.

Determination in Soil: Soil Adsorption Index (K_{oc}) = 4000 (estimate).

Routes of Entry: Inhalation, ingestion, skin absorption, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: A cholinesterase inhibitor. EPN can affect the nervous system, causing convulsions and possible respiratory failure. Exposure may result in unconsciousness or death. The effects may be delayed. Medical observation is indicated. This material may be fatal if swallowed. It is poisonous if inhaled and extremely hazardous by skin contact. Repeated exposure may, without symptoms, be increasingly hazardous. The estimated fatal oral dose is 0.3 g for a 150-lb (70-kg) person. Acute exposure to EPN may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Giddiness, slurred speech, confusion, and psychosis may also be observed. A rebuttable presumption against pesticide registration was issued for EPN on September 19, 1979 by EPA on the basis of neurotoxicity. Human Tox = 0.07000 ppb (EXTRA HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. EPN may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, cardiovascular system, central nervous system, eyes, skin, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. NIOSH lists the following tests: Cholinesterase: blood serum, red blood cells/count; cholinesterase: red blood cells/count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 mg/m^3* Sa (APF = 10) (any supplied-air respirator) or SCBA (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with EPN you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and EPN in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover with soda ash; mix, and spray with water. Place in container of water and allow to stand for 2 days, then neutralize with 6 molar hydrochloric acid. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemicals, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including carbon monoxide, phosphine, phosphoric acid, nitrogen oxides, phosphorous oxides, sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Fight fire from maximum distance. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: EPN plant wastes are treated by preaeration, activated sludge treatment, recycle, chlorination, and final polishing where additional natural biological stabilization occurs. EPN is also relatively rapidly hydrolyzed in alkaline solution to benzene thiophosphoric acid; alcohol and *p*-nitrophenol and soil burial with alkali may be used. For large quantities, however, incineration is recommended.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: EPN*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: EPN*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration,*

Reregistration, and Special Review (Rainbow Report). Washington, DC

Epoxy ethyloxy propane E:0180

Molecular Formula: $C_5H_{10}O_2$
Synonyms: 1,2-Epoxy-3-ethoxy-propane (DOT); (Ethoxymethyl)oxirane; Ethyl glycidyl ether; Oxirane, (ethoxymethyl); Ppropane, 1,2-epoxy-3-ethoxy-
CAS Registry Number: 4016-11-9
RTECS$^®$ Number: TZ3200000
UN/NA & ERG Number: UN2752/127
EC Number: 223-671-3
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): No value assigned.
Description: Epoxy ethyloxy propane is a colorless, highly flammable, polymerizable liquid. Molecular weight = 102.15. Flash point = (approx.) 37°C. Mixes with water; may partially decompose.
Potential Exposure: Compound Description: Mutagen. It has limited commercial use in organic synthesis.
Incompatibilities: Polymerizable. Keep away from strong oxidizers, heat, flames.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Epoxy ethyloxy propane can affect you when breathed in and by passing through your skin.
Harmful Effects and Symptoms
Short Term Exposure: Contact can irritate or burn the eyes and skin with possible permanent damage. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs, causing coughing and/or shortness of breath. Very high levels could cause you to feel dizzy, lightheaded, and pass out.
Long Term Exposure: Epoxy ethyloxy propane can cause a skin allergy to develop. Similar very irritating substances can affect the lungs.
Points of Attack: Skin, lungs.
Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Lung function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to epoxy ethyloxy propane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where epoxy ethyloxy propane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and 1,2-epoxy-3-ethoxypropane in Packing Group III.
Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep 1,2-epoxy-3-ethoxypropane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Epoxy Ethyloxy Propane*. Trenton, NJ

Ergocalciferol E:0190

Molecular Formula: $C_{28}H_{44}O$

Synonyms: Activated ergosterol; D-Arthin; Calciferol; Calciferon; Candacaps; Condocaps; Condol; Crtron; Crystallina; Dacitin; Daral; Davitamon D; Decaps; Dee-Osterol; Dee-Ron; Dee-Ronal; Dee-Roual; Deltalin; Deratol; Detalup; Diactol; Ergorone; Ergosterol; Ergosterol, activated; Ertron; 1,2-Ethylidene dichloride; Fortodyl; Geltabs; Hi-Deratol; Infron; Irradiated; Irradiated ergosta-5,7,22, -trien-3-β-ol; Metadee; Mulsiferol; Mykostin; Oleovitamin D; Ostelin; Radiostol; Radsterin; 9,10, Secoergosta-5,7,10(19), 22-tetraen-3-β-ol; Shock-Ferol; Sterogly; Vigantol; Viosterol; Vitamin D2; Vitavel-D

CAS Registry Number: 50-14-6

RTECS® Number: KE1050000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-014-9 [*Annex I Index No.:* 603-179-00-9]

Regulatory Authority and Advisory Bodies

DOT regulated (see 49CFR173.4); small quantity provisions apply.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: Hazard Symbol: T + ; Risk phrases: R24/25; R26; R48/25; Safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ergocalciferol is an odorless white crystalline solid. Molecular weight = 396.72; Freezing/Melting point = 116°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Natural Product (Ergosterol); Reproductive Effector. Used as a nutrient and/or dietary supplement food additive.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 40 mg/m^3

Routes of Entry: Ingestion, inhalation, skin or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 10 mg/kg. Highly toxic. Ergocalciferol in a single acute ingestion presents no toxic hazard. Daily ingestion in excess of 5000 units/day in children or 7500 units/day in adults will produce toxic symptoms associated with hypervitaminosis D. Initial symptoms of ergocalciferol poisoning include anorexia, nausea, and vomiting. It often mimics hyperparathyroidism with thirst, muscular weakness, nervousness, kidney impairment, hypertension, and excessive urination.

Long Term Exposure: Ergocalciferol poisoning disturbs calcium metabolism and causes kidney damage.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Medicine, solid, toxic, n.o.s. requires "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and ergocalciferol in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ergocalciferol*. Washington, DC: Chemical Emergency Preparedness Program

Ergotamine tartrate E:0200

Molecular Formula: $C_{70}H_{76}N_{10}O_{16}$

Common Formula: $C_{66}H_{70}N_{10}O_{10} \cdot C_4H_6O_6$

Synonyms: Ercal; Ergam; Ergate; Ergomar; Ergostat; Ergotamine bitartrate; Ergotartrate; Etin; Exmigra; Femergin; Gotamine tartrate; Gynergen; Lingraine; Lingran; Medihaler ergotamine; Migraine Dolviran; Neo-Ergotin; Rigetamin; Secagyn; Secupan; Tartrato de ergosterol (Spanish)

CAS Registry Number: 379-79-3

RTECS® Number: KE8225000

UN/NA & ERG Number: UN2811 (Toxic solid, organic, n.o.s.)/154; UN1544 (Alkaloids, solid, n.o.s.)/151

EC Number: 206-835-9

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Developmental/Reproductive toxin 4/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ergotamine tartrate is a crystalline solid. Molecular weight = 1313.56; Freezing/Melting point = (decomposes) 203°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = <1 mg/mL at 20°C.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Mutagen; Reproductive Effector. The major uses of the ergot alkaloids fall into two categories: applications in obstetrics and treatment of migraine headaches. May be used in the production of "street" drugs.

Incompatibilities: Light and heat.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 60 mg/m^3

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Has high oral toxicity and acts as a convulsant in humans. People with liver damage are at a greater risk. Nausea and vomiting occur in some patients after oral administration. Weakness in the legs is common and muscle pains in the extremities may occur. Numbness and tingling of the fingers and toes may also occur.

Long Term Exposure: May cause liver damage.

Points of Attack: Liver, nervous system.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Alkaloids, solid, n.o.s. require a label of “POISONOUS/TOXIC MATERIALS.” They fall in Hazard Class 6.1 and ergotamine tartrate in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. Use water vapor to reduce vapors. Absorb spills with sand or other noncombustible absorbent material. *Small dry spills*: with clean shovel, place material into clean, dry container and cover; move containers from spill area. For *large spills*, dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous nitrogen oxide gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ergotamine Tartrate*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 64−65

Estradiol 17b E:0210

Molecular Formula: $C_{18}H_{24}O_2$

Synonyms: Altrad; Bardiol; Dihydroxyestrin; Dihydroxy follicular hormone; Oestra-1,3,5(10)triene-3,17-β-diol; Syndiol

CAS Registry Number: 50-28-2; 57-63-6 (Estradiol, 17-ethynyl-)

RTECS® Number: KG2975000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-023-8; 200-342-2 (Estradiol, 17-ethynyl-)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP: 11th Report on Carcinogens.[10]

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Estradiol, 17-*beta*- is an odorless white to yellow crystalline substance. Molecular weight = 272.42; Boiling point = (decomposes); Freezing/Melting point = 173−179°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: The working environment may be contaminated during sex hormone manufacture, especially during the extraction and purification of natural steroid hormones; grinding of raw materials; handling of powdered products and recrystallization. Airborne particles of sex hormones may be absorbed through the skin, ingested, or inhaled. Enteric absorption results in quick inactivation of sex hormones in the liver. The rate of inactivation is decreased for the oral, alkylated steroid hormones (methyl testosterone, anabolic steroids, etc.). Sex hormones may accumulate and reach relatively high levels even if their absorption is intermittent. Consequently, repeated absorption of small amounts may be detrimental to health. Intoxication by sex hormones may occur in almost all the exposed workers if preventive measures are not taken. The effect in the industrial sector is more successful than the agricultural one (chemical caponizing of cockerels by stilbestrol implants and incorporation of estrogens in feed for body weight gain promotion in beef cattle), where measures taken are summary and the number of cases of intoxication is consequently bigger.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Adverse effects of estrogens in men: Anorrhexia, nausea, vomiting, edema; a feminization syndrome characterized by gynecomastia (uni- or bi-lateral); increased pigmentation of the areollae; tenderness of the nipples, with or without secretion, slight loss of libido with difficulty in erection, with or without involution of the secondary sex organs; and sterility (by inhibition of spermatogenesis), may occur. Urinary estrogens are increased. A differential diagnosis of breast tumors in men occupationally exposed to estrogen is needed. Gynecomastia may occur in cases of functional insufficiency of organs involved in the metabolism of estrogens (chronic liver or kidney diseases) or of increased endogenous estrogen synthesis by neoplastic growths, such as pituitary, adrenal and testicular tumors, or ectopic secretion of gonadotropins or prolactin by lung tumors. Endocrinopathies may be accompanied by gynecomastia. The conversion of androgen into estrogen may explain the occurrence of gynecomastia in the case of gonadotropin or androgen excess in men. Some drugs (spironolactone, digitalis, etc.) may induce gynecomastia. Physiological gynecomastia at birth, puberty, and old age, as well as the possibility of the occurrence of breast cancer in men, should be also considered.

Adverse effects of estrogens in women: Prolonged estrogen therapy has caused malignant endometrial changes in predisposed persons. Endometrial hyperplasia and endometrial carcinoma have also occurred after exposure to diethylstilbestrol. Clear cell adenocarcinoma of the vagina and cervix uteri occurred in young women exposed prenatally to diethylstilbestrol or other nonsteroidal estrogens. Women treated with estrogen may complain of menstrual disorders, nausea, headaches, etc. Similar effects were observed during occupational exposure to natural or synthetic estrogens and oral contraceptives. Menstrual disorders were frequent. Menorrhagia occurred in women workers with endometrial hyperplasia. In menopausal women, diethylstilbestrol may produce abnormal uterine bleeding, which often leads to suspicion of cancer of the uterine body. Manifestations like metrorrhagia, nausea, and headache usually disappear after discontinuance of exposure. Excess of progesterone may be responsible for weight gain, acne, mastalgia, breast enlargement, and recurrent monilial virginities. Toxicity may also include headache, nausea, chloasma, breakthrough bleeding, weight gain, loss of libido, cholestatic liver damage; sterility may also occur.

Medical Surveillance: Persons directly involved in the hazardous sectors of manufacture should be examined every 2 weeks. Persons engaged in the pharmaceutical stage of manufacture should be examined monthly. The frequency of the physical examination of the employees should increase with the age of the worker. Feminization in men, masculinization or menstrual disorders in women, changes in certain metabolic parameters, and other symptoms detrimental to health are indications for changing the workplace. Before admission of a new employee, a very careful health examination will serve to exclude persons at risk, namely women of childbearing age, epileptics (steroid hormones may increase the frequency of seizures by changes in fluid retention), and persons with hepatic insufficiency.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Adequate preventive measures, taken in the pharmaceutical industry, have succeeded in eliminating the occurrence of intoxications almost completely. The air polluting processes are isolated in areas having adequate exhaust facilities and hermetically sealed machines. The isolated areas are entered only by workers wearing special clothing including underwear, stockings, long-sleeved overalls (with no pockets) buttoned to the neck and with ties at the bottom of the trousers for tying over the boots, rubber gloves, head cover, and dust respirators. Air-supplied vinyl suits may be used by the groups at highest risk. When workers leave the polluted area they should undress, take a shower, wash their hair, clean their nails, and put on their own clothes if the working day is over. Workers indirectly exposed to hormonal dust (i.e., mechanics who change the filters in the ventilation system) must also be provided with adequate protective equipment. The contaminated work clothing should be thoroughly cleaned. Disposable paper garments can be burned. Gloves should be rinsed with acetone or methanol, then washed and dried. Respiratory protection equipment should also be cleaned before reuse. Workrooms must be kept very clean. An alkaline detergent has been found to be most suitable for washing clothes and wiping surfaces. Mixers, stirring rods, spatulas, glassware, dishes, etc. should be rinsed after use with acetone or methanol in a hood or near a vacuum and then washed in the conventional manner. Methanol should be used on plastic items. It is important to inform workers of the risk represented by the workplace and to win their cooperation in lowering of occupational exposure; for example, not putting on rubber gloves after having worked barehanded; not rubbing the face or nose with contaminated gloves; not contaminating the inside of respirators by leaving them exposed to processing dust; not using outside the work area items which have been inside it (cigarettes, pipes, handkerchiefs); and being alert to detect deficiencies in preventive measures. In some pharmaceutical companies, the workers alternate 1 week in the polluted areas with 2 weeks in another place of work. In other companies rotation is carried out only when signs of intoxication occur. If women are employed, the alternating work environment should respect their cyclic hormonal pattern. Workers who develop symptoms of chronic intoxication in the presence of a low concentration of hormones in the air must be FORBIDDEN to return to the polluted area. The effectiveness of preventive measures should be checked by analyses of the amount of hormonal compounds in the air of the working environment, and in the plasma of the employees, and by clinical examinations. The fact that cases of chronic intoxication may occur in spite of considerable efforts to minimize occupational exposure to sex hormones suggests the need for a closed system of the entire production process.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and estradiol in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 59−60

Parmeggiani, L. (Ed.). (1983). *Encyclopedia of Occupational Health & Safety* (3rd ed., Vol. 1, pp. 1049−1052). Geneva: International Labour Office

Estrone E:0220

Molecular Formula: $C_{18}H_{22}O_2$

Synonyms: Follicular hormone; 3-Hydroxyestra-1,3, 5(10)-trien-17-one; 3-Hydroxy-17-keto-estra-1,3,5-triene; 3-Hydroxy-17-ketoestra-1,3,5-triene; 3-Hydroxy-1,3, 5(10)-oestratrien-17-one; 3-Hydroxy-oestra-1,3,5(10)-trien-17-one

CAS Registry Number: 53-16-7

RTECS® Number: KG8575000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-164-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP: 11th Report on Carcinogens.[10]

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Estrone is an odorless white crystalline powder. Molecular weight = 270.40; Freezing/Melting point = 258−262°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Synthesized from ergosterol. See corresponding section in entry on estradiol 17b.

Permissible Exposure Limits in Air

No standards or TEEL available.

Note: An industrial guideline of 0.05 μg airborne (estrogen dust)/m^3 TWA (8-h work-day) was adopted at one manufacturing company.

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Adverse effects of estrogens in men: Anorrhexia, nausea, vomiting, edema; a feminization syndrome characterized by gynecomastia (uni- or bi-lateral); increased pigmentation of the areollae; tenderness of the nipples, with or without secretion; slight loss of libido with difficulty in erection, with or without involution of the secondary sex organs; and sterility (by inhibition of spermatogenesis) may occur. Urinary estrogens are increased. A differential diagnosis of breast tumors in men occupationally exposed to estrogen is needed. Gynecomastia may occur in cases of functional insufficiency of organs involved in the metabolism of estrogens (chronic liver or kidney diseases) or of increased endogenous estrogen synthesis by neoplastic growths, such as pituitary, adrenal and testicular tumors, or ectopic secretion of gonadotropins or prolactin by lung tumors. Endocrinopathies may be accompanied by gynecomastia. The conversion of androgen into estrogen may explain the occurrence of gynecomastia in the case of gonadotropin or androgen excess in men. Some drugs (spironolactone, digitalis, etc.) may induce gynecomastia. Physiological gynecomastia at birth, puberty, and old age, as well as the possibility of the occurrence of breast cancer in men, should be also considered.

Adverse effects of estrogens in women: Prolonged estrogen therapy has caused malignant endometrial changes in predisposed persons. Endometrial hyperplasia and endometrial carcinoma have also occurred after exposure to diethylstilbestrol. Clear cell adenocarcinoma of the vagina and cervix uteri occurred in young women exposed prenatally to diethylstilbestrol or other nonsteroidal estrogens. Women treated with estrogen may complain of menstrual disorders, nausea, headaches, etc. Similar effects were observed during occupational exposure to natural or synthetic estrogens and oral contraceptives. Menstrual disorders were frequent. Metrorrhagia was observed in women who started to work. Menorrhagia occurred in women workers with endometrial hyperplasia. In menopausal women, diethylstilbestrol may produce abnormal uterine bleeding, which often leads to suspicion of cancer of the uterine body. Manifestations like metrorrhagia, nausea, and headache, usually disappear after discontinuance of exposure. Excess of progesterone may be responsible for weight gain, acne, mastalgia, breast enlargement, and recurrent monilial virginities. Toxicity may also include headache, nausea, chloasma, breakthrough bleeding, weight gain, loss of libido, cholestatic liver damage, sterility may also occur.

Long Term Exposure: Confirmed carcinogen.

Medical Surveillance: Persons directly involved in the hazardous sectors of manufacture should be examined every 2 weeks. Persons engaged in the pharmaceutical stage of manufacture should be examined monthly. The frequency of the physical examination of the employees should increase with the age of the worker. Feminization in men, masculinization or menstrual disorders in women, changes in certain metabolic parameters, and other symptoms detrimental to health are indications for changing the workplace. Before admission of a new employee, a very careful health examination will serve to exclude persons at risk, namely women of childbearing age, epileptics (steroid hormones may increase the frequency of seizures by changes in fluid retention), and persons with hepatic insufficiency.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Adequate preventive measures, taken in the pharmaceutical industry, have succeeded in eliminating the occurrence of intoxications almost completely. The air-polluting processes are isolated in areas having adequate exhaust facilities and hermetically sealed machines. The isolated areas are entered only by workers wearing special clothing including underwear, socks, long-sleeved overalls (with no pockets) buttoned to the neck and with ties at the bottom of the trousers for tying over the boots, rubber gloves, head cover, and dust respirators. Air-supplied vinyl suits may be used by the groups at highest risk. When workers leave the polluted area they should undress, take a shower, wash their hair, clean their nails, and put on their own clothes if the working day is over. Workers indirectly exposed to hormonal dust (i.e., mechanics who change the filters in the ventilation system) must also be provided with adequate protective equipment. The contaminated work clothing should be thoroughly cleaned. Disposable paper garments can be burned. Gloves should be rinsed with acetone or methanol, then washed and dried. Respiratory protection equipment should also be cleaned before reuse. Workrooms must be kept very clean. An alkaline detergent has been found to be most suitable for washing clothes and wiping surfaces. Mixers, stirring rods, spatulas, glassware, dishes, etc. should be rinsed after use with acetone or methanol in a hood or near a vacuum and then washed in the conventional manner. Methanol should be used on plastic items.

It is important to inform workers of the risk represented by the workplace and to win their cooperation in lowering of occupational exposure; for example, not putting on rubber gloves after having worked barehanded; not rubbing the face or nose with contaminated gloves; not contaminating the inside of respirators by leaving them exposed to processing dust; not using outside the work area items which have been inside it (cigarettes, pipes, handkerchiefs); and being alert to detect deficiencies in preventive measures. In some pharmaceutical companies, the workers alternate 1 week in the polluted areas with 2 weeks in another place of work. In other companies, rotation is carried out only when signs of intoxication occur. If women are employed, the alternating work environment should respect their cyclic hormonal pattern. Workers who develop symptoms of chronic intoxication in the presence of a low concentration of hormones in the air must be FORBIDDEN to return to the polluted area. The effectiveness of preventive measures should be checked by analyses of the amount of hormonal compounds in the air of the working environment, and in the plasma of the employees, and by clinical examinations. The fact that cases of chronic intoxication may occur in spite of considerable efforts to minimize occupational exposure to sex hormones suggests the need for a closed system of the entire production process.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and estrone in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 63−64

Parmeggiani, L. (Ed.). (1983). *Encyclopedia of Occupational Health & Safety* (3rd ed., Vol. 1, pp. 1049−1052). Geneva: International Labour Office

Ethane E:0230

Molecular Formula: C_2H_6

Synonyms: Bimethyl; Dimethyl; Etano (Spanish); Ethyl hydride; Methylmethane

CAS Registry Number: 74-84-0

RTECS® Number: KH3800000

UN/NA & ERG Number: UN1035 (compressed gas)/115; UN1961 (refrigerated liquid)/115

EC Number: 200-814-8 [*Annex I Index No.:* 601-002-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Ethane is a compressed, liquefied, colorless gas with a mild, gasoline-like odor. Odorless when pure. Odor threshold = 899 ppm. Molecular weight = 30.08; Boiling point = −89°C; Freezing/Melting point = −183°C; Flash point = flammable gas; Autoignition temperature = 472°C. Explosive limits: LEL = 3.0%; UEL = 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water. An aliphatic hydrocarbon gas (C_1-C_4).

Potential Exposure: Ethane is used as a fuel, in making chemicals, or as a freezing agent. The health effects caused by ethane exposure are much less serious than the fire and explosion risk posed by this chemical.

Incompatibilities: Flammable gas; forms explosive mixture with air. Strong oxidizers may cause fire and explosions. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: Simple asphyxiant (Shipyards, Construction).

ACGIH TLV®[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1-C_4).

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 5000 ppm

PAC-3: 25,000 ppm

Australia: Asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 10000 ppm (12500 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can cause headache, dizziness, and make you feel lightheaded. Very high levels can cause suffocation from lack of oxygen. Contact with liquid ethane can cause frostbite. Ethane is highly flammable. It is a dangerous fire hazard.

Long Term Exposure: Chronic health effects are unknown at this time.

First Aid: Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Wear gas-proof goggles unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Chemical cartridge respirators should not be used where ethane exposure occurs. For high exposures use air-supplied respirators. Exposure to ethane is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in the positive-pressure mode should be used in oxygen deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where ethane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of ethane. Wherever ethane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Ethane requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1 and there is no Packing Group.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ethane is a flammable gas. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Ethane*. Trenton, NJ

Ethanolamines E:0240

Molecular Formula: C_2H_7NO; $C_4H_{11}NO$; $C_6H_{15}NO_3$

Common Formula: $H_2NCH_2CH_2OH$; $HN(CH_2CH_2OH)_2$; $N(CH_2CH_2OH)_3$

Synonyms: *monoethanolamine:* 2-Aminoethanol; β-Aminoethyl alcohol; Colamine; Ethylolamine; 2-Hydroxyethylamine; MEA; Monoethanolamine

diethanolamine: see separate entry D:0770.

triethanolamine: Daltogen; 2,2′,2″-Nitrilo-triethanol; TEA; Thiofaco T-35; Triethylolamine; Tri(2-hydroxyethyl)amine; Tri(hydroxytriethyl)amine; Tris(hydroxyethyl)amine; Trolamine

CAS Registry Number: 141-43-5 *(mono-)*; 111-42-2 (*di-*); 102-71-6 (*tri-* or 2,2′,2″-)

RTECS® Number: KJ5775000 *(mono-)*; KL9275000 (*tri-*)

UN/NA & ERG Number: UN2491/153

EC Number: 205-483-3 [*Annex I Index No.:* 603-030-00-8] (*mono-* or *2-*); 203-868-0 [*Annex I Index No.:* 603-071-00-1] (*di-* or 2,2′-); 203-049-8 (*tri-* or *2,2′,2″-*)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 220 (≥80.00% concentration) (*triethanolamine*).

Carcinogenicity: *(tri-)* IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI (*tri-*): Carcinogenesis Studies (derm); equivocal evidence: rat; inadequate study: mouse; on test (2 year studies), October 2000.

US EPA, FIFRA1998 Status of Pesticides (*tri-*): Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section (*di-*).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) (*di-*).

Reportable Quantity (RQ): 1 lb (0.454 kg) (*di-*).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (*di-*).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, all isomers.

FDA—over-the-counter drug (*tri-*).

European/International Regulations: Hazard Symbol: C; Risk phrases: R 20/21/22; R34; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*all isomers*).

Description: Ethanolamines can be detected by odor as low as 2−3 ppm. *Monoethanolamine* is a colorless, viscous liquid or solid (below 111°C) with an unpleasant, ammonia-like odor. Molecular weight = 61.10; Boiling point = 170.6°C; Freezing/Melting point = 10.6°C; Vapor pressure = 0.4 mmHg at 20°C; Flash point = 85°C (cc); Autoignition temperature = 410°C. Explosive limits: LEL = 3.0% (at 140°C); UEL = 23.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water. *Triethanolamine* has only a faint nonammonia odor. Molecular weight = 149.22; Boiling point = 343°C; Freezing/Melting point = 21°C; Flash point = 179°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Soluble in water. All three compounds are water-soluble liquids.

Potential Exposure: Compound Description (*mono-*): Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant; (*tri-*) Agricultural Chemical; Tumorigen, Mutagen, Primary Irritant. *Monoethanolamine* is widely used in industry for scrubbing acid gases and in production of detergents and alkanolamide surfactants; to remove carbon dioxide and hydrogen from natural gas; to remove hydrogen sulfide and carbonyl sulfide; as an alkaline conditioning agent; as an intermediate for soaps, detergents, dyes, and textile agents. *Diethanolamine* is an absorbent for gases, a solubilizer for 2,4-dichlorophenoxyacetic acid (2,4-D), and a softener and emulsifier intermediate for detergents. It also finds use in the dye and textile industry. *Triethanolamine* is used as plasticizers, neutralizer for alkaline dispersions; lubricant additive; corrosion inhibitor; and in the manufacture of soaps, detergents, shampoos, shaving preparations, face and hand creams, cements, cutting oils, insecticides, surface active agents, waxes, polishes, and herbicides.

Incompatibilities: *Monoethanolamine:* This chemical is a medium strong base. Reacts violently with strong oxidizers, acetic acid, acetic anhydride, acrolein, acrylic acid, acrylonitrile, cellulose nitrate, chlorosulfonic acid, epichlorohydrin, hydrochloric acid, hydrogen fluoride, mesityl oxide, nitric acid, oleum, sulfuric acid, β-propiolactone, vinyl acetate. Reacts with iron. May attack copper, aluminum and their alloys, and rubber. *di-isomer*: Oxidizers, strong acids, acid anhydrides, halides. Reacts with CO_2 in the air. Hygroscopic (i.e., absorbs moisture from the air). Corrosive to copper, zinc, and galvanized iron (di-). The aqueous solution is a medium strong base. Attacks copper, zinc, aluminum, and their alloys.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.50 mg/m^3 at 25°C & 1 atm.

Monoethanolamine 141-43-5

OSHA PEL: 3 ppm/6 mg/m^3 TWA.

NIOSH REL: 3 ppm/8 mg/m^3 TWA; 6 ppm/15 mg/m^3 STEL.

ACGIH TLV®[1]: 3 ppm/7.5 mg/m^3 TWA; 6 ppm/15 mg/m^3 STEL.

DFG MAK: 2 ppm/5.1 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C, *as 2-aminoethanol*.

NIOSH IDLH: 30 ppm.

Protective Action Criteria (PAC)

141-43-5

TEEL-0: 3 ppm

PAC-1: 6 ppm

PAC-2: 20 ppm

PAC-3: 30 ppm

Arab Republic of Egypt: TWA 3 ppm (6 mg/m^3), 1993; Australia: TWA 3 ppm (8 mg/m^3); STEL 6 ppm, 1993; Austria: MAK 3 ppm (8 mg/m^3), 1999; Belgium: TWA 3 ppm (7.5 mg/m^3); STEL 6 ppm (15 mg/m^3), 1993; Denmark: TWA 3 ppm (6 mg/m^3), 1999; Finland: TWA 3 ppm (7.5 mg/m^3); STEL 6 ppm (15 mg/m^3), 1999; France: VME 3 ppm (8 mg/m^3), 1999; the Netherlands: MAC-TGG 2.5 mg/m^3, [skin], 2003; Norway: TWA 3 ppm (8 mg/m^3), 1999; the Philippines: TWA 3 ppm (6 mg/m^3), 1993; Poland: TWA 3 mg/m^3; STEL 10 mg/m^3, 1999; Russia: TWA 3 ppm; STEL 0.5 mg/m^3, [skin], 1993; Sweden: TWA 3 ppm (8 mg/m^3); STEL 6 ppm (15 mg/m^3), [skin], 1999; Switzerland: TWA 3 ppm (8 mg/m^3); STEL 6 ppm (15 mg/m^3), [skin], 1999; United Kingdom: TWA 3 ppm (7.6 mg/m^3); STEL 5 ppm (15 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 6 ppm.

Triethanolamine 102-71-6

ACGIH TLV®[1]: 5 ppm TWA.

DFG MAK: 5 ppm, inhalable fraction TWA; Peak Limitation Category I(4); Pregnancy Risk Group D.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 250 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Denmark: TWA 0.5 ppm (3.1 mg/m^3), 1999; Sweden: NGV 5 mg/m^3, KTV 10 mg/m^3 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003.

Diethanolamine 111-42-2

Several states have set guidelines or standards for diethanolamine in ambient air[60] ranging from 150 μg/m^3 (North Dakota) to 250 μg/m^3 (Virginia) to 300 μg/m^3 (Connecticut) to 357 μg/m^3 (Nevada). A large number of states have set guidelines or standards for monoethanolamine in ambient air[60] ranging from 19.048 μg/m^3 (Kansas) to 26.7 μg/m^3 (New York) to 80.0 μg/m^3 (Florida) to 80.0−150.0 μg/m^3 (North Dakota) to 120 μg/m^3 (Connecticut) to 130.0 μg/m^3 (Virginia) to 190.0 μg/m^3 (Nevada) to 200.0 μg/m^3 (South Carolina).

Determination in Air: *Monoethanolamine*: Use NIOSH Analytical Method: Aminoethanol compounds I: 2007; or OSHA Analytical Method PV-2111.

Permissible Concentration in Water: EPA[32] has suggested permissible ambient limits of 83 μg/L. Russia[43] has set a MAC value of 0.8 mg/L in water bodies used for domestic purposes for diethanolamine and 1.4 mg/L for triethanolamine but no MAC for monoethanolamine.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = -1.3$.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion and skin and/or eye contact.

Harmful Effects and Symptoms

The LD_{50} oral-rat for the isomers is as follows: *mono*-2,050 mg/kg (slightly toxic); *di*-710 mg/kg (slightly toxic); *tri*-8000 mg/kg (insignificantly toxic). All three compounds cause irritation to nose, throat, and lungs upon inhalation. Skin contact causes irritation, stinging, and burns. Eye contact can cause severe irritation. Ingestion can cause nausea and intestinal irritation. Fatal doses are estimated by NY State to be 6 g of monoethanolamine for a 150-lb man.

Short Term Exposure: *Mono-isomer:* Corrosive to the eyes and irritates the skin and respiratory tract. Inhalation may cause asthmatic reactions. May affect central nervous system and may cause unconsciousness. *Di-isomer:* Corrosive to the eyes. Irritates the eyes, skin, respiratory tract.

Long Term Exposure: *Mono-isomer:* Repeated or prolonged contact with skin may cause dermatitis and ulceration and lungs may be affected. May affect the central nervous system, kidneys, liver, and blood, causing asthenia, hematological changes, and tissue lesions. *di-isomer:* May affect the kidneys and liver.

Points of Attack: Eyes, skin, respiratory system, central nervous system

Medical Surveillance: With monoethanolamine, if symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

With diethanolamine: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Skin testing with dilute diethanolamine may help diagnose allergy if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. **8 h:** Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Tychem 1000™ suits; **4 h:** polyvinyl chloride gloves, suits, boots. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Monoethanolamine: Up to 30 ppm:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethanolamine must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) and strong acids (such as hydrochloric, sulfuric, and nitric acids) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethanolamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of “CORROSIVE.” It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound

increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Ethanolamine*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Diethanolamine*. Trenton, NJ

Ethinylestradiol E:0250

Molecular Formula: $C_{20}H_{24}O_2$

Synonyms: 3,17-β-Dihydroxy-17-α-ethynyl-1,3,5(10)-estratriene; 3,17-β-Dihydroxy-17-α-ethynyl-1,3,5(10)-oestratriene; Estrogen; 17-α-Ethinyl-3,17-dihydroxy-d1,3,5-estratriene; 17-α-Ethinyl-3,17-dihydroxy-d1,3,5-oestratriene; 17-α-Ethinyl-17-β-estradiol; 17-α-Ethinylestradiol; 17-Ethinyl-3,17-estradiol; 17-Ethinylestradiol; 17-α-Ethinylestra-1,3,5(10)-triene-3,17-β-diol; Ethinylestriol; 17-Ethinyl-3,17-oestradiol; Ethinyloestradiol; Ethinyl-oestranol; 17-α-Ethinyl-d1,3,5(10) oestratriene-3,17-β-diol; 17-α-Ethinyloestra-1,3,5(10)-triene-3,17-β-diol; Ethinyloestriol; 17-Ethynyl-3,17-dihydroxy-1,3,5-oestratriene; 17-α-Ethynylestradiol; 17-α-Ethynylestradiol-17-b; Ethynylestradiol; 17-α-Ethynyl-1,3,5(10)-estratriene-3,17-β-diol; 17-α-Ethynylestra-1,3,5(10)-triene-3,17-β-diol; 17-α-Ethynyl-17-β-oestradiol; 17-α-Ethynyloestradiol; 17-α-Ethynyloestradiol-17-b; 17-Ethynyloestradiol; Ethynyloestradiol; 17-α-Ethynyl-1,3,5(10)-oestratriene-3,17-β-diol; 17-α-Ethynyl-1,3,5-oestratriene-3,17-β-diol; 17-α- Ethynyl-oestra-1,3,5(10)-triene-3,17-β-diol; 17-Ethynyloestra-1,3,5 (10)-triene-3,17-β-diol; (17-a)-19-Norpregna-1,3,5(10)-trien-20-yne-3,17, diol; 19-Nor-17-α-pregna-1,3,5(10)-trien-2-yne-3,17-diol

CAS Registry Number: 57-63-6

RTECS® Number: RC8925000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-342-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP: 11th Report on Carcinogens.[10]

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 1/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethinylestradiol is a white to creamy-white odorless powder. Molecular weight = 296.44; Freezing/Melting point = 142−146°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: Used in medicine as an estrogenic hormone and as an oral contraceptive.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Nausea, vomiting, abdominal cramps, bloating, cholasma, cholestatic jaundice, skin eruptions, loss of scalp hair, hirsutism, changes in menstrual flow, headache, migraine, dizziness, mental depression, increase or decrease in weight, edema, changes in libido, and breast enlargement.

Long Term Exposure: A confirmed carcinogen. May have teratogenic effects and reproductive effects. Human mutation data reported.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from exposure to light.

Shipping: Medicine, solid, toxic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and estrogen in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with 60−70% ethanol. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Ethion E:0260

Molecular Formula: $C_9H_{22}O_4P_2S_4$

Synonyms: AC 3422; Bis[S-(diethoxy-phosphinothioyl) mercapto]methane; Bis (dithiophosphatede *O*,*O*-diethyle) de *S*,*S*′-methylene (French); Bladan; Diethion; Embathion; ENT 24,105; Ethanox; Ethiol; Ethodan; Ethyl methylene phosphorodithioate; Etion (Spanish); FMC-1240; Fosfono 50; Hylemox; Itopaz; Kwit; Methanedithiol, *S*,*S*-diester with *O*,*O*-diethyl phosphorodithioate acid; Methylene-*S*,*S*′-bis(*O*,*O*-diaethyl-dithiophosphat) (German); a,*S*′-Methylene *O*,*O*,*O*′,*O*′-tetraethyl ester phosphorodithioic acid; *S*,*S*′-Methylene *O*,*O*,*O*′,*O*′-tetraethyl phosphorodithioate; NIA 1240; Niagara 1240; Nialate; Phosphorodithioic acid, *O*,*O*-diethyl ester, *S*,*S*-diester with methanedithiol; Phosphotox E; Rhodiacide; Rhodocide; Rodocid; RP 8167; Soprathion; STCC 4921565; *O*,*O*,*O*′,*O*′-Tetraaethyl-bis(dithiophosphat) (German); *O*,*O*,*O*′,*O*′-Tetraethyl *S*,*S*′-methylenebis(dithiophosphate); *O*,*O*,*O*′,*O*′-Tetraethyl *S*,*S*′-methylenebisphosphordithioate; Tetraethyl *S*,*S*′-methylene bis (phosphorothiolothionate); *O*,*O*,*O*′,*O*′-Tetraethyl *S*,*S*′-methylene di(phosphorodithioate); Vegfru Fosmite; Vegfrufosmite

CAS Registry Number: 563-12-2

RTECS® Number: TE4550000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 209-242-3 [*Annex I Index No.:* 015-047-00-2]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test Negative: *In vitro* UDS—human fibroblast; TRP reversion Negative: *S. cerevisiae*—homozygosis Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R25; R50/53; Safety phrases: S1/2; S25; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethion is a colorless to amber-colored, odorless liquid. The technical product has a very disagreeable odor; Freezing/Melting point = −13 to −12°C. Molecular weight = 384.49; Boiling point = 164°C; Vapor pressure = 0.0000015 mmHg at 20°C; Flash point = 176°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.0001%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Human Data. Those involved in the manufacture, formulation, and application of this insecticide and acaricide. Ethion is a preharvest topical insecticide used primarily on citrus fruits, deciduous fruits, nuts, and cotton. It is also used as a cattle dip for ticks and as a treatment for buffalo flies.

Incompatibilities: Incompatible with alkaline formulations and strong acids. Decomposes violently when heated above 150°C. Mixtures with magnesium may be explosive. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.4 mg/m^3 [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued as Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 13 mg/m^3

PAC-3: 350 mg/m^3

Australia: TWA 0.4 mg/m^3, [skin], 1993; Belgium: TWA 0.4 mg/m^3, [skin], 1993; Denmark: TWA 0.4 mg/m^3, [skin], 1999; France: VME 0.4 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.4 mg/m^3, [skin], 2003; Switzerland: MAK-W 0.4 mg/m^3, [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for Ethion in ambient air[60] ranging from 4.0 $\mu g/m^3$ (North Dakota) to 6.0 μ/m^3 (Connecticut) to 9.0 $\mu g/m^3$ (Nevada).

Determination in Air: Use NIOSH (IV), Method #5600, Organophosphorus Pesticide.

Permissible Concentration in Water: California[61] has set a guideline for Ethion in drinking water of 35 μg/L.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 5.073.

Harmful Effects and Symptoms

Symptoms may include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, weakness, muscle twitching, difficult breathing, blurring or dimness of vision, and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. This material is very toxic; the probable oral lethal dose for humans is 50−500 mg/kg, which is between 1 teaspoonful and 1 oz for a 150-lb person.

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Exposure may cause unconsciousness and death. The effects may be delayed and medical observation is recommended.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Ethion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **4 h:** Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or wear dust-proof goggles when working with powders or dusts unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.4 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline material, strong acids, and other incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and ethion in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts can be burned with alkali.[22] For larger amounts, the suggested method is incineration with added solvent in furnace equipped with afterburner and alkali scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (April 30, 1980). *S, S′-Methylene-O,O,O′,O′-Tetraethyl Phosphorodithioate: Health and Environmental Effects Profile No. 127*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 69−74 (1984) and 7, No. 1, 9−37 (1987)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethion*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Ethion*. Trenton, NJ

Ethoprophos E:0270

Molecular Formula: $C_8H_{19}O_2PS_2$

Synonyms: AI3-27318; Caswell No.434C; ENT 27,318; EPA pesticide chemical code 041101; Ethoprop (ANSI); *O*-Ethyl *S,S*-dipropyl dithiophosphate; *O*-Ethyl *S,S*-dipropyl phosphorodithioate; Jolt; Mobil V-C 9-104; Mocap; Mocap 10G; Phosethoprop; Phosphorodithioic acid, *O*-ethyl *S,S*-dipropyl ester; V-C 9-104; V-C Chemical V-C 9-104; Virginia-Carolina VC 9-104

CAS Registry Number: 13194-48-4

RTECS® Number: TE4025000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 236-152-1[*Annex I Index No.*: 015-107-00-8]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Malaysia, Philippines) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical as organophosphates.

California Proposition 65 Chemical: Cancer 2/27/01.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R25; R26/27; R43; R50/53; Safety phrases: S1/2; S27/28; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethoprophos is a pale yellow liquid. Molecular weight = 242.36; Boiling point = 88°C at 0.2 mmHg; Vapor pressure = 0.0004 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this nematocide and soil insecticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 26 mg/m^3

PAC-3: 26 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 0.47783000 ppb (EXTRA HIGH).

Determination in Soil: Soil Adsorption Index (K_{oc}) = 70.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms are similar to parathion and may include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, weakness, muscle twitching, difficult breathing, blurring or dimness of vision, and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. Human Tox = 12.45550 ppb (INTERMEDIATE). It is a cholinesterase inhibitor which affects the nervous system.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and ethoprop in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including phosphorus oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 85−88

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethoprophos*. Washington, DC: Chemical Emergency Preparedness Program

2-Ethoxyethanol E:0280

Molecular Formula: $C_4H_{10}O_2$

Common Formula: $C_2H_5OCH_2CH_2OH$

Synonyms: Athylenglykol-monoathylather (German); Cellosolve; Cellosolve solvent; DAG 154; Developer 1002; Dowanol E; Dowanol EE; Dynasolve MP-500; Dynasolve MP aluminium grade; 2EE; Ektasolve EE; Emkanol; Ethanol, 2-ethoxy-; Ether monoethylique de l'ethylene glycol (French); β-Ethoxyethanol; 2-Ethoxyethyl alcohol; Ethyl cellosolve; Ethylene glycol ethyl ether; Ethylene glycol monoethyl ether; 2-Etoxietanol (Spanish); Glycol ethyl ether; Glycol monoethyl ether; Hydroxy ether; Jeffersol EE; Justrite thinner and cleaner; NCI-C54853; Oxitol; Poly-Solv E; Poly-Solv EE; Pyralin PI 2563; Ultramac 55

CAS Registry Number: 110-80-5; *(alt.)* 96231-36-6

RTECS® Number: KK8050000

UN/NA & ERG Number: UN1171/127

EC Number: 203-804-1[*Annex I Index No.*: 603-012-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U359.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9072.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Developmental/Reproductive toxin (male) 1/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; R10; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 2-Ethoxyethanol is a colorless, viscous liquid with a sweetish odor. Odor threshold = 2.7 ppm. Molecular weight = 90.12; Boiling point = 135°C; Freezing/Melting point = −90°C; Vapor pressure = 4 mmHg at 20°C; Flash point = 43.3°C; Autoignition temperature = 235°C. Explosive limits: LEL = 1.7% at 93°C; UEL = 15.6% at 93°C. Hazard

Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. This material is used as a solvent for nitrocellulose and alkyd resins in lacquers; as a solvent for printing inks; in dyeing leathers and textiles; in the formulation of cleaners and varnish removers; as an anti-icing additive in brake fluids and auto and aviation fuels.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings. Able to form peroxides. Incompatible with strong acids, aluminum and its alloys.

Permissible Exposure Limits in Air

OSHA PEL: 200 ppm/740 mg/m^3 TWA [skin].

NIOSH REL: 0.5 ppm/1.8 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/18 mg/m^3 TWA [skin]; BEI: 100 mg [2-ethoxyacetic acid]/g creatinine in urine at end-of-work-week.

NIOSH IDLH: 500 ppm.

Temporary Emergency Exposure Limits (DOE).

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 5 ppm

PAC-3: 500 ppm

DFG MAK: 5 ppm/19 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; BAT: 50 mg [Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long term); Pregnancy Risk Group B.

Australia: TWA 5 ppm (19 mg/m^3), [skin], 1993; Austria: MAK 20 ppm (75 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (18 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (18.5 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (185 mg/m^3); STEL 100 ppm (370 mg/m^3), [skin], 1999; France: VME 5 ppm (19 mg/m^3), [skin], 1999; Hungary: TWA 70 mg/m^3; STEL 140 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 19 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (18 mg/m^3), 1999; the Philippines: TWA 200 ppm (740 mg/m^3), [skin], 1993; Poland: MAC (TWA) 20 mg/m^3, MAC (STEL) 80 mg/m^3, 1999; Russia: TWA 5 ppm; STEL 5 mg/m^3, 1993; Sweden: NGV 5 ppm (19 mg/m^3), KTV 10 ppm (40 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (19 mg/m^3), KZG-W 10 ppm (38 mg/m^3), [skin], 1999; Turkey: TWA 200 ppm (740 mg/m^3), 1993; United Kingdom: TWA 10 ppm (37 mg/m^3), [skin], 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm [skin]. Finally, Russia[43] set a MAC of 0.7 mg/m^3 in ambient air in residential areas on a once daily basis.[35] Several states have set guidelines or standards for ethoxyethanol in ambient air[60] ranging from 120−190 μ/m^3 (North Carolina) to 180 μg/m^3 (Florida and New York) to 190 μg/m^3 (North Dakota) to 320 μg/m^3 (Virginia) to 380 μg/m^3 (Connecticut) to 452 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1403, alcohols IV or OSHA Analytical Methods 53 or 79.

Permissible Concentration in Water: Russia set a MAC of 1.0 mg/L in surface water.

Determination in Water: No tests listed. Octanol−water coefficient: Log $K_{ow} = -0.5$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: 2-Ethoxyethanol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. High levels may cause headache, drowsiness, dizziness, lightheadedness, and even passing out. Exposure may cause central nervous system depression, liver and kidney damage. LD_{50} = (oral-rat) 2125 mg/kg (slightly toxic). Medical observation is recommended.

Long Term Exposure: 2-Ethoxyethanol should be handled as a teratogen—with extreme caution. It may damage the testes, resulting in decreased fertility. Exposure may affect blood cells, causing a low blood count (anemia) and lesions of blood cells. Prolonged or repeated contact defats the skin. May cause liver and kidney damage.

Points of Attack: Eyes, respiratory system, blood, kidneys, liver, reproductive system, hematopoietic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: complete blood count. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Liver function tests. NIOSH lists the following test: urine (chemical/metabolite) End-of-shift at end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim under medical observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** Saranex™ coated suits; Responder™ suits; **4 h:** 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 5 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 25 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Ethoxyethanol must be stored to avoid contact with strong oxidizers, such as nitrates, permanganates, chlorine, bromine, or chlorine dioxide, since violent reactions occur. Store in tightly closed containers in a dark, cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 2-ethoxyethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Keep in dark because of possible formation of explosive peroxides.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (May 2, 1983). *Glycol Ethers: 2-Methoxyethanol and 2-Ethoxyethanol*, Current Intelligence Bulletin No. 39. Cincinnati, OH

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: 2-Ethoxyethanol*. Trenton, NJ

2-Ethoxyethyl acetate E:0290

Molecular Formula: $C_6H_{12}O_3$

Common Formula: $C_2H_5OCH_2CH_2OCOCH_3$

Synonyms: Acetato de 2-etoxietilo (Spanish); Acetic acid, 2-ethoxyethyl ester; 1-Acetoxy-2-ethoxyethane; Aristoline (+); AZ 1310-SF(+); AZ 1312-SFD(+); AZ 1318-SFD(+); AZ 1350J(+); AZ 1370(+); AZ 1370-SF(+); AZ 1375(+); AZ 1470(+); AZ 4140(+); AZ 4210(+); AZ 4330(+); AZ 4620(+); AZ protective coating; AZ thinner; Cellosolve acetate; EE acetate; EGEEA; EGMEA; Ethanol, 2-ethoxy-, acetate; Ethoxyethanol acetate; β-Ethoxyethyl acetate; Ethoxyethyl acetate; Ethyl cellosolve acetate; Ethylene glycol acetate monoethyl ether; Ethylene glycol ethyl ether acetate; Ethylene glycol monoethyl ether acetate; Ethylene glycol monoethyl ether monoacetate; Ethyloxitol acetate; Glycol monoethyl ether acetate; H.M.D.S. III; Hydroxy ether; Kodak MX-936; Kodak photoresist developer; KTI 1300 thinner; KTI 1350J(+); KTI 1370; KTI 1375(+); KTI 1470(+); KTI 820(+); KTI 820J (+); KTI 9000; KTI 9000K; KTI 9010(+); KTI II; Liquid alkaline strip 7463; Markem thinner XF; Microposit 111S(+); Microposit 119S (+); Microposit 119 thinner; Microposit 1375(+); Microposit 1400-33(+); Microposit 1400S(+); Microposit 1450J(+); Microposit 1470(+); Microposit Sal 601-ER7 (+); Microposit XP-6009(+); Microposit XP-6012(+); MS-470 urethane coating; OFPR-800 AR-15(+); Poly-Solv EE acetate; PR-21 Resist; PR-55 Resist; Selectilux P-15(+); Sensolve EEA; Thinner E; TSMR 8800(+); Ultamac PR-68 Resin; Ultramac PR-1024 MB-628 Resin; Waxivation compound; Waycoat 204(+); Waycoat 207(+); Waycoat HPR 205; Waycoat RX 507(+); Xanthochrome(+)

CAS Registry Number: 111-15-9

RTECS® Number: KK8225000

UN/NA & ERG Number: UN1172/139

EC Number: 203-839-2 [*Annex I Index No.:* 607-037-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0693-9068.

California Proposition 65 Chemical: Developmental/Reproductive toxin 1/1/93.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; R10; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Ethoxyethyl acetate is a colorless liquid with a mild, nonresidual odor. The odor threshold is 0.056 ppm in air. Molecular weight = 132.18; Specific gravity (H_2O:1) = 0.98 at 20°C; Boiling point = 156°C; Freezing/Melting point = −61.7°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 47°C; Autoignition temperature = 380°C. Explosive limits: LEL = 1.7%; UEL = 12.7%. The UEL is also reported as 14%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water; solubility = 23%.

Potential Exposure: Compound Description: Reproductive Effector; Primary Irritant. This material is used as a solvent for different purposes, including for nitrocellulose and other resins. Used in automobile lacquers to retard evaporation and impart a high gloss.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, strong alkalies, nitrates. Violent reaction with oxidizers. May form unstable peroxides. Softens many plastics. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.41 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/540 mg/m^3 TWA [skin].

NIOSH REL: 0.5 ppm/2.7 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/27 mg/m^3 TWA [skin]; BEI: 100 mg [2-Ethoxyacetic acid]/g creatinine in urine at end-of-work-week.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 7.5 ppm

PAC-3: 500 ppm

DFG MAK: 2 ppm/11 mg/m^3 TWA; Peak Limitation Category II(8); [skin]; BAT: 50 mg [Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long term); Pregnancy Risk Group B.

Australia: TWA 5 ppm (27 mg/m^3), [skin], 1993; Austria: MAK 20 ppm (110 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (27 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (27.0 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (270 mg/m^3); STEL 100 ppm (540 mg/m^3), [skin], 1999; France: VME 5 ppm (27 mg/m^3), [skin], 1999; Hungary: TWA 25 mg/m^3; STEL 50 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 27 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (27 mg/m^3), 1999; the Philippines: TWA 100 ppm (540 mg/m^3), [skin], 1993; Poland: MAC (TWA) 100 mg/m^3, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (30 mg/m^3), KTV 10 ppm (50 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (27 mg/m^3), KZG-W 10 ppm (54 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (540 mg/m^3), 1993; United Kingdom: TWA 10 ppm (55 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm [skin]. Several states have set guidelines or standards for ethoxyethyl acetate in ambient air[60] ranging from 270 $\mu g/m^3$ (North Dakota) to 450 $\mu g/m^3$ (Virginia) to 540 $\mu g/m^3$ (Connecticut and South Dakota) to 643 $\mu g/m^3$ (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1450 or OSHA Analytical Methods 53 and 79.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = <0.3.

Routes of Entry: Inhalation, ingestion, eyes and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: 2-Ethoxyethyl acetate can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. High levels could cause you to become dizzy, lightheaded, and to pass out. Very high exposures could cause kidney damage and even death. May affect the blood and central nervous system.

Long Term Exposure: 2-Ethoxyethyl-acetate may damage the developing fetus. It may damage the testes (male reproductive glands), resulting in decreased fertility. It may affect the blood, liver, and kidneys. Many similar petroleum-based solvents have been shown to cause brain and nerve damage.

Points of Attack: Inhalation, skin absorption, ingestion, skin and/or eye contact

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Complete blood count. Evaluate for brain effects and consider evaluation of the nervous systems.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** Barricade® coated suits; Responder™ suits; **4 h:** polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *5 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *25 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Ethoxyethyl acetate must be stored to avoid contact with strong oxidizers, such as nitrates, permanganates, bromine, chlorine, and chlorine dioxide; strong alkalis, such as sodium hydroxide and potassium hydroxide; and strong acids, such as nitric, hydrochloric, and sulfuric acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 2-ethoxyethyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous and irritating gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 64−67

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: 2-Ethoxyethyl Acetate*. Trenton, NJ

Ethyl acetate E:0300

Molecular Formula: C_4H_8O2

Common Formula: $CH_3COOC_2H_5$

Synonyms: Acetato de etilo (Spanish); Acetic acid, ethyl ester; Acetic ester; Acetic ether; Acetidin; Acetoxyethane; Aethylacetat (German); Arsenosilica film 0308; AS-1; AS 1400; AS 18CZ10A; AS 18CZ5E; AS 18CZ6E; AS 1CE; AS 5CE; B446; Essigester (German); Ethyl acetic ester; Ethyle (acetate d') (French); Ethyl ester of acetic acid; Ethyl ethanoate; KTI 1470(+); Vinegar naphtha

CAS Registry Number: 141-78-6

RTECS® Number: AH5425000

UN/NA & ERG Number: UN1173/129

EC Number: 205-500-4 [*Annex I Index No.:* 607-022-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA1998 Status of Pesticides: Canceled.

US EPA Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

US EPA Hazardous Waste Number (RCRA No.): U112.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.34; Nonwastewater (mg/kg), 33.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36; R66; R67; Safety phrases: S2; S16; S26; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl acetate is a colorless liquid with a pleasant, fruity odor (odor threshold = 3.9 ppm in air). Molecular weight = 88.12; Specific gravity = 0.90; Boiling point = 77°C; Freezing point = −82.8; Vapor pressure = 73 mmHg at 20°C; Flash point = −4.4°C; Autoignition temperature = 426°C. Explosive limits: LEL = 2.0%; UEL = 11.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 0.9%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Human Data; Primary Irritant. This material is used as a solvent for nitrocellulose and lacquer. It is also used in making dyes, flavoring, and perfumery; and in smokeless powder manufacture.

Incompatibilities: Forms explosive mixture with air. Heating may cause violent combustion or explosion. Incompatible with strong acids, strong alkalies, nitrates, strong oxidizers, chlorosulfonic acid, lithium aluminum hydride; oleum will hydrolyze on standing in forming acetic acid and ethyl alcohol. This reaction is greatly accelerated by alkalies. Decomposes under influence of UV light, bases, acids. Attacks aluminum and plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.60 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 400 ppm/1400 mg/m^3 TWA.

NIOSH REL: 400 ppm/1400 mg/m^3 TWA.

ACGIH TLV®[1]: 400 ppm/1440 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 400 ppm

PAC-1: 400 ppm

PAC-2: 400 ppm

PAC-3: 2000 ppm

DFG MAK: 400 ppm/1500 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

NIOSH IDLH: 2000 ppm [LEL].

Australia: TWA 400 ppm (1400 mg/m^3), 1993; Austria: MAK 400 ppm (1400 mg/m^3), 1999; Belgium: TWA 400 ppm (1440 mg/m^3), 1993; Denmark: TWA 150 ppm (540 mg/m^3), 1999; Finland: TWA 300 ppm (1100 mg/m^3); STEL 500 ppm (1800 mg/m^3), 1993; France: VME 400 ppm (1400 mg/m^3), 1999; Hungary: TWA 400 mg/m^3; STEL 1200 mg/m^3, 1993; the Netherlands: MAC-TGG

550 mg/m^3, 2003; Norway: TWA 150 ppm (550 mg/m^3), 1999; the Philippines: TWA 400 ppm (1400 mg/m^3), 1993; Poland: MAC (TWA) 200 ppm, MAC (STEL) 600 mg/m^3, 1999; Russia: TWA 400 ppm; STEL 200 mg/m^3, 1993; Sweden: NGV 150 ppm (500 mg/m^3), KTV 300 ppm (1100 mg/m^3), 1999; Switzerland: MAK-W 400 ppm (1400 mg/m^3), KZG-W 800 ppm (2800 mg/m^3), 1999; Turkey: TWA 400 ppm (1400 mg/m^3), 1993; United Kingdom: TWA 400 ppm (1460 mg/m^3), 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 400 ppm. The Czech Republic[35]: 400 mg/m^3, Russia[35,43] set a MAC value of 0.1 mg/m^3 in the ambient air of residential areas on either a momentary or a daily average basis. Several States have set guidelines or standards for ethyl acetate in ambient air[60] ranging from 2.0 mg/m^3 (Massachusetts) to 14.0 mg/m^3 (North Dakota) to 23.0 mg/m^3 (Virginia) to 28.0 mg/m^3 (Connecticut, Florida, New York and South Dakota) to 33.333 mg/m^3 (Nevada) to 140.0 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1450 or OSHA Analytical Method 7.

Permissible Concentration in Water: Russia set a MAC of 0.2 mg/L in surface water.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl acetate can affect you when breathed in and by passing through your skin. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels could cause you to pass out. Repeated contact can cause drying and cracking of the skin. The vapor can irritate the eyes and respiratory tract. Ethyl acetate is a flammable liquid and a fire hazard. May affect the central nervous system. Very high exposure may result in death.

Long Term Exposure: May decrease fertility in males. Repeated contact can cause drying and cracking of the skin. Many similar petroleum-based chemicals can cause brain and nerve damage.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Evaluate for brain and nervous system damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** 4H™ and Silver Shield™ gloves; Barricade® coated suits; CPF3™ suits; Responder™ suits, Trellchem HPS™ suits; Trychem 1000™ suits, **4 h:** polyvinyl alcohol gloves; Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl acetate must be stored to avoid contact with nitrates; strong oxidizers, such as chlorine, bromine, chlorine dioxide, nitrates, and permanganates; strong alkalis, such as sodium hydroxide and potassium hydroxide; or strong acids, such as sulfuric acid, hydrochloric acid, and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of ethyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl acetate. Store in containers that are properly labeled with health hazard information and safe handling procedures. Wherever ethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 75−78

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Ethyl Acetate*. Trenton, NJ

Ethyl acetylene E:0310

Molecular Formula: C_4H_6

Common Formula: $C_2H_5C{\equiv}CH$

Synonyms: 1-Butino (Spanish); 1-Butyne; Ethyl ethyne

CAS Registry Number: 107-00-6

RTECS® Number: ER9553000

UN/NA & ERG Number: UN2452 (stabilized)/116

EC Number: 203-451-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl acetylene is a colorless, compressed gas or liquid. Molecular weight = 54.0; Boiling point = 8.1°C; Freezing/Melting point = −130°C; Flash point ≤ −7°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: A simple asphyxiant. Ethyl acetylene is used as a fuel and as a chemical intermediate.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosion danger. May undergo violent polymerization when subjected to heat, direct sunlight, or contamination.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl acetylene can affect you when breathed in. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Exposure to very high levels can cause suffocation and death due to lack of oxygen.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear gas-proof goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to ethyl acetylene is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethyl acetylene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Protect cylinders from physical damage and store away from potential heat sources. Sources of ignition, such as smoking and open flames, are prohibited where ethyl acetylene is handled, used, or stored. Wherever ethyl acetylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Water spray may be used to reduce vapors. Keep ethyl acetylene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

Fire Extinguishing: This chemical is an unstable, flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Ethyl Acetylene*. Trenton, NJ

Ethyl acrylate E:0320

Molecular Formula: $C_5H_8O_2$

Common Formula: $CH_2{=}CHCOOC_2H_5$

Synonyms: Acrilato de etilo (Spanish); Acrylate d'ethyle (French); Acrylic acid, ethyl ester; Acrylsaeuraethylester (German); Aethylacrylat (German); Ethoxy carbonyl ethylene; Ethyl 2-propenoate; Ethyl propenoate; NCI-C50384; 2-Propenoic acid, ethyl ester

CAS Registry Number: 140-88-5

RTECS® Number: AT0700000

UN/NA & ERG Number: UN1917 (stabilized)/129

EC Number: 205-438-8 [*Annex I Index No.:* 607-032-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U113.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Marine Pollutant (49CFR, Subchapter 172.101, Appendix B).

California Proposition 65 Chemical: Cancer 7/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; R36/37/38; R43; Safety phrases: S2; S9; S16; S33; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethyl acrylate is a colorless liquid with a sharp, acrid odor. The odor threshold is 0.00024−0.0009 ppm. Molecular weight = 100.13; Boiling point = 94.4°C; Melting point = −71°C; Vapor pressure = 29 mmHg at 20°C; Flash point = 10°C (oc); Autoignition temperature = 372°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Explosive limits: LEL = 1.4%; UEL = 14%. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. This material is used in emulsion polymers for paints, textiles, adhesives, coatings, and binders; as a monomer in the manufacture of homopolymer and copolymer resins for the production of paints and plastic films.

Incompatibilities: Forms explosive mixture with air. Atmospheric moisture and strong alkalies may cause fire and explosions unless properly inhibited (*Note:* Inert gas blanket not recommended). Heat, light, or peroxides can cause polymerization. Incompatible with oxidizers (may be violent), peroxides, polymerizers, strong alkalis, moisture, chlorosulfonic acid, strong acids, amines. May accumulate static electrical charges, and may cause ignition of its vapors. Polymerizes readily unless an inhibitor, such as hydroquinone, is added. Uninhibited vapors may plug vents by the formation of polymers.

Permissible Exposure Limits in Air

OSHA PEL: 25 ppm/100 mg/m^3 TWA [skin].

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 5 ppm/20 mg/m^3 TWA; 15 ppm/61 mg/m^3 STEL; [skin], not classifiable as a human carcinogen.

NIOSH IDLH: 300 ppm, Potential occupational carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 5 ppm

PAC-1: **8.3** ppm

PAC-2: **36** ppm

PAC-3: **240** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/21 mg/m^3; [skin] danger of skin sensitization; Pregnancy Risk Group C.

Australia: TWA 5 ppm (20 mg/m^3), 1993; Austria: MAK 5 ppm (20 mg/m^3), 1999; Belgium: TWA 5 ppm (20 mg/m^3); STEL 25 ppm (100 mg/m^3), 1993; Denmark: TWA 5 ppm (20 mg/m^3), [skin] 1999; Finland: TWA 5 ppm (20 mg/m^3); STEL 10 ppm (40 mg/m^3), [skin] 1993; France: VME 5 ppm (20 mg/m^3), [skin] 1999; Hungary: STEL 10 mg/m^3, [skin] carcinogen, 1993; the Netherlands: MAC-TGG 20 mg/m^3, [skin] 2003; Norway: TWA 5 ppm (20 mg/m^3), 1999; the Philippines: TWA 25 ppm (100 mg/m^3), [skin] 1993; Poland: TWA 20 mg/m^3; STEL 80 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Sweden: NGV 5 ppm (20 mg/m^3), KTV 10 ppm (40 mg/m^3), [skin] 1999; Switzerland: MAK-W 5 ppm (20 mg/m^3), KZG-W 10 ppm (40 mg/m^3), 1999; Turkey: TWA 25 ppm (100 mg/m^3), [skin] 1993; United Kingdom: TWA 5 ppm (21 mg/m^3); STEL 15 ppm (62 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm.

The Czech Republic[35] and Russia[43] have set a MAC value of 0.05 mg/m^3 (50 μg/m^3) in ambient air of residential areas. Several states have set guidelines or standards for ethyl acrylate in ambient air[60] ranging from 0.28 μg/m^3 (Massachusetts) to 350.0 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 200−1000 μg/m^3 (North Dakota) to 476.0 μ/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1450 or OSHA Analytical Method 92.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.005 mg/L (5 μg/L) in water bodies used for domestic purposes.

Determination in Water: No tests listed. Octanol−water coefficient: Log K_{ow} = 1.3.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl acrylate can affect you when breathed in and by passing through your skin. Ethyl acrylate is corrosive and can severely irritate and burn the eyes and skin. Inhalation can cause severe irritation and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Breathing very high levels of ethyl acrylate can cause dizziness, difficulty in breathing, and even death. Contact may cause a skin allergy.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis and skin allergy. May affect the liver and kidneys. This chemical may be a human carcinogen; it has been shown to cause stomach cancer in animals. May damage the developing fetus. Highly irritating substances may cause lung damage.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: forestomach.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests; liver function tests; kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** polyvinyl alcohol gloves; Teflon™ gloves, suits, boots; Responder™ suits; Trychem 1000™ suits, **4 h:** 4H™ and Silver Shield™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Ethyl acrylate must be stored to avoid contact with oxidizers (such as peroxides, perchlorates, chlorates, nitrates, and permanganates), strong alkalis (such as sodium hydroxide and potassium hydroxide) and moisture since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Heat can cause ethyl acrylate to react by itself. If this takes place in a closed container, an explosion could occur. Ethyl acrylate usually contains an inhibitor, such as hydroquinone or its methyl ether, to prevent a self-reaction. If it does not contain an inhibitor, the reaction may occur without the application of heat. Sources of ignition, such as smoking and open flames, are prohibited where ethyl acrylate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl acrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl acrylate. Wherever ethyl acrylate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Ethyl acrylate requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases or irritating fumes are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas.

Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration[22] or by absorption and landfill disposal.[22]

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 35−37

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Ethyl Acrylate*. Trenton, NJ

Ethyl alcohol E:0330

Molecular Formula: C_2H_6O

Common Formula: CH_3CH_2OH

Synonyms: Absolute ethanol; Aethanol (German); Aethyldlkohol (German); Alcohol; Alcohol, anhydrous; Alcohol C-2; Alcohol, dehydrated; Alcool ethylique (French); Algrain; Alkohol (German); Anhydrol; Cologne spirit; Cologne spirits; Ethanol; Ethanol 200 proof; Ethyl alcohol anhydro-S; Ethyl hydrate; Ethyl hydroxide; Fermentation alcohol; Grain alcohol; Jaysol S; Methyl carbinol; Molasses alcohol; NCI-CO3134; Potato alcohol; Pure grain alcohol; SD alcohol 23-hydrogen; Spirit; Spirits of wine; Tescol

CAS Registry Number: 64-17-5

RTECS® Number: KQ6300000

UN/NA & ERG Number: UN1170/127

EC Number: 200-578-6 [*Annex I Index No.:* 603-002-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: *Alcoholic Beverage Consumption* NTP 11th Report on Carcinogens, Known to be a Human Carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

US EPA Gene-Tox Program, Positive: Rodent dominant lethal; Negative: *Aspergillus*—forward mutation; SHE—clonal assay; Negative: Cell transform.—RLV F344 rat embryo; Negative: *In vitro* cytogenetics—nonhuman; Mammalian micronucleus; Negative: *N. crassa—aneuploidy*; Histidine reversion—Ames test; Negative: *In vitro* SCE—human lymphocytes; *In vitro* SCE—human; Negative: *In vitro* SCE—nonhuman; Sperm morphology—mouse; Negative/limited: Carcinogenicity—mouse/rat.

FDA—over-the-counter and proprietary drug.

California Proposition 65 Chemical: Cancer (alcoholic beverages, when associated with alcohol abuse).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1; Class B2, D2A, D2B.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S7−S16 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl alcohol is a colorless, volatile, flammable liquid with a sweet, fruity odor. The odor threshold is 0.135−5 ppm. Molecular weight = 46.08; Specific gravity (H_2O:1) = 0.8; Boiling point = 78.3°C; Melting point = − 113.9°C; Vapor pressure = 44 mmHg at 20°C; Flash point = 12.8°C (96%). Explosive limits: LEL = 3.3%; UEL = 19.0%; Autoignition temperature = 363°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Ethyl alcohol is used as a topical anti-infective agent; solvent to make beverages; in the chemical synthesis of a wide variety of compounds, such as acetaldehyde, ethyl ether, ethyl chloride, and butadiene. It is a solvent or processing agent in the manufacture of pharmaceuticals, plastics, lacquers, polishes, plasticizers, perfumes, cosmetics, rubber accelerators, explosives, synthetic resins, nitrocellulose, adhesives, inks, and preservatives. It is also used as an antifreeze and as a fuel. It is an intermediate in the manufacture of many drugs and pesticides.

Incompatibilities: Forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Reactions may be violent with oleum, sulfuric acid, nitric acid, bases, aliphatic amines, isocyanates, strong oxidizers. Also incompatible with potassium dioxide, bromine pentafluoride, acetyl bromide, acetyl chloride, platinum, sodium.

Permissible Exposure Limits in Air

OSHA PEL: 1000 ppm/1900 mg/m^3 TWA.

NIOSH REL: 1000 ppm/1900 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/1880 mg/m^3 STEL; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 500 ppm

PAC-1: **1800** ppm

PAC-2: **3300** ppm

PAC-3: 3300 ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 500 ppm/960 mg/m^3 TWA; Peak Limitation Category II(2); Carcinogen Category 5; Pregnancy Risk Group C.

NIOSH IDLH: 3300 ppm [LEL].

Australia: TWA 1000 ppm (1900 mg/m^3), 1993; Austria: MAK 1000 ppm (1900 mg/m^3), 1999; Belgium: TWA 1000 ppm (1880 mg/m^3), 1993; Denmark: TWA 1000 ppm (1900 mg/m^3), 1999; Finland: TWA 1000 ppm (1900 mg/m^3); STEL 1250 ppm (2400 mg/m^3), 1999; France: VME 1000 ppm (1900 mg/m^3), VLE 5000 ppm, 1999; Hungary: TWA 1000 mg/m^3; STEL 3000 mg/m^3, 1993; the Netherlands: MAC-TGG 1000 mg/m^3, 2003; Norway: TWA 500 ppm (950 mg/m^3), 1999; the Philippines: TWA 1000 ppm (1900 mg/m^3), 1993; Poland: MAC (TWA) 1000 mg/m^3, MAC (STEL) 3000 mg/m^3, 1999; Russia: STEL 1000 mg/m^3, 1993; Sweden: NGV 500 ppm (1000 mg/m^3), KTV 1000 ppm (1900 mg/m^3), 1999; Switzerland: MAK-W 1000 ppm (1900 mg/m^3), 1999; Thailand: TWA 1000 ppm (1900 mg/m^3), 1993; Turkey: TWA 1000 ppm (1900 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (1950 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] set a MAC in ambient air of residential areas of 5.0 mg/m^3 on either a momentary or a daily average basis. Several states have set guidelines or standards for ethanol in ambient air[60] ranging from 0.26 mg/m^3 (Massachusetts) to 16.0 mg/m^3 (Virginia) to 19.0 mg/m^3 (North Dakota) to 38.0 mg/m^3 (Connecticut and South Dakota) to 45.238 mg/m^3 (Nevada).

Determination in Air: Collection by charcoal tube, 2-butanol/CS_2; analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1400, alcohols I.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 26,000 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.32$.

Routes of Entry: Inhalation of vapor and percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Levels of 5000−10,000 ppm may result in irritation of mouth, nose, throat and coughing, leading to sleep and stupor. *Skin:* Pure ethyl alcohol may cause drying, redness, and irritation. May be absorbed through damaged skin. *Eyes:* Irritation and tearing may result at 5000 ppm of vapor. Contact with liquid may cause severe irritation. *Ingestion:* 1 oz of pure ethyl alcohol may cause reddening of face and neck and an exaggerated feeling of well-being. 3 oz of pure ethyl alcohol may cause an initial burst of excitement and activity followed by increasing loss of coordination, slurred speech, nausea, and drowsiness. This may proceed to stupor, coma, and death. Lethal dose of ethyl alcohol ranges from 2 to 5 oz, depending on age and size of the individual. *Note:* many denatured alcohols contain additives which are extremely poisonous and cannot be removed by normal methods. Ingestion of denatured alcohol will produce much more serious poisoning.

Long Term Exposure: Prolonged inhalation of concentrations above 5000 ppm may produce symptoms listed under inhalation and the additional symptoms of headache, dizziness, tremor, and fatigue. Additives in denatured alcohol may result in other more severe symptoms. Alcohol has been linked to birth defects in humans. Ethyl alcohol may cause mutations. Repeated exposure (including alcoholic beverages) may cause spontaneous abortions as well as birth defects and other developmental problems, including "fetal alcohol syndrome." Chronic use of ethanol may cause cirrhosis of the liver. *Alcoholic Beverage Consumption* is on the NTP 11th Report on Carcinogens, Known to be a Human Carcinogen.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, blood, reproductive system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater or significant skin contact), the following are recommended before beginning work and at regular times after that: Liver function tests. Ethyl alcohol can be measured in the blood, urine, and exhaled breath. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite) End-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; **4 h:** Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *3300 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl alcohol must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, chlorates, nitrates, and permanganates, because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Sources of ignition, such as smoking and open flames, are prohibited where ethyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of ethyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl alcohol.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 55−57

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ethyl Alcohol*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Ethyl Alcohol*. Trenton, NJ

Ethylamine E:0340

Molecular Formula: C_2H_7N
Common Formula: $C_2H_5NH_2$
Synonyms: Aethylamine (German); 1-Aminoethane; Aminoethane; EA; Etanamina (Spanish); Ethanamine; Etilamina (Spanish); MEA; Monoethylamine
CAS Registry Number: 75-04-7
RTECS$^{®}$ Number: KH2100000
UN/NA & ERG Number: UN1036/118; UN2270 [aqueous solution with not <50% but not >70% ethylamine]/132

EC Number: 200-834-7 [*Annex I Index No.:* 612-002-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F +, Xi; Risk phrases: R12; R36/37; Safety phrases: S2; S16; S26; S29 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethylamine is a colorless gas or water-white liquid (below 17°C) with a strong, ammonia-like odor. Shipped as a liquefied compressed gas. Molecular weight = 45.10; Specific gravity (H_2O:1) = 0.69 (liquid); Boiling point = 16.7°C; Freezing/Melting point = − 81°C; Vapor pressure = 847 mmHg at 20°C; Flash point ≤ − 18°C; Autoignition temperature = 385°C. Explosive limits: LEL = 3.5%; UEL = 14.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Monoethylamine (MEA) is used as an intermediate in the manufacture of the following chemicals: triazine herbicides, 1,3-diethylthiourea (a corrosion inhibitor); ethylamino-ethanol; 4-ethylmorpholine (urethane foam catalyst); ethyl isocyanate; and dimethylolethyltriazone (agent used in wash-and-wear fabrics). The cuprous chloride salts of MEA are used in the refining of petroleum and vegetable oil.

Incompatibilities: The aqueous solution is a strong base. Forms explosive mixture with air. Reacts violently with strong acids, strong oxidizers, cellulose nitrate, and organic compounds, causing fire and explosion hazard. Also incompatible with organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks nonferrous metals: aluminum, copper, lead, tin, zinc and alloys; some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.85 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/18 mg/m^3 TWA.

NIOSH REL: 10 ppm/18 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/9.2 mg/m^3 TWA; 15 ppm/27.6 mg/m^3 STEL [skin].

Protective Action Criteria (PAC)*

TEEL-0: 7.5 ppm

PAC-1: **7.5** ppm

PAC-2: **49** ppm

PAC-3: **270** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/9.4 mg/m^3 TWA; Peak Limitation Category I(2) a momentary value of 10 mL/m^3/19 mg/m^3 should not be exceeded; Pregnancy Risk Group D.

NIOSH IDLH: 600 ppm.

Australia: TWA 10 ppm (18 mg/m^3), 1993; Austria: MAK 10 ppm (18 mg/m^3), 1999; Belgium: TWA 10 ppm (18 mg/m^3), 1993; Denmark: TWA 10 ppm (18 mg/m^3), [skin], 1999; Finland: TWA 10 ppm (18 mg/m^3); STEL 20 ppm (37 mg/m^3), [skin], 1999; France: VME 10 ppm (18 mg/m^3), VLE 15 ppm (27 mg/m^3), 1999; Japan: 10 ppm (18 mg/m^3), 1993; the Netherlands: MAC-TGG 9 mg/m^3, 2003; Norway: TWA 10 ppm (18 mg/m^3), 1999; the Philippines: TWA 10 ppm (18 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 15 mg/m^3, 1999; Russia: TWA 10 ppm, 1993; Sweden: NGV 10 ppm (18 mg/m^3), KTV 15 ppm (30 mg/m^3), [skin], 1999; Switzerland: MAK-W 10 ppm (18 mg/m^3), KZG-W 20 ppm (36 mg/m^3), 1999; Turkey: TWA 10 ppm (18 mg/m^3), 1993; United Kingdom: TWA 2 ppm (3.8 mg/m^3); STEL 6 ppm (11 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm [skin]. Russia set a MAC of 0.01 mg/m^3 in ambient air in residential areas on both a momentary and a daily average basis. Several states have set guidelines or standards for monoethylamine in ambient air[60] ranging from 180 μg/m^3 (North Dakota) to 300 μg/m^3 (Virginia) to 360 μg/m^3 (Connecticut) to 429 μg/m^3 (Nevada).

Determination in Air: Use NIOSH [II(3)] Method #S144 or OSHA Analytical Method 36.

Permissible Concentration in Water: EPA[32] has suggested an ambient environmental goal of 248 μg/L on a health basis. Russia[35] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = −0.27/−0.08 (calculated).

Routes of Entry: Inhalation, skin absorption (liquid), ingestion (liquid), skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Ethylamine can affect you when breathed in and by passing through your skin. Contact can severely burn the eyes and skin. Inhalation can severely irritate the eyes, nose, throat, and lungs, causing cough, wheezing, and/or shortness of breath. Repeated exposure may damage the lungs, kidneys, and heart.

Long Term Exposure: Repeated exposure can cause damage to the kidneys, liver, and heart. Can affect the eyes, causing blurred vision and/or cause the victim to see halos around lights, and result in permanent damage. Repeated exposure can affect the lungs, causing bronchitis; and tissue lesions.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Examination of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: examination of the heart; kidney function tests; liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** butyl rubber gloves, suits, boots; **4 h:** Teflon™ gloves, suits, boots; Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *500 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s) or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *600 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Ethylamine must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) or strong oxidizers (such as chlorine and bromine) because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethylamine is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more of ethylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethylamine. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1 and there is no Packing Group listed. Ethylamine, aqueous solution with not <50% but not >70% ethylamine, requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Gas:* This chemical is flammable. Poisonous gases are produced in fire, including nitrogen oxides. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Solution: This chemical is flammable. Poisonous gases, including nitrogen oxides, are produced in fire. Shut off supply. If not possible, and at no risk to surroundings, let the fire burn itself out; in other cases use dry chemical or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.[22]

References

US Environmental Protection Agency. (April 1, 1978). *Chemical Hazard Information Profile: Ethylamines*. Washington, DC

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Ethylamine*. Trenton, NJ

Ethyl amyl ketone E:0350

Molecular Formula: $C_8H_{16}O$

Common Formula: $CH_3CH_2COCH_2CH(CH_3)CH_2CH_3$

Synonyms: Amyl ethyl ketone; EAK; Ethyl *sec*-amyl ketone; 5-Methyl-3-heptanone (NIOSH, OSHA); 5-Metilheptano-3-ona (Spanish); 3-Octanone

CAS Registry Number: 541-85-5

RTECS® Number: MJ7350000

UN/NA & ERG Number: UN2271/128

EC Number: 208-793-7 [*Annex I Index No.:* 606-020-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R36/37; Safety phrases: S2; S23 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl amyl ketone is a colorless liquid with a mild, fruity odor. Molecular weight = 128.24; Boiling point = 157.2°C; Freezing/Melting point = −56.7°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 57°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. Ethyl amyl ketone is used as a solvent for resins, in the manufacture of perfume, and as an organic intermediate.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers may cause fire and explosions. Incompatible with strong bases, reducing agents, aldehydes, nitric acid, aliphatic amines.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.24 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/130 mg/m^3 TWA.

NIOSH REL: 25 ppm/130 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/52 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 25 ppm

PAC-1: 25 ppm

PAC-2: 25 ppm

PAC-3: 100 ppm

DFG MAK: 10 ppm/53 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

NIOSH IDLH: 100 ppm.

Australia: TWA 25 ppm (130 mg/m^3), 1993; Austria: MAK 25 ppm (130 mg/m^3), 1999; Belgium: TWA 25 ppm (131 mg/m^3), 1993; Denmark: TWA 25 ppm (130 mg/m^3), 1999; Finland: TWA 25 ppm (130 mg/m^3), ceiling 50 ppm (260 mg/m^3), 1999; France: VME 25 ppm (130 mg/m^3), 1999; the Netherlands: MAC-TGG 133 mg/m^3, 2003; Norway: TWA 20 ppm (100 mg/m^3), 1999; Sweden: TWA

25 ppm (130 mg/m^3); STEL 50 ppm (250 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (130 mg/m^3), 1999; United Kingdom: TWA 25 ppm (133 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. Several states have set guidelines or standards for ethyl amyl ketone in ambient air[60] ranging from 1.3 mg/m^3 (North Dakota) to 2.2 mg/m^3 (Virginia) to 2.6 mg/m^3 (Connecticut) to 3.095 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1301 or #2553.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Prolonged contact can cause skin rash. Inhalation can irritate the respiratory tract with coughing and shortness of breath. Exposure can cause headache, nausea, dizziness, lightheadedness, and unconsciousness.

Long Term Exposure: Can cause skin rash and drying and cracking of skin. Similar petroleum-based chemicals can cause brain and nerve damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Evaluate for brain and nervous system damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *100 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethyl amyl ketone must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl amyl ketone. Wherever ethyl amyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EAK out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Ethyl Amyl Ketone*. Trenton, NJ

2-Ethylaniline E:0360

Molecular Formula: $C_8H_{11}N$

Synonyms: 2-Aethylanilin (German); *o*-Aminoethylbenzene; Aniline, *o*-ethyl-; Benzenamine, 2-ethyl-; 2-Ethyl aniline; 2-Ethylbenzenamine; 2-Ethylbenzenamino; 2-Etilanilina (Spanish)

CAS Registry Number: 578-54-1

RTECS® Number: BX9800000

UN/NA & ERG Number: UN2273/153

EC Number: 209-424-2

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Ethylaniline is a yellow liquid that turns brown on standing in air. Molecular weight = 121.20; Boiling point = 215°C; 210°C at 760 mmHg; Freezing/Melting point = 44°C; Vapor pressure = 0.11 mmHg at 20°C; Flash point = 85°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used in making drugs, dyes, and pesticides.

Incompatibilities: Decomposes on contact with light or air. Violent reaction on contact with strong oxidizers, strong acid anhydrides, and chloroformates.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *N*-Ethylaniline can affect you when breathed in and by passing through your skin. High exposure can reduce the blood's ability to supply oxygen to the body (methemoglobinemia) and can cause the skin and lips to turn a blue color. Headache, weakness, and passing out may occur. Death could result from high exposures to skin or breathing. Contact can irritate or burn skin and eyes.

Long Term Exposure: Exposure can cause skin allergy to develop, with rash and itching. Once allergy is present, even low exposures may trigger symptoms. May affect the nervous system, causing headache, drowsiness, irritability, and confusion. May cause liver damage.

Points of Attack: Skin, blood, nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin (the blood change caused by ethylaniline). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver function tests.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention if any symptoms are present. *Skin Contact:* Quickly remove contaminated clothing. Immediately wash area with large amounts of soap; promptly seek medical attention. *Breathing:* Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethylaniline, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. 2-Ethylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), strong oxidizers, acid anhydrides (such as maleic anhydride), and chloroformates since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where 2-ethylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep 2-ethylaniline out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including aniline and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: 2-Ethylaniline*. Trenton, NJ

N-Ethylaniline E:0370

Molecular Formula: $C_8H_{11}N$
Common Formula: $C_6H_5NHC_2H_5$
Synonyms: Aethylanilin (German); Anilinoethane; Benzenamine, *n*-ethyl-; *n*-Ethylaminobenzene; Ethylaniline; *n*-Ethylbenzenamine; *n*-Ethylbenzenamino; Ethylphenylamine; *n*-Etilanilina (Spanish)
CAS Registry Number: 103-69-5
RTECS® Number: BX9780000
UN/NA & ERG Number: UN2272
EC Number: 203-135-5

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: *N*-Ethylaniline is a yellow brown oil with a weak fishy odor. Molecular weight = 121.20; Boiling point = 205°C; Freezing/Melting point = −64°C; Flash point = 85°C (oc). Flammable Limits: LEL 1.6%; UEL 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Mutagen. This material is used as an intermediate in dyes, pharmaceuticals, and explosives; in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Decomposes on contact with light or air. Reacts with many materials. Contact with strong oxidizers, strong acids can cause fire; explosions with formation of toxic vapors of aniline and oxides of nitrogen.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *N*-Ethylaniline can affect you when breathed in and by passing through your skin. High exposure can reduce the blood's ability to supply oxygen to the body (methemoglobinemia) and can cause the skin and lips to turn a blue color. Headache, weakness, and passing out may occur. Death could result from high exposures to skin or breathing. Contact can irritate or burn skin and eyes.

Long Term Exposure: Exposure can cause skin allergy to develop, with rash and itching. Once allergy is present, even low exposures may trigger symptoms. May affect the nervous system causing headache, drowsiness, irritability, and confusion.

Points of Attack: Skin, blood, nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobinemia. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention if any symptoms are present.

Skin Contact: Quickly remove contaminated clothing. Immediately wash area with large amounts of soap, promptly seek medical attention.

Breathing: Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethylaniline, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Ethylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and strong oxidizers since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylaniline out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including aniline and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Ethylaniline*. Trenton, NJ

Ethylbenzene E:0380

Molecular Formula: C_8H_{10}

Common Formula: $C_6H_5CH_2CH_3$

Synonyms: Aethylbenzol (German); Aristoline(+); AZ 1470(+); AZ 4210(+); Benzene, ethyl-; CEM 388; EB; Ethylbenzol; Etilbenceno (Spanish); KTI 1350J(+); KTI photoresist standard (−); α-Methyltoluene; NCI-C56393; Phenylethane

CAS Registry Number: 100-41-4

RTECS® Number: DA0700000

UN/NA & ERG Number: UN1175/130

EC Number: 202-849-4 [*Annex I Index No.:* 601-023-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; some evidence: mouse; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse; IARC: Animal Sufficient Evidence; Human Inadequate evidence, *possibly carcinogenic to humans*, Group 2B, 1977; EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

NTP: Toxicity studies, RPT#TOX-10, October 2000.

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 10.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5).

Safe Drinking Water Act: MCL, 0.7 mg/L; MCLG, 0.7 mg/L.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 6/11/04.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20; Safety phrases: S2; S16; S24/25; S29 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethylbenzene is a colorless liquid with a pungent aromatic odor. The odor threshold is 0.092−0.60 ppm. Molecular weight = 106.18; Specific gravity (H_2O:1) = 0.87; Boiling point = 136°C; Freezing/Melting point = − 95°C; Vapor pressure = 7% mmHg at 20°C; Flash point = 12.8°C; Autoignition temperature = 432°C. Explosive limits: LEL = 0.8%; UEL = 6.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.7%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylbenzene is used in styrene manufacture and in the synthesis of *p*-nitroacetophenone; in the manufacture of cellulose acetate and synthetic rubber. It is also used as a solvent or diluent and as a component of automotive and aviation gasoline. Significant quantities of EB are present in mixed xylenes. These are used as dilatants in the paint industry, in agricultural sprays for insecticides, and in gasoline blends (which may contain as much as 20% EB). In light of the large quantities of EB produced and the diversity of products in which it is found, there may exist environmental sources for ethylbenzene, e.g., vaporization during solvent use; pyrolysis of gasoline and emitted vapors at filling stations. Groups of individuals who are exposed to EB to the greatest extent and could represent potential pools for the expression of EB toxicity include (1) individuals in commercial situations where petroleum products or by-products are manufactured (e.g., rubber or plastics industry); (2) individuals residing in areas with high atmospheric smog generated by motor vehicle emissions.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, nitric acid. Attacks plastics and rubber. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.34 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/435 mg/m^3 TWA.

NIOSH REL: 100 ppm/435 mg/m^3 TWA; 125 ppm/545 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm/434 mg/m^3 TWA; 125 ppm/543 mg/m^3 STEL; BEI: 1.5 g[Mandelic acid]/g creatinine in urine at end-of-shift at end-of-work-week; 2 ppm [ethylbenzene] in end-exhaled air prior to next shift.

NIOSH IDLH: 800 ppm [LEL].

Protective Action Criteria (PAC)*

TEEL-0: 33 ppm

PAC-1: **33** ppm

PAC-2: **110** ppm

PAC-3: **1800** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Germ Cell Mutagen Category 3A (2006).

Australia: TWA 100 ppm (435 mg/m^3); STEL 125 ppm, 1993; Austria: MAK 100 ppm (440 mg/m^3), 1999; Belgium: TWA 100 ppm (434 mg/m^3); STEL 125 ppm (543 mg/m^3), 1993; Denmark: TWA 50 ppm (217 mg/m^3), 1999; Finland: TWA 100 ppm (435 mg/m^3); STEL 150 ppm (655 mg/m^3), 1999; France: VME 100 ppm (435 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 215 mg/m^3, [skin], 2003; Norway: TWA 50 ppm (220 mg/m^3), 1999; the Philippines: TWA 100 ppm (435 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 350 mg/m^3, 1999; Russia: TWA 100 ppm; STEL 50 mg/m^3, 1993; Sweden: NGV 50 ppm (200 mg/m^3), KTV 100 ppm (450 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (435 mg/m^3), KZG-W 500 ppm (2175 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (435 mg/m^3), 1993; United Kingdom: TWA 100 ppm (441 mg/m^3); STEL 125 ppm (552 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: STEL 125 ppm. The Czech Republic: TWA 200 mg/m^3. Russia[35, 43] set a MAC of 0.02 mg/m^3 in the ambient air in residential areas on either a momentary or a daily average basis. Several states have set guidelines or standards for ethylbenzene in ambient air[60] ranging from 0.12 mg/m^3 (Massachusetts) to 1.45 mg/m^3 (New York) to 4.35 mg/m^3 (Florida, South Carolina) to 4.35−5.45 mg/m^3 (North Dakota) to 7.25 mg/m^3 (Virginia) to 8.7 mg/m^3 (Connecticut) to 10.357 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. NIOSH Analytical Method #1501 for aromatic hydrocarbons.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 32,000 μg/L, on an acute toxicity basis. *To protect saltwater aquatic life:* 430 μg/L, on an acute toxicity basis. *For the protection of human health*: 1.4 mg/L.[6] The EPA[48] has developed a lifetime health advisory for ethylbenzene of 0.68 mg/L, rounded to 0.7.[61] Russia[35,43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes and 0.011 mg/L in water bodies used for fishery purposes. Several states have set guidelines for ethylbenzene in drinking water[61] ranging from 1.0 μg/L (Illinois) to 680 μg/L (Arizona, California, Kansas, Minnesota) to 750 μg/L (New Mexico) to 1400 μg/L (Vermont and Wisconsin).

Determination in Water: Inert gas purge followed by gas chromatography and photoionization detection (EPA Method 602) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethylbenzene irritates the eyes, skin, and respiratory tract. Exposure to high concentrations can cause dizziness, lightheadedness, and unconsciousness. Very high exposures (above the OEL) can cause difficult breathing, narcosis, coma, and even death. Swallowing the liquid may cause aspiration into the lungs, resulting in chemical pneumonitis. May affect the central nervous system. Concentration of 200 ppm can cause irritation.

Long Term Exposure: Repeated or prolonged exposure to the skin may cause drying, scaling, and blistering. May cause kidney disease, liver disease, chronic respiratory disease, skin disease: EB is not nephrotoxic. Concern is expressed because the kidney is the primary route of excretion of EB and its metabolites. EB is not hepatotoxic. Since EB is metabolized by the liver, concern is expressed for these tissues. Exacerbation of pulmonary pathology might occur following exposure to EB. Individuals with impaired pulmonary function might be at risk. EB is a defating agent and may cause dermatitis following prolonged exposure. Individuals with preexisting skin problems may be more sensitive to EB. There is limited evidence that EB may damage the developing fetus, and may cause mutations.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Kidney function tests. Evaluate for brain and nervous system effects. NIOSH lists the following tests: whole blood (chemical/metabolite); during exposure, expired air, expired air: prior to next shift; urine (chemical/metabolite); urine (chemical/metabolite) End-of-shift; urine (chemical/metabolite) End-of-shift, end-of-work-week; urine (chemical/metabolite). Last 2 h of 8-h exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Viton™ gloves, suits, Barricade® coated suits; Responder™ suits; Trychem 1000™ suits, **4 h:** Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *800 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferable. Inside storage should be in a standard flammable liquids storage room or cabinet. Isolate from acute fire hazards and oxidizing agents. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EB out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

US Environmental Protection Agency. (1980). *Ethylbenzene: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 57−60 (1982) and 7, No. 2, 13−35

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ethylbenzene*. Albany, NY: Bureau of Toxic Substance Assessment

N-Ethylbenzyltoluidine E:0390

Molecular Formula: $C_{16}H_{19}N$

Common Formula: $H_3CC_6H_4N(C_2H_5)(CH_2C_6H_5)$

Synonyms: Benzenemethanamine; Ethylbenzyltoluidine*; N*-Ethyl-*N*-(3-methylphenyl)toluidine

CAS Registry Number: 119-94-8

RTECS® Number: XU3676000

UN/NA & ERG Number: UN2753/153

EC Number: 204-359-6

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethylbenzyltoluidine is a yellowish to light brown liquid with an unpleasant odor. Boiling point = 230°C; Flash point = 167°C. Insoluble in water.

Potential Exposure: This compound is used in dye synthesis.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can interfere with the ability of the blood to carry oxygen (methemoglobinemia), causing headaches, dizziness, weakness, a bluish skin color, and even death. This substance can damage the kidneys and bladder, causing painful, bloody urine. Eye contact causes irritation and can lead to permanent damage. Skin contact can cause a rash and burning feeling.

Points of Attack: Blood, skin.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: blood methemoglobin level. Kidney function tests. Urine tests for blood and for *n*-acetyl *p*-aminophenol.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately.

Skin Contact: Quickly remove contaminated clothing. Immediately wash area with large amounts of soap and water. Seek medical attention if symptoms develop and remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethylbenzyltoluidine, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and light. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ethylbenzyltoluidine may burn but does not readily ignite. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Ethylbenzyltoluidine*. Trenton, NJ

Ethylbis(2-chloroethyl)amine (Agent HN-1, WMD) E:0400

Molecular Formula: $C_6H_{13}Cl_2N$

Common Formula: $C_2H_5N(CH_2CH_2Cl)_2$

Synonyms: AI3-16200; 2-Chloro-*N*-(2-chloroethyl)-*N*-ethylethanamine; 2,2′-Dichlorotriethylamine; Ethanamine, 2-chloro-*N*-(2-chloroethyl)-*N*-ethyl-; Ethyl-S; Ethylbis (β-chloroethyl)amine; HN-1 (military designation); Nitrogen mustard-1; TL 1149; TL329; Triethylamine, 2,2′-dichloro-

CAS Registry Number: 538-07-8

RTECS® Number: YE1225000

UN/NA & ERG Number: UN2810 (toxic liquids, organic, n.o.s.)/153

UN/NA & ERG Number: Not assigned.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

According to NIOSH, HN-1 is a *known carcinogen, developmental toxin, and reproductive toxin.*[NIOSH]

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrogen mustard is a pale yellow, oily, mobile liquid. HN-1 is a mustard blister agent (vesicant) that has a faint musty or fishy odor. *Nitrogen mustards* are colorless when pure but are typically a yellow to brown oily substance. Odors are variably described as sweet, agreeable, slightly garlic- or mustard-like. It evaporates slowly. Molecular weight = 170.11; 170.08[NIOSH]; Specific gravity 1.09 g/cm^3 at 25°C; Boiling point = (decomposes) 194°C; Freezing/Melting point = − 3.4°C; Volatility = 2.29 mg/L at 25°C; Vapor density (air = 1) = 5.9; Vapor pressure = 0.25 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Slightly soluble in water. 160 mg/L at 25°C.

Potential Exposure: Sulfur mustards were formerly used as a gas warfare agent. Nitrogen mustards have not previously been used in warfare.[NIOSH] HN-1 can be used as a delayed-action military casualty agent. Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal.[NIOSH]

Persistence of Chemical Agent: HN: Summer: 3 days to 1 week; Winter: May last for weeks.

Incompatibilities: Avoid contamination with oxidizing agents, e.g., nitrates, oxidizing acids, chlorine bleaches, swimming pool chlorine, which may result in ignition. Toxic intermediate products are produced during hydrolysis of HN-1.[NIOSH] Unstable in the presence of light and heat and forms dimers at temperatures above 122°F/50°C. Corrosive to ferrous alloys beginning at 149°F/65°C. Contact with metals may evolve flammable hydrogen gas. Polymerizes slowly, so munitions would be effective for several years.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) HN-1*
TEEL-0: 0.004 mg/m^3
PAC-1: 0.0125 mg/m^3
PAC-2: **0.022** mg/m^3
PAC-3: **0.37** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face.**

Determination in Water: HN-1 is a water contaminant. Octanol−water coefficient: Log K_{ow} = (estimated) 2.02.

Harmful Effects and Symptoms

Nitrogen mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells. Clinical effects do not appear until hours after exposure. Nitrogen mustards penetrate and bind quickly to cells of the body; their health effects develop slowly. The full extent of cellular injury may not be known for days. The sooner after exposure that health effects occur, the more likely it is that the patient/victim was exposed to a high concentration of HN-2. Similarly, the sooner that health effects occur, the more likely it is that they will progress and become severe. *Eye exposure*: The eyes are the organs that are most sensitive to mustard vapor; eye injury may occur within 1−2 h after severe exposure or 3−12 h after a mild to moderate exposure. Inhalation exposure: Airway injury may occur within 2−6 h after severe exposure and within 12−24 h after mild exposure. Skin exposure: The symptom-free (latent) period is 6−12 h in temperate conditions; hot, humid weather strikingly increases the action of nitrogen mustards. Some skin injury may appear as late as 48 h after exposure.[NIOSH]

Short Term Exposure: Poisonous by all routes. HN-1 is a nitrogen mustard. It is highly irritating to skin, eyes, and mucous membranes. Nitrogen mustards have preferential toxicity for rapidly dividing cells. Workers exposed briefly to estimated concentrations of 10−100 ppm by inhalation became severely ill. The median lethal dosage is 1500 mg-min/m^3. Irritate the eyes in quantities which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. After mild vapor exposure, there may be no skin lesions. After severe vapor exposures, or after exposure to the liquid, erythema may appear. Irritation and itching may occur. Later, blisters may appear in the erythematous areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and a persistent cough. Fever, labored respiration, and moist riles develop. Bronchial pneumonia may appear after the first 24 h. Following ingestion or systemic absorption, material causes inhibition of cell mitosis, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and narcosis in the mucous membranes. Ingestion of 2−6 mg causes nausea and vomiting.

Long Term Exposure: Following significant whole-body (systemic) absorption of nitrogen mustard, injury to the bone marrow, lymph nodes, and spleen may cause a drop in white blood cell counts (beginning on days 3−5), which can result in an increased risk for developing (life-threatening) infections. Counts of red blood cells and platelets may also fall due to bone marrow damage.

First Aid: There is no antidote for nitrogen mustard toxicity. Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage.[NIOSH] Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 h. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. Stop exposure and treat symptomatically. Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage.[NIOSH] Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first 2 min following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/health-care providers or the health-care facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing. (2) Patients exposed to liquid should be decontaminated by (a) washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes, or open wounds with sterile saline or water.

(3) The health-care provider should (a) check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process; (b) be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time-consuming process. The health-care provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Personal Protective Methods: Wear Totally Encapsulating Chemical Protective (TECP) suit that provides protection against CBRN agents; Chemical-resistant inner and outer gloves; Chemical-resistant boots with a steel toe and shank; Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items. Take all necessary precautions to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Where a potential exposure to the chemical exists, use a NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation Hazard, Packing Group I, Zone B] requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group 1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation and skin contact. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

HN-1, when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)

Day	0.2/0.3
Night	0.4/0.6

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. When heated to decomposition, it emits poisonous gases of hydrogen chloride and nitrogen oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethylbis(2-Chloroehtyl)Amine*. Washington, DC: Chemical Emergency Preparedness Program

The Riegle Report: A Report of Chairman Donald W. Riegle, Jr. and Ranking Member Alfonse M. D'Amato of the Committee on Banking, Housing and Urban Affairs with Respect to Export Administration, United States Senate, 103rd Congress, 2d Session (May 25, 1994)

Ethyl bromide E:0410

Molecular Formula: C_2H_5Br
Synonyms: Bromic ether; Bromoethane; Bromure d'ethyle (French); Halon 2001; Hydrobromic ether; Monobromoethane; NCI-C55481
CAS Registry Number: 74-96-4
RTECS® Number: KH6475000
UN/NA & ERG Number: UN1891/131
EC Number: 200-825-8 [*Annex I Index No.:* 602-055-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis Studies (inhalation); some evidence: rat; IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

California Proposition 65 Chemical: Cancer 12/22/00.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; R40; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl bromide is a colorless liquid (turns yellow on contact with air) with an ether-like odor and a burning taste. A gas above the boiling point. Odor threshold = 3.1 ppm. Molecular weight = 108.98; Specific gravity (H_2O:1) = 1.46; Boiling point = 38.3°C; Freezing/Melting point = -118.9; Vapor pressure = 375 mmHg at 20°C; Flash point = < -15.6°C; Autoignition temperature = 511°C. Explosive limits: LEL = 6.8%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.9%.

Potential Exposure: Compound Description: Tumorigen, Mutagen. This chemical is used as an industrial chemical, pharmaceutical, and veterinary drug; as an ethylating agent in organic synthesis and gasoline; as a refrigerant; and as an extraction solvent. It has limited use as a local anesthetic.

Incompatibilities: Forms explosive mixture with air. Hydrolyzes in water, forming hydrogen bromide. Oxidizers may cause fire or explosions. Fire and explosions may be caused by contact with chemically active metals: aluminum, magnesium or zinc powders, lithium, potassium, sodium. Attacks some plastic, rubber, and coatings.

Note: Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine, vigorously chlorinate nitrogen mustards to the carbon chain, giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.46 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 200 ppm/890 mg/m^3 TWA.
NIOSH REL: None.

ACGIH TLV®[1]: 5 ppm/22 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: 2000 ppm.
Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 750 ppm
PAC-2: 2000 ppm
PAC-3: 2000 ppm
DFG MAK: [skin] Carcinogen Category 2.
Australia: TWA 200 ppm (890 mg/m^3); STEL 250 ppm, 1993; Austria: carcinogen, 1999; Belgium: TWA 200 ppm (891 mg/m^3); STEL 250 ppm (1100 mg/m^3), 1993; Denmark: TWA 5 ppm (22 mg/m^3), [skin], 1999; Finland: TWA 200 ppm (890 mg/m^3); STEL 250 ppm (1115 mg/m^3), 1999; France: VME 288 ppm (890 mg/m^3), 1999; Hungary: TWA 50 mg/m^3; STEL 100 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 22 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (22 mg/m^3), 1999; the Philippines: TWA 300 ppm (890 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, MAC (STEL) 400 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 5 ppm (22 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 200 ppm (890 mg/m^3), 1993; United Kingdom: TWA 200 ppm (906 mg/m^3); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines for ethyl bromide in ambient air[60] ranging from 8.9−11.1 mg/m^3 (North Dakota) to 14.8 mg/m^3 (Virginia) to 17.8 mg/m^3 (Connecticut) to 21.19 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with isopropanol, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1011.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Nitrogen Mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells.

Short Term Exposure: Irritates the skin, eyes, and respiratory tract. Inhalation can cause lung irritation with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause central nervous system depression, headache, nausea, dizziness, loss of balance, slurred speech, numbness, unconsciousness, and death. Exposure to high concentrations can cause cardiac arrhythmia. This can be fatal.

Points of Attack: Skin, liver, kidneys, respiratory system, lungs, cardiovascular system, central nervous system.

Medical Surveillance: Liver and kidney function tests. EKG. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *Up to 2000 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBA (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator under an inert atmosphere and protect from light. Keep away from incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup

is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl bromide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and hydrogen bromide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with adequate scrubbing and ash disposal facilities.

Ethyl bromoacetate E:0420

Molecular Formula: $C_4H_7BrO_2$

Synonyms: Acetic acid, bromo-, ethyl ester; Antol; Bromoacetic acid, ethyl ester; Ethoxycarbonylmethyl bromide; Ethyl α-bromoacetate; Ethyl bromoacetate; Ethyl monobromoacetate

CAS Registry Number: 105-36-2

RTECS® Number: AF6000000

UN/NA & ERG Number: UN1603/155

EC Number: 203-290-9 [*Annex I Index No.:* 607-069-00-1]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R26/27/28; Safety phrases: S1/2; S7/9; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl bromoacetate is a clear, colorless to light-yellow liquid. Molecular weight = 167.02; Boiling point = 159°C. Freezing point ≤−20°C; Flash point = 48°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Used for making pharmaceuticals; as a warning gas in poisonous, odorless gasses; as a tear gas.

Incompatibilities: Forms explosive mixture with air. Oxidizers, strong acids, strong bases, and reducing agents.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.00075 ppm
PAC-1: 0.0025 ppm
PAC-2: 0.02 ppm
PAC-3: 0.1 ppm

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can irritate the respiratory tract and cause headache, nausea, and vomiting. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Can irritate the skin causing rash or a burning sensation on contact. Can cause severe eye burns leading to permanent damage.

Long Term Exposure: May cause skin allergy and irritate the lungs, causing bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function tests. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases, reducing agents, heat, and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: DOT label requirement of "POISONOUS/ TOXIC MATERIALS, FLAMMABLE LIQUID." Ethyl bromoacetate falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and hydrogen bromide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Ethyl Bromoacetate*. Trenton, NJ

Ethylbutanol E:0430

Molecular Formula: $C_6H_{14}O$

Synonyms: 2-Ethyl-1-butanol; 2-Ethylbutanol-1; 2-Ethylbutyl alcohol; *sec*-Hexanol; *sec*-Hexyl alcohol; 3-Methylolpentane; *sec*-Pentylcarbinol; 3-Pentylcarbinol; Pseudohexyl alcohol

CAS Registry Number: 97-95-0

RTECS® Number: EL3850000

UN/NA & ERG Number: UN2275/129

UN/NA & ERG Number: 97-95-0 [*Annex I Index No.*: 603-051-00-2]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: S21/22; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethylbutanol is a colorless liquid with a mild, alcoholic odor. Molecular weight = 102.20; Boiling point = 149°C. Freezing/Melting point = −114°C; Vapor pressure = 0.89 mmHg at 20°C; Flash point = 58°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Used as a solvent; for making dyes, perfumes, flavorings, and drugs.

Incompatibilities: Forms explosive mixture with air. Incompatible with oxidizers, strong acids, caustics, isocyanates, amines, isocyanates.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, eyes, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause skin irritation. Eye contact can cause severe irritation and burns; possible permanent damage. Inhalation can cause irritation of the respiratory tract, causing coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases, reducing agents, heat, and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." Ethylbutanol is in DOT/UN Hazard Class 3 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration by spraying or in paper packaging. Flammable solvent may be added.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethylbutanol*. Trenton, NJ

Ethyl butyl ether E:0440

Molecular Formula: $C_6H_{14}O$

Synonyms: Butane, 1-ethoxy-; Butyl ethyl ether; Ether ethylbutylique (French); Ethyl-*n*-butyl ether

CAS Registry Number: 628-81-9

RTECS® Number: KN4725000

UN/NA & ERG Number: UN1179/127

EC Number: 211-055-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl butyl ether is a colorless liquid. Molecular weight = 102.21; Boiling point = 92°C; Freezing/Melting point = − 124°C; Flash point = 4°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a solvent for extraction and in making other chemicals.

Incompatibilities: Forms explosive mixture with air. Heat or prolonged storage may cause the formation of unstable peroxides. Violent reaction with strong oxidizers. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, eyes, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract with coughing and wheezing. High levels can cause dizziness and loss of consciousness.

Long Term Exposure: Repeated or high exposures may affect the nervous system. Repeated exposure may remove the oils from the skin causing dryness, rash, or cracking.

Points of Attack: Skin, nervous system.

Medical Surveillance: Test the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, heat, and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "FLAMMABLE LIQUID." It is in DOT/UN Hazard Class 3 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure

position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March, 1999). *Hazardous Substances Fact Sheet: Ethylbutyl Ether*. Trenton, NJ

Ethyl butyl ketone E:0450

Molecular Formula: $C_7H_{14}O$

Common Formula: $C_2H_5COC_4H_9$

Synonyms: *n*-Butyl ethyl ketone; Butyl ethyl ketone; 3-Heptanone; Heptan-3-one

CAS Registry Number: 106-35-4

RTECS® Number: MJ5250000

UN/NA & ERG Number: UN1224/127

EC Number: 203-388-1 [*Annex I Index No.*: 606-003-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R 10; R20; R36; Safety phrases: S2; S24 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl butyl ketone is a colorless liquid with a powerful, fruity odor. Molecular weight = 114.21; Specific gravity (H_2O:1): 0.82; Boiling point = 147.8°C; Freezing/ Melting point = −38.9°C; Vapor pressure = 4 mmHg at 20°C; Flash point = 46°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water; solubility = 1%.

Potential Exposure: Compound Description: Primary Irritant. Ethyl butyl ketone is used as a solvent and as an intermediate in organic synthesis. It is a solvent for vinyl and nitrocellulose resins. It is used in food flavoring.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers, acetaldehyde, perchloric acid. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 50 ppm/230 mg/m^3 TWA.

NIOSH REL: 50 ppm/230 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/234 mg/m^3 TWA; 75 ppm/ 350 mg/m^3 STEL.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 75 ppm

PAC-2: 200 ppm

PAC-3: 1000 ppm

DFG MAK: 10 ppm/47 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D.

Australia: TWA 50 ppm (230 mg/m^3), 1993; Austria: MAK 50 ppm (230 mg/m^3), 1999; Belgium: TWA 50 ppm (234 mg/m^3), 1993; Denmark: TWA 50 ppm (230 mg/m^3), 1999; Finland: TWA 50 ppm (230 mg/m^3); STEL 75 ppm (345 mg/m^3), 1999; France: VME 50 ppm (230 mg/m^3), 1999; the Netherlands: MAC-TGG 163 mg/m^3, 2003; Norway: TWA 25 ppm (115 mg/m^3), 1999; Sweden: TWA 25 ppm (120 mg/m^3); STEL 50 ppm (250 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (230 mg/m^3), 1999; United Kingdom: TWA 50 ppm (237 mg/m^3); STEL 100 ppm [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 75 ppm. Several states have set guidelines or standards for ethyl butyl ketone in ambient air[60] ranging from 2.3−3.45 mg/m^3 (North Dakota) to 3.8 mg/m^3 (Virginia) to 4.6 mg/m^3 (Connecticut) to 5.476 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1301, #2553, or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl butyl ketone irritates the eyes, skin, and respiratory tract. Exposure to high concentrations can affect the central nervous system, cause dizziness, lightheadedness, and to lose consciousness.

Long Term Exposure: Repeated or prolonged contact with skin may cause dryness and cracking.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing

material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *500 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or Sa (APF = 10) (any supplied-air respirator). *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethyl butyl ketone must be stored to avoid contact with oxidizers, such as peroxides, chlorates, perchlorates, permanganates, and nitrates, because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethyl butyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Ketones, liquid, n.o.s. require a shipping label of "FLAMMABLE LIQUID." They fall in Hazard Class 3 and ethyl butyl ketone in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl butyl ketone out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Ethyl Butyl Ketone*. Trenton, NJ

Ethyl butyraldehyde E:0460

Molecular Formula: $C_6H_{12}O$

Common Formula: $(C_2H_5)_2CHCHO$

Synonyms: Aldehyde-2-ethylbutyrique (French); Butyraldehyde, 2-ethyl-; Diethyl acetaldehyde; 2-Ethylbutanal; α-Ethylbutyraldehyde; 2-Ethylbutyraldehyde; Ethylbutyraldehyde; 2-Ethylbutyric aldehyde
CAS Registry Number: 97-96-1
RTECS® Number: ES2625000
UN/NA & ERG Number: UN1178/130
EC Number: 202-623-5
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Ethyl butyraldehyde is a colorless liquid. Molecular weight = 100.18; Boiling point = 116.8°C; Freezing/Melting point = −89°C; Flash point = 21°C (oc). Explosive limits: LEL = 1.2%; UEL = 7.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Insoluble in water.
Potential Exposure: Used in organic synthesis of pharmaceuticals and rubber chemicals.
Incompatibilities: Strong oxidizers, strong bases, reducing agents.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the skin and eyes on contact. Inhalation irritates the respiratory tract causing coughing and wheezing.
Long Term Exposure: Unknown at this time.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, polyurethane foams, or a similar material and deposit in sealed containers. Keep ethyl butyraldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be

trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 69−71 (1981) and 3, No. 2, 85−87

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethylbutyraldehyde*. Trenton, NJ

Ethyl butyrate E:0470

Molecular Formula: $C_6H_{12}O_2$

Common Formula: $C_3H_7COOC_2H_5$

Synonyms: Butonic acid, ethyl ester; Butyric acid, ethyl ester; Butyric ether; Ethyl butanoate; Ethyl *n*-butyrate

CAS Registry Number: 105-54-4

RTECS® Number: ET1660000

UN/NA & ERG Number: UN1180/130

EC Number: 203-306-4

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl butyrate is a colorless liquid with a pineapple-like odor. The odor threshold is 0.015 ppm.[41] Molecular weight = 116.16; Boiling point = 120°C; Flash point = 24°C; Autoignition temperature = 463°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Ethyl butyrate is used in flavorings, extracts, perfumery, and as a solvent.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidizers, strong acids, strong bases, heat.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl butyrate can affect you when breathed in and by passing through your skin. Contact can irritate the skin and eyes. The vapor irritates the eyes, nose, throat, and lungs. Symptoms may include nosebleeds, sore throat, cough with phlegm, and/or difficulty in breathing. Overexposure may cause headaches and make you feel dizzy and lightheaded. Higher levels can make you pass out.

Long Term Exposure: Unknown at this time.

Points of Attack: Lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests, especially with irritation symptoms. Consider liver function tests after suspected overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl butyrate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethyl butyrate is incompatible with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), bases, and heat. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethyl butyrate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl butyrate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl butyrate.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Cover spill with activated carbon adsorbent, take up and deposit in sealed containers. Keep ethyl butyrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Ethyl Butyrate*. Trenton, NJ

Ethyl chloride E:0480

Molecular Formula: C_2H_5Cl

Common Formula: CH_3CH_2Cl

Synonyms: Aethylchlorid (German); Aethylis; Aethylis chloridum; Anesthetic chloryl; Anodynon; Chelen; Chlorene; Chlorethyl; Chloridum; Chlorure d'ethyle (French); Chloryl; Chloryl anesthetic; Cloretilo; Cloroetano (Spanish); Dublofix; Ethane, chloro-; Ether chloratus; Ether hydrochloric; Ether muriatic; Hydrochloric ether; Kelene; Monochlorethane; Monochloroethane; Muriatic ether; Narcotile; NCI-C06224

CAS Registry Number: 75-00-3

RTECS® Number: KH7525000

UN/NA & ERG Number: UN1037/115

EC Number: 200-830-5 [*Annex I Index No.:* 602-009-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as chlorinated ethanes.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.27; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (10).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer.

European/International Regulations: Hazard Symbol: F+, Xn, N; Risk phrases: R12; R40; R52/53; Safety phrases: S2; S9; S16; S33; S36/37; S61.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethyl chloride is a colorless gas or liquid (below 12°C) with a pungent, ether-like odor and a burning taste. Shipped as a liquefied compressed gas. Molecular weight = 64.52; Specific gravity (H_2O:1) = 0.92 (liquid at 0°C); Boiling point = 12.2°C; Freezing/Melting point = −138.9; Vapor pressure = 1000 mmHg at 20°C; Flash point = −50°C (liquid); Autoignition temperature = 519°C. Explosive limits: LEL = 3.8%; UEL = 15.4%. Hazard Identification (based on NFPA-704

M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.6%.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone. Ethyl chloride is used as an ethylating agent in the manufacture of tetraethyl lead, dyes, drugs, and ethyl cellulose; as a pharmaceutical solvent; alkylating agent; as a refrigerant; and as a local anesthetic (freezing).

Incompatibilities: Flammable gas. Slow reaction with water; forms hydrogen chloride gas. Contact with moisture (water, steam) forms hydrochloric acid and/or fumes of hydrogen chloride. May accumulate static electrical charges, and may cause ignition of its vapors. Forms explosive mixture with air. Contact with chemically active metals: aluminum, lithium, magnesium, sodium, potassium, zinc may cause fire and explosions. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.64 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/2600 mg/m^3 TWA.

NIOSH REL: Handle with caution in the workplace. NIOSH considers chloroethanes to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 100 ppm [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 3800 [LEL].

Temporary Emergency Exposure Limits (DOE).

TEEL-0: 100 ppm

PAC-1: 200 ppm

PAC-2: 1500 ppm

PAC-3: 3800 ppm

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 1000 ppm (2600 mg/m^3), 1993; Austria Suspected: carcinogen, 1999; Belgium: TWA 1000 ppm (2640 mg/m^3), 1993; Denmark: TWA 1000 ppm (2600 mg/m^3), 1999; Finland: TWA 500 ppm (1300 mg/m^3); STEL 625 ppm (1625 mg/m^3), 1999; France: VME 1000 ppm (2600 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 300 mg/m^3, 1993; the Netherlands: MAC-TGG 2600 mg/m^3, 2003; Norway: TWA 500 ppm (1300 mg/m^3), 1999; the Philippines: TWA 1000 ppm (2600 mg/m^3), 1993; Poland: MAC (TWA) 200 mg/m^3, MAC (STEL) 1600 mg/m^3, 1999; Russia: TWA 1000 ppm; STEL 50 mg/m^3, 1993; Sweden: NGV 500 ppm (1300 mg/m^3), KTV 700 ppm (1900 mg/m^3), 1999; Switzerland: MAK-W 1000 ppm (2600 mg/m^3), 1999; Turkey: TWA 1000 ppm (2600 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (2700 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[35, 43] set a MAC in work-place air of 50 mg/m^3. Limits on ambient air in residential areas have been set by Russia[35] at 0.2 mg/m^3 on a daily average basis and by the Czech Republic at 0.1 mg/m^3 on a daily average basis. Several states have set guidelines or standards for ethyl chloride in ambient air[60] ranging from zero (Virginia) to 0.36 mg/m^3 (Massachusetts) to 26.0 mg/m^3 (North Dakota) to 52.0 mg/m^3 (Connecticut, Florida, New York) to 61.88 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 2519.[18]

Permissible Concentration in Water: No criteria set due to volatility and low specific gravity.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.53$.

Routes of Entry: Inhalation of gas, slight percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl chloride irritates eyes, skin, and respiratory tract. Inhalation of vapor may have a narcotic effect. Skin contact with the liquid may cause frostbite. Ethyl chloride exposure may produce headache, dizziness, lack of coordination, stomach cramps, and eventual loss of consciousness. In high concentrations, it is a respiratory tract irritant, and death due to cardiac arrest has been recorded. Renal damage has been reported in animals.

Long Term Exposure: There is limited evidence that ethyl chloride causes skin or uterine cancer in animals. May affect the nervous system, liver, and kidneys.

Points of Attack: Liver, kidneys, respiratory system, cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heartbeat. Tests of liver and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **4 h:** Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *Up to 3800 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF* (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl chloride must be stored to avoid contact with oxidizers (such as peroxides, chlorates, perchlorates, nitrates, and permanganates) or chemically active metals (such as sodium, potassium, calcium, powdered aluminum, zinc, and magnesium) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethyl chloride is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more of ethyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl chloride. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1 and there is no Packing Group.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *If ethyl chloride gas is leaked*, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep ethyl chloride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid or gas. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire.

Liquid: Establish forced ventilation to keep levels below explosive limit. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Establish forced ventilation to keep levels below explosive limit. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in

OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Chloroethane*. Washington, DC

US Environmental Protection Agency. (1980). *Chloroethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Chloroethane: Health and Environmental Effects Profile No. 44*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 64−66

US Public Health Service. (December 1988). *Toxicological Profile for Chloroethane*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Ethyl Chloride*. Trenton, NJ

Ethyl chloroacetate E:0490

Molecular Formula: $C_4H_7ClO_2$

Common Formula: $CH_3CH_2OCO \cdot CH_2Cl$

Synonyms: Chloroacetic acid, ethyl ester; Ethyl α-chloroacetate; Ethyl chloroacetate; Ethyl chloroethanoate; Ethyl monochloracetate; Ethyl monochloroacetate

CAS Registry Number: 105-39-5

RTECS® Number: AF9110000

UN/NA & ERG Number: UN1181/155

EC Number: 203-294-0 [*Annex I Index No.*: 607-070-00-7]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R50; Safety phrases: S1/2; S7/9; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethyl chloroacetate is a water-white liquid with a pungent, fruity odor. Molecular weight = 122.56; Boiling point = 145°C. Freezing point = −27°C; Flash point = 64°C. Hazard Identification (based on NFPA-704 M Rating System): Health: 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Primary Irritant. Used to make rodenticides, dyes, and other chemicals. Also used as a military poison.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong bases, strong acids, reducing agents. Moisture, water, and steam contact forms toxic and corrosive fumes. Violent reaction with oxidizers, alkaline earth metals (barium, calcium, magnesium, strontium, etc.), alkaline metals, sodium cyanide. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.15 ppm
PAC-1: 0.4 ppm
PAC-2: 3 ppm
PAC-3: 15 ppm

Routes of Entry: Inhalation, eyes, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can severely irritate and burn eyes and skin. Inhalation can irritate the respiratory tract with coughing and wheezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, nausea, and vomiting.

Long Term Exposure: Very irritating substances may cause lung damage.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases, reducing agents, heat, and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethyl Chloroacetate*. Trenton, NJ

Ethyl 2-chloropropionate E:0500

Molecular Formula: $C_5H_9ClO_2$

Common Formula: $CH_3CHClCOOC_2H_5$

Synonyms: 2-Chloropropionic acid, ethyl ester; Propanoic acid, 2-chloro-, ethyl ester

CAS Registry Number: 535-13-7

RTECS® Number: UE8870000

UN/NA & ERG Number: UN2935/129

EC Number: 208-610-0

Regulatory Authority and Advisory Bodies

WGK (Germany) 3 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl-2-chloropropionate is a liquid with a pleasant odor. Molecular weight = 136.8; Boiling point = 147°C; Flash point = 41.8°C.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Acids, bases, oxidizers, reducing agents.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl-2-chloropropionate can affect you when breathed in. Eye or skin contact may irritate the nose, throat, and bronchial tubes. High exposures might cause a dangerous fluid buildup in the lungs (pulmonary edema); a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Some related chemicals may cause skin allergy. Very irritating substances may cause lung problems.

Points of Attack: Respiratory tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests, especially if lung symptoms are present. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl-2-chloropropionate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, bases, oxidizing and reducing agents. Sources of ignition, such as smoking and open flames, are prohibited where ethyl-2-chloropropionate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including chlorides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Ethyl-2-Chloropropionate*. Trenton, NJ

Ethyl cyanoacetate E:0510

Molecular Formula: $C_5H_7NO_2$

Synonyms: Acetic acid, cyano-, ethyl ester; Cyanacetate ethyle (German); Cyanoacetic acid ethyl ester; Cyanoacetic ester; Estere cianoacetico; Ethyl cyanoacetate; Ethyl cyanoethanoate; Malonic acid, ethyl ester nitrile

CAS Registry Number: 105-56-6

RTECS® Number: AG4110000

UN/NA & ERG Number: UN2666/156

EC Number: 203-309-0

Regulatory Authority and Advisory Bodies

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl cyanoacetate is a colorless to straw-colored liquid with a mild pleasant odor. Molecular weight = 113.14; Boiling point = 207°C; Freezing/Melting point = −23°C; Vapor pressure = 1 mmHg at 68°C; Flash point = 110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Used to manufacture dyes, pharmaceuticals, and other chemicals.

Incompatibilities: Oxidizers, strong acids, strong bases, and reducing agents. Reacts with moisture, water, and steam, forming toxic fumes.

Permissible Exposure Limits in Air

NIOSH REL: (*nitriles*) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.

No TEEL available.

Determination in Air: See NIOSH Criteria Document 78-212, NITRILES.

Routes of Entry: Inhalation. May be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: An organic cyanide compound. Irritates the eyes, skin, and respiratory tract. Exposure can cause headache, nausea, and vomiting. Poisonous if ingested.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases, strong acids, reducing agents, moisture, and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: DOT label requirement is “POISONOUS/TOXIC MATERIALS.” Ethyl cyanoacetate falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, nitrogen oxides, and cyanides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound

increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethyl Cyanoacetate*. Trenton, NJ

Ethyl-4,4′-dichlorobenzilate E:0520

Molecular Formula: $C_{16}H_{14}C_{12}O_3$

Synonyms: Acar; Acaraben; Acaraben 4E; Akar 338; Benzeneacetic acid, 4-chloro-α-(4-chlorophenyl)-α-hydroxy-, ethyl ester; Benzilan; Benzilic acid, 4,4′-dichloro-, ethyl ester; Benzilic acid,4,4′-dichloro, ethyl ester; Benz-*o*-chlor; Chlorbenzilate; Chlorbenzilat; 4-Chloro-α-(4-chlorophenyl)-α-hydroxybenzeneacetic acid ethyl ether; 4,4′-Cichlorbenzilsaeureaethylester (German); Compound 338; 4,4′-Dichlorobenzilate; 4,4′-Dichlorobenzilic acid ethyl ester; ECB; ENT 18,596; Ethyl 4-chloro-α-(4-chlorophenyl)-α-hydroxybenzene acetate; Ethyl *p*,*p*′-dichlorobenzilate; Ethyl 4,4′-dichlorobenzilate; Ethyl-4,4′-dichlorodiphenyl glycollate; Ethyl-4,4′-dichlorophenyl glycollate; Ethyl ester of 4,4′-dichlorobenzilic acid; Ethyl 2-hydroxy-2,2-bis(4-chlorophenyl)acetate; Folbex; Folbex smoke strips; G 23992; G 338; Geigy 338; Kop Mite; NCI-C00408; NCI-C60413

CAS Registry Number: 510-15-6

RTECS® Number: DD2275000

UN/NA & ERG Number: UN2761/151 (solid); UN2996 (liquid)/151

EC Number: 208-110-2 [*Annex I Index No.*: 607-159-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat, 1978.

US EPA Gene-Tox Program, Negative: *In vitro* SCE—human lymphocytes; *In vitro* SCE—human.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U038.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.10; Nonwastewater (mg/kg), N/A.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as chlorobenzilate).

California Proposition 65 Chemical: Cancer 1/1/90.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl 4,4′-dichlorobenzilate is a yellow solid when pure. The technical product is a brownish liquid. Molecular weight = 82.04; Specific gravity (water = 1) = 1.282; Boiling point = 146−148°C; Freezing/Melting point = 35−37.3°C (pure); Vapor pressure = 2.2×10^{-6} mmHg at 20°C; Flashpoint = 40°C. Practically insoluble in water; solubility = <0.1 mg/mL at 22°C.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. It is a buffer in many chemical intermediates; an organochlorine miticide to kill mites, ticks, and other insects; as a synergist for DDT.

Incompatibilities: Strong acids, strong bases, lime.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 300 mg/m^3

Routes of Entry: Inhalation, ingestion, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the skin causing rash or burning sensation. Exposure can cause headache, loss of appetite, nausea, vomiting, and diarrhea.

Long Term Exposure: This chemical may damage the male reproductive glands. May cause liver and kidney damage. Repeated or prolonged exposure may affect the nervous system, causing a loss of coordination, muscle weakness, tremors, convulsions, dizziness, and possible coma. This chemical may be a human carcinogen.

Points of Attack: Liver, kidneys, nervous system.

Medical Surveillance: Examination of the nervous system. Liver and kidney function tests. More than light alcohol consumption may exacerbate liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention

immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition are prohibited where this chemical is used, handled, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Organochlorine pesticide, liquid, toxic. DOT label requirement is "POISONOUS/TOXIC MATERIALS." This chemical falls in Hazard Class 6.1 and Packing Group II.[19,20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Ethyl-4,4′-Dichlorobenzilate*. Trenton, NJ

Ethyl dichlorosilane E:0530

Molecular Formula: $C_2H_6Cl_2Si$

Common Formula: $Cl_2SiHC_2H_5$

Synonyms: Dichloroethylsilane; Ethyldichlorosilane; Monoethyldichlorosilane; Silane, dichloroethyl-

CAS Registry Number: 1789-58-8

RTECS® Number: VV3230000

UN/NA & ERG Number: UN1183/139

EC Number: 217-255-0

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl dichlorosilane is a colorless liquid with a sharp, irritating odor. Molecular weight = 129.07; Boiling point = 75.5°C; Flash point = −1°C. Explosive limits: LEL: 2.9%; UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2₩. Dangerously reactive with water.

Potential Exposure: This material is used in silicone polymer manufacture.

Incompatibilities: Forms explosive mixture with air. Reacts vigorously with water, steam, or surface moisture, generating hydrogen chloride. Incompatible with strong oxidizers, strong bases. Attacks most common metals in the presence of moisture.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl dichlorosilane is corrosive. It can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death. Ethyl dichlorosilane is a corrosive chemical and contact can cause severe skin and eye burns leading to permanent eye damage.

Long Term Exposure: This chemical can irritate the lungs. Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl dichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl dichlorosilane must be stored to avoid contact with moisture and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride can be produced. Sources of ignition, such as smoking and open flames, are prohibited where ethyl dichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl dichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl dichlorosilane.

Shipping: This compound requires a shipping label of “DANGEROUS WHEN WET, CORROSIVE, FLAMMABLE LIQUID.” It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical. *Do not use water* (forms hydrogen chloride gas). Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Ethyl Dichlorosilane*. Trenton, NJ

Ethylene E:0540

Molecular Formula: C_2H_4

Synonyms: Acetene; Athylen (German); Bicarburretted hydrogen; Dicarburetted hydrogen; Elayl; Eteno (Spanish); Ethene; Etherin; Heavy carburetted hydrogen; Olefiant gas

CAS Registry Number: 74-85-1; *(alt.)* 33060-30-9; *(alt.)* 87701-64-2; *(alt.)* 87701-65-3

RTECS® Number: KU5340000

UN/NA & ERG Number: UN1038 (liquid)/115; UN1962 (compressed)/116

EC Number: 200-815-3 [*Annex I Index No.:* 601-010-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal No Adequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: F + ; Risk phrases: R12; R67; Safety phrases: S2; S9; S16; S33; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Ethylene, an alkene, is a colorless gas (at room temperature) with a sweet odor. The minimum detectable odor is 260 ppm. Molecular weight = 28.06; Boiling point = −104°C; Freezing/Melting point = −169°C; Autoignition temperature = 450−490°C. Explosive limits: LEL = 2.7%; UEL = 36.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen. Ethylene is used in the production of fabricated plastics, antifreeze; making fibers; to manufacture ethylene oxide, polyethylene for plastics, alcohol, mustard gas, and other organics. It is used to accelerate ripening of fruit; as an anesthetic; and for oxyethylene welding; and cutting of metals.

Incompatibilities: A highly flammable gas at room temperature. Contact with oxidizers may cause explosive polymerization and fire. May be spontaneously explosive in sunlight or ultraviolet light when mixed with chlorine. Reacts violently with mixtures of carbon tetrachloride and benzoyl peroxide; bromotrichloromethane; aluminum chloride; and ozone. Incompatible with acids, halogens, nitrogen oxides, hydrogen bromide, aluminum chloride, chlorine dioxide, nitrogen dioxide. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL (*construction & shipyards only*): Simple asphyxiants—inert gas and vapor.

NIOSH REL: None.

ACGIH TLV®[1]: 200 ppm/230 mg/m^3 TLV; not classifiable as a human carcinogen (2001).
Protective Action Criteria (PAC)
TEEL-0: 200 ppm
PAC-1: 600 ppm
PAC-2: 1500 ppm
PAC-3: 7500 ppm
DFG MAK: Carcinogen Category 3B.
Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; the Netherlands: MAC-TGG 330 mg/m^3, 2003; Russia: STEL 100 mg/m^3, 1993; Switzerland: MAK-W 10000 ppm (11500 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia cites a MAC of 3 mg/m^3 for ambient air of residential areas on either a momentary or a daily average basis. Virginia[60] has set a guideline of 3.0 μg/m^3 for ethylene in ambient air.

Permissible Concentration in Water: Russia[43] gives a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Severe exposures may cause faintness, a lack of coordination; excitement, stupor, unconsciousness, convulsions, stopped breathing; paralysis; and heart, liver, and kidney damage. 20−25% (200,000−250,000 ppm) gas has caused loss of sense of pain. 80−90% (800,000−900,000 ppm) has caused anesthesia. *Skin:* Contact with liquid can cause a "freezing burn." *Eyes:* Same as skin. *Ingestion:* No information available.

Long Term Exposure: Inhalation may cause loss of appetite and weight, irritability, insomnia, increase in red blood cell count, and inflammation of the kidneys.

Points of Attack: Kidneys.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to ethylene gas is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from chlorine compounds, oxidizing agents, and combustible materials. Sources of ignition, such as smoking and open flames, are prohibited where ethylene is handled, used, or stored, Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene. Wherever ethylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Compressed or cryogenic liquid ethylene requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1 and there is no Packing Group.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal

environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible gas or liquid. Poisonous gases are produced in fire.

Liquid: Use dry chemical, carbon dioxide, or water spray in large amounts. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Ventilate area of leak to disperse gas. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 79−81

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ethylene*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Ethylene*. Trenton, NJ

Ethylene chlorohydrin E:0550

Molecular Formula: C_2H_5ClO

Common Formula: CH_2ClCH_2OH

Synonyms: Aethylenechlorhydrin (German); 2-Chlorethanol (German); β-Chlorethyl alcohol; β-Chloroethanol; 2-Chloroethanol; Chloroethanol; 2-Chloroethyl alcohol; 2-Cloroetanol (Spanish); Cloroetanol (Spanish); delta-Chloroethanol; Ethanol, 2-chloro-; Ethylene chlorohydrine; Glycol chlorohydrin; Glycol monochlorohydrin; Monochlorhydrine du glycol (French); 2-Monochloroethanol; NCI-C50135

CAS Registry Number: 107-07-3

RTECS® Number: KK0875000

UN/NA & ERG Number: UN1135/131

EC Number: 203-459-7 [*Annex I Index No.:* 603-028-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (dermal); no evidence: mouse, rat.

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9; Histidine reversion—Ames test EPA; Negative: Sperm morphology—mouse; *S. cerevisiae* gene conversion EPA; Negative: *S. pombe*—forward mutation.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/27/28; Safety phrases: S1/2; S7/9; S28; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethylene chlorohydrin is a colorless liquid with a faint, ether-like odor. Molecular weight = 80.52; Specific gravity (H_2O:1) = 1.20; Boiling point = 127.8°C; Freezing/Melting point = − 67.8°C; Vapor pressure = 5 mmHg at 20°C; Flash point = 60°C (cc); Autoignition temperature = 425°C. Explosive limits: LEL = 4.9%; UEL = 15.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene chlorohydrin is used as a solvent and emulsifier; in the synthesis of ethylene glycol, ethylene oxide, amines, carbitols, indigo, malonic acid, novocaine; and in other reactions where the hydroxyethyl group is introduced into organic compounds; for the separation of butadiene from hydrocarbon mixtures; in dewaxing and removing cycloalkanes from mineral oil; in the refining of rosin; in the manufacture of certain pesticides; and in the extraction of pine lignin. In the lacquer industry, it is used as a solvent for cellulose acetate, cellulose esters, resins and waxes; and in the dyeing and cleaning industry, it is used to remove tar spots; as a cleaning agent for machines; and as a solvent in fabric dyeing. It has also found use in agriculture in speeding up sprouting of potatoes and in treating seeds to inhibit biological activity. Making chemical warfare agents.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with strong caustics (formation of ethylene gas), strong acids, alkaline metals, aliphatic amines, isocyanates. Violent reaction with ethylene diamine, chlorosulfonic acid. Attacks some plastics, rubber, and coatings. Reacts with water or steam producing toxic and corrosive fumes.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.29 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/16 mg/m^3 TWA [skin].

NIOSH REL: 1 ppm/3 mg/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 1 ppm/3.3 mg/m^3 Ceiling Concentration [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 7 ppm.

Protective Action Criteria (PAC)*

EEL-0: 1 ppm

PAC-1: 1 ppm

PAC-2: **4** ppm

PAC-3: **12** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 1 ppm/3.3 mg/m^3 Peak Limitation Category II (1) [skin]; Pregnancy Risk Group C.

Australia: TWA 1 ppm (3 mg/m^3), [skin], 1993; Austria: MAK 1 ppm (3 mg/m^3), [skin], 1993; Belgium: STEL 1 ppm (3.3 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (3 mg/m^3), [skin], 1999; Finland: STEL 1 ppm (3 mg/m^3), [skin], 1999; France: VLE 1 ppm (3 mg/m^3), [skin], 1999; the Netherlands: MAC 3 mg/m^3, [skin], 2003; the Philippines: TWA 5 ppm (16 mg/m^3), [skin], 1993; Poland: MAC (TWA) 1 mg/m^3; STEL 3 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, [skin], 1993; Sweden: TGV 1 ppm (3.5 mg/m^3), [skin], 1999; Switzerland: MAK-W 1 ppm (3 mg/m^3), KZG-W 5 ppm (15 mg/m^3), [skin], 1999; Turkey: TWA 5 ppm (16 mg/m^3), 1993; United Kingdom: STEL 1 ppm (3.4 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1 ppm [skin]. Several states have set guidelines or standards for 2-chloroethanol in ambient air[60] ranging from 30 μg/m^3 (North Dakota) to 71 μg/m^3 (Nevada) to 320 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #2513 or OSHA Analytical Method 7.[18]

Permissible Concentration in Water: Russia[43] set a MAC of 0.7 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.06$.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause severe irritation, with cough and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure to 18 ppm has resulted in vomiting and shock. Additional symptoms may include irritation of the nose, throat, and lungs. Poor coordination, numbness, visual disturbance, headache, difficult breathing, and unconsciousness may also occur. Death has resulted from inhalation of 300 ppm for 2½ h. Signs and symptoms of acute exposure to this chemical may include weakness, dizziness, confusion, visual disturbances, shock, seizures, and coma. Weak pulse, hypotension (low blood pressure), and cyanosis (blue tint to the skin and mucous membranes) may be observed. Nausea, vomiting, and hematuria (bloody urine) may be seen after exposure. Chloroethanol affects the central nervous system, cardiovascular system, liver, and kidneys. This chemical readily absorbed through the skin even though no irritation occurs and may cause symptoms listed above. Death has occurred from skin absorption of 1 teaspoon of liquid. Ingestion can cause irritation to the throat. May cause symptoms listed under inhalation. About 1/5 oz may be lethal to a 150-lb adult.

Long Term Exposure: Can cause damage to the kidneys, liver, cardiovascular system, and nervous system. May cause reproductive damage. Can irritate the lungs. Repeated exposure may cause bronchitis. High or repeated exposure can cause disturbed sleep; with loss of coordination in arms and legs.

Points of Attack: Respiratory system, liver, kidneys, central nervous system, cardiovascular system, eyes.

Medical Surveillance: Preplacement examination, including a complete history and physical should be performed. Examination of the respiratory system, liver, kidneys, and central nervous system should be stressed. The skin should be examined. A chest X-ray should be taken and pulmonary function tests should be performed (FVC-FEV). The above procedures should be repeated on an annual basis, except that the X-ray is needed only when indicated by pulmonary function testing. NIOSH lists the following tests: Expired Air; liver function tests; urinalysis (routine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. *Beware:* the liquid penetrates rubber. **8 h:** Viton™ gloves, suits, polyvinyl alcohol gloves; Barricade® coated suits; **4 h:** 4H™ and Silver Shield™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any possibility of eye contact. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *7 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosivecon-centration does not exist. Keep in a cool, well-ventilated area, protected from physical damage, ignition sources, and separated from strong oxidizers or caustics. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.7/1.2

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to

fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Chloroethanol*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1999). *Chemical Fact Sheet: Ethylene Chlorohydrin*. Albany, NY: Bureau of Toxic Substance Assessment

Ethylenediamine E:0560

Molecular Formula: $C_2H_8N_2$

Common Formula: $H_2NCH_2CH_2NH_2$

Synonyms: Aethaldiamin (German); Aethylenediamin (German); β-Aminoethylamine; 1,2-Diaminoaethan (German); 1,2-Diaminoethane, anhydrous; Dimethylenediamine; 1,2-Ethanediamine; 1,2-Ethylenediamine; Etilendiamina (Spanish); NCI-C60402; Sel-Rex circuitprep SC replinisher/makeup; Sel-Rex XR-170A pretreatment

CAS Registry Number: 107-15-3

RTECS® Number: KH8575000

UN/NA & ERG Number: UN1604/132

EC Number: 203-468-6 [*Annex I Index No.:* 612-006-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Gene-Tox Program, Negative: CHO gene mutation.

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: Hazard Symbol: C; Risk phrases: R10; R21/22; R34; R42/43; Safety phrases: S1/2; S23-S26-S36/37/39-S45.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethylenediamine, a polyamine, is a strongly alkaline, colorless, clear, thick liquid with an ammonia odor. A solid below 8.5°C. The odor threshold is 1.0 ppm. Molecular weight = 60.12; Specific gravity (H_2O:1) = 0.91; Boiling point = 116°C; Freezing/Melting point = 8.5°C; Vapor pressure = 11 mmHg at 20°C; Flash point = 33.9°C; Autoignition temperature = 385°C. Explosive limits: LEL = 2.5% at 100°C; UEL = 12% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Ethylenediamine is used as an intermediate; as a urine acidifier; as a solvent; an emulsifier for casein and shellac solutions; a stabilizer in rubber late. A chemical intermediate in the manufacture of dyes; corrosion inhibitors; synthetic waxes; fungicides, resins, insecticides, asphalt wetting agents; and pharmaceuticals. Ethylenediamine is a degradation product of the agricultural fungicide Maneb.

Incompatibilities: Forms explosive mixture with air. Ethylenediamine is a medium strong base. Violent reaction with strong acids, strong oxidizers, chlorinated organic compounds, acetic acid, acetic anhydride, acrolein, acrylic acid, acrylonitrile, allyl chloride, carbon disulfide, chlorosulfonic acid, epichlorohydrin, ethylene chlorohydrin, oleum, methyl oxide, vinyl acetate. Also incompatible with silver perchlorate, 3-propiolactone, mesityl oxide, ethylene dichloride, organic anhydrides, isocyanates, acrylates, substituted allyls, alkylene oxides, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc and alloys and some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.46 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/25 mg/m^3 TWA.

NIOSH REL: 10 ppm/25 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/25 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 9.7 ppm

PAC-1: 9.7 ppm

PAC-2: **9.7** ppm
PAC-3: **20** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: previous MAK suspended 2004; [skin] Danger of sensitization of the airways and skin.

Australia: TWA 10 ppm (25 mg/m^3), 1993; Austria: MAK 10 ppm (25 mg/m^3), 1999; Belgium: TWA 10 ppm (25 mg/m^3), 1993; Denmark: TWA 10 ppm (25 mg/m^3), 1999; Finland: TWA 10 ppm (25 mg/m^3); STEL 20 ppm (50 mg/m^3), 1999; France: VME 10 ppm (25 mg/m^3), VLE 15 ppm (35 mg/m^3), 1999; Japan; 10 ppm (25 mg/m^3) [skin] 1999; the Netherlands: MAC-TGG 18 mg/m^3, 2003; Norway: TWA 10 ppm (25 mg/m^3), 1999; the Philippines: TWA 10 ppm (25 mg/m^3), 1993; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 6 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 2 mg/m^3, 1993; Sweden: NGV 10 ppm (25 mg/m^3), KTV 15 ppm (35 mg/m^3), 1999; Switzerland: MAK-W 1000 ppm (6400 mg/m^3), 1999; Turkey: TWA 10 ppm (25 mg/m^3), 1993; United Kingdom: TWA 10 ppm (25 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for ethylenediamine in ambient air[60] ranging from 250 μg/m^3 (North Dakota) to 300−2500 μg/m^3 (North Carolina) to 400 μg/m^3 (Virginia) to 500 μg/m^3 (Connecticut) to 595 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2540 or OSHA Analytical Method 60.

Permissible Concentration in Water: Russia[43] set a MAC of 0.7 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -1.2$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethylenediamine is corrosive to the eyes, skin, and respiratory tract. Skin contact can cause blistering. Eye contact can cause pain, serious injury, and permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Acute exposure to ethylenediamine may result in cough, difficulty in breathing, irritation of the lungs, and pneumonia. Nausea, vomiting, and diarrhea are often seen. Contact with ethylenediamine may result in redness, pain, irritation, and burns. Vapor inhalation at a concentration of 200 ppm for 5−10 min will lead to nasal irritation and produce a tingling sensation. Inhalation at concentrations of 400 ppm or greater leads to severe nasal irritation. Respiratory irritation may result. Many individuals are hypersensitive to ethylenediamine exposure; therefore, safe threshold limits are difficult to set.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin allergy. Repeated or prolonged exposure can cause an asthma-like allergy. Repeated high exposure may cause liver, kidney, and lung damage.

Points of Attack: Respiratory system, liver, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests; liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Saranex™ coated suits; Responder™ suits; **4 h:** Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash if liquids containing >5% contaminants are involved.

Respirator Selection: *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *500 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s) or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethylenediamine must be stored to avoid contact with acetic acid, acetic anhydride, acrolein, acrylic acid, acrylonitrile, allyl chloride, carbon disulfide, chlorosulfonic acid, epichlorhydrin, ethylene chlorohydrin, oleum, methyl oxide, vinyl acetate, hydrogen chloride, and sulfuric acid since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Detached outdoor storage is preferred. Sources of ignition, such as smoking and open flames, are prohibited where ethylenediamine is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethylenediamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of ethylenediamine.

Shipping: This compound requires a shipping label of "CORROSIVE, FLAMMABLE LIQUID." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind and keep out of low areas. Isolate area for 1/2 mile in all directions if tank car or truck is involved in fire. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use water spray, dry chemical, alcohol foam, or carbon dioxide. Wear full protective clothing including gloves and boots. If necessary to enter closed area, wear full-faced gas masks with self-contained breathing apparatus. *Do not use water* in case of drum or tank fires. If a leak or spill has not ignited, use water spray to reduce the vapors and dilute spills to nonflammable mixtures. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

US Environmental Protection Agency. (May 9, 1978). *Chemical Hazard Information Profile: Ethylenediamine*. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 54−57

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethylenediamine*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Ethylene Diamine*. Trenton, NJ

Ethylenediamine tetraacetic acid (EDTA) E:0570

Molecular Formula: $C_{10}H_{16}N_2O$
Synonyms: Acetic acid (ethylenedinitrilo)tetra-; Acide ethylenediaminetetracetique (French); Acido etilendiaminotetraacetico (Spanish); Aroquest 75; Celon A; Celon ATH; Cheelox; Chemcolox 340; Complexon II; 3,6-Diazaoctanedioic acid, 3,6-bis(carboxymethyl)-; Edathamil; Edetic; Edetic acid; EDTA; EDTA acid; Endrate; Ethylenediamine tetraacetate; Ethylenediamine-*N*,*N*,*N*′,*N*′-tetraacetic acid; Ethylenediaminetetraacetic acid; Ethylenedinitrilotetraacetic acid; Glycine, *N*,*N*′-1,2-ethanediylbis[*N*-(carboxymethyl)-9CI]; Hamp-ENE acid; Havidote; Kalex acids; Metaquest A; Nervanaid B acid; Nullapon B acid; Nullapon BF acid; Perma Kleer 50 acid; Questric acid 5286; SEQ-100; Sequestrene AA; Sequestric acid; Sequestrol; Tetrine acid; Titriplex; Tricon BW; Trilon B; Trilon BS; Trilon BW; Versene; Versene acid; Warkeelate acid
CAS Registry Number: 60-00-4
RTECS® Number: AH4025000
UN/NA & ERG Number: Not regulated.
EC Number: 200-449-4 [*Annex I Index No.*: 607-429-00-8]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA1998 Status of Pesticides: Canceled.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 5000 lb (2270 kg).
European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36; Safety phrases: S2; S26 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: EDTA is a white, odorless, crystalline material or white powder. Molecular weight = 292.28; Boiling point = 150°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: Compound Description: Drug, Mutagen, Primary Irritant. EDTA is a general purpose chelating agent; used as a drug and food additive; in cosmetics; in household and textile articles; in pharmaceutical products; and in biochemicals. It is also used as a laboratory chemical in research; in photographic processing.
Incompatibilities: Reacts with strong oxidants, strong bases, copper, copper alloys, and nickel.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 40 mg/m^3
PAC-1: 125 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 150 mg/m^3
Determination in Air: None available.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: EDTA irritates the eyes, skin, and respiratory tract. Skin contact may cause a burning sensation and rash. May affect the kidneys.
Long Term Exposure: May damage the developing fetus. May cause kidney damage.
Points of Attack: Kidneys.
Medical Surveillance: Kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: Not regulated.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It does not easily ignite. Use dry chemical, carbon dioxide, water spray, alcohol or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Ethylenediamine Tetraacetic Acid*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Ethylene dibromide E:0580

Molecular Formula: $C_2H_4Br_2$
Common Formula: $BrCH_2CH_2Br$
Synonyms: Aadibroom; Aethylenbromid (German); Bromofume; Celmide; DBE; 1,2-Dibromaethan (German); 1,2-Dibromoetano (Spanish); α,β-Dibromoethane; *sym*-Dibromoethane; 1,2-Dibromoethane; Dibromoethane; Dibromudo de etileno (Spanish); Dibromure d'ethylene (French); Dowfume 40; Dowfume EDB; Dowfume W-8; Dowfume W-85; EDB; EDB-85; E-D-BEE; ENT 15,349; Ethane, 1,2-dibromo-; Ethylene bromide; 1,2-Ethylene dibromide; Fumo-gas; Glycol bromide; Glycol dibromide; Iscobrome D; Kopfume; NCI-C00522; Nefis; Nephis; Pestmaster; Pestmaster EDB-85; Sanhyuum; Soilbrom; Soilbrom-40; Soilbrom-85; Soilbrom-90EC; Soilbrome-85; Soilfume; Unifume

CAS Registry Number: 106-93-4
RTECS® Number: KH9275000
UN/NA & ERG Number: UN1605/154
EC Number: 203-444-5 [*Annex I Index No.:* 602-010-00-6]
Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; EPA: Likely to produce cancer in humans; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NTP: Carcinogenesis Bioassay (inhalation); clear evidence: mouse, rat; Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Host-mediated assay; Positive: L5178Y cells *In vitro*—TK test; *N. crassa*—forward mutation; Positive: *E. coli* polA without S9; Sperm morphology—human; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Negative: UDS in mouse germ cells; Inconclusive: Histidine reversion—Ames test; Positive: CHO gene mutation; IARC: Human Inadequate Evidence, Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999.

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (many countries) (UN).[3,35]

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U067.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5).

Safe Drinking Water Act: MCL, 0.00005 mg/L; MCGL, zero.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 1/1/87; Developmental/Reproductive toxin 5/15/98.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [as 1,2-dibromoethane (EDB)].

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/24/25; R36/37/38; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethylene dibromide is a colorless nonflammable liquid or solid (below 10°C) with a sweet, chloroform-like odor. The minimum concentration detectable by odor is 10 ppm. Molecular weight = 187.88; Specific gravity (H_2O:1) = 2.17; Boiling point = 131°C; Freezing/Melting point = 10°C; Relative vapor density (air = 1) = 6.5; Vapor pressure = 12 mmHg. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene dibromide is used as a chemical intermediate; as a fumigant for ground pest control; as a constituent of ethyl gasoline (antiknock agent). It is also used in fire extinguishers, gauge fluids, and waterproofing preparations, and it is used as a solvent for celluloid, fats, oils, and waxes.

Incompatibilities: Reacts vigorously with chemically active metals, liquid ammonia, strong bases, strong oxidizers, causing fire and explosion hazard. Light, heat, and moisture can cause slow decomposition, forming hydrogen bromide. Attacks fats, rubber, some plastics and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.69 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm TWA; 30 ppm Ceiling Concentration; 50 ppm [5-min maximum peak] [skin]. For Construction, Shipyards, and Federal Contractors: 25 ppm/190 mg/m^3 Ceiling Concentration [skin].

NIOSH REL: 0.045 ppm TWA; 0.13 ppm [15-min] Ceiling Concentration; Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: Potential occupational carcinogen, 100 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 17 ppm

PAC-1: **17** ppm

PAC-2: **24** ppm

PAC-3: **46** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

Arab Republic of Egypt: TWA 0.13 ppm (1 mg/m^3), 1999; Australia: [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: [skin], carcinogen, 1993; Finland: TWA 20 ppm (145 mg/m^3); STEL 30 ppm, [skin], carcinogen, 1999; France: carcinogen, 1993; Hungary: STEL 0.8 mg/m^3, [skin], carcinogen, 1993; the Netherlands: MAC-TGG 0.002 mg/m^3, 2003; the Philippines: TWA 25 ppm (190 mg/m^3), [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.8 mg/m^3), [skin], carcinogen, 1999; Thailand: TWA 20 ppm; STEL 30 ppm, 1993; Turkey: TWA 25 ppm (190 mg/m^3), [skin], 1993; United Kingdom: TWA 0.5 ppm (3.9 mg/m^3), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic[35] has set a TWA of 10 mg/m^3 with a ceiling value of 20 mg/m^3. Several states have set guidelines or standards for ethylene dibromide in ambient air[60] ranging from zero (North Dakota and New York) to 0.045 μg/m^3 (North Carolina) to 2.47 μg/m^3 (Pennsylvania) to 720 μg/m^3 (Indiana) to 770 μg/m^3 (South Carolina) to 1500 μg/m^3 (Virginia) to 1550 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #1008 or OSHA Analytical Method 2.

Permissible Concentration in Water: Several states have set guidelines or standards for ethylene dibromide in drinking water[61] ranging from 0.005 μg/L (Kansas) to 0.008 μg/L (Minnesota) to 0.01 μg/L (Arizona) to 0.02 μg/L (California and Washington) to 0.04 μg/L (Massachusetts) to 0.10 μg/L (Connecticut and New Mexico) to 0.50 μg/L (Wisconsin) to 1.0 μg/L (Maine). EPA[62] has proposed a maximum concentration level of 0.05 μg/L in drinking water.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.93

Routes of Entry: Inhalation of the vapor, absorption through the skin, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause severe skin and eye burns, with permanent eye damage. Exposure to the vapor may also damage the eyes. Inhalation may irritate and damage the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposure can cause dizziness, drowsiness, vomiting, unconsciousness, and death. High exposure can damage the liver or kidneys enough to cause death. *Inhalation:* Levels of 75 ppm may cause irritation of the nose, throat, and lungs. 100−200 ppm for 1 h may cause diarrhea, abdominal pain, and vomiting. Other symptoms may include headache, loss of appetite, swollen glands, pale skin coloring, insomnia, dizziness, and depression. Accidental high exposure has caused symptoms as listed above; internal bleeding and death. *Skin:* Contact with as little as 1 g (1/28 oz) may cause itching, swelling, redness, burning, and blistering. May be absorbed through the skin and cause symptoms as listed under inhalation. *Eyes:* May cause irritation of eyes and eyelids. *Ingestion:* May cause vomiting, diarrhea, abdominal pain, nausea, and damage to the liver and kidneys. As little as 4.5 mL (about 1 teaspoon) has caused death.

Long Term Exposure: May cause irritation of the throat, headaches, loss of appetite, swollen glands, paleness, insomnia, vomiting, diarrhea, abdominal pain, and damage to the liver and kidneys. Ethylene dibromide is a probable carcinogen in humans. It causes birth defects and changes in the genetic material of laboratory animals. It may damage the reproductive system, causing abnormal sperm in males and decreased fertility in females. Handle with extreme caution.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, reproductive system. Cancer site in animals: skin and lung.

Medical Surveillance: Preemployment and periodic examinations should evaluate the skin and eyes, respiratory tract, and liver and kidney functions.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** polyvinyl alcohol gloves; Teflon™ gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade® coated suits; Trychem 1000™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place that is well ventilated. Keep in tightly sealed containers and away from light, heat, active metals, and liquid ammonia. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: EDB is a noncombustible liquid. Use an extinguishing agent suited to a surrounding fire. Poisonous gases are produced in fire, including bromine and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with adequate scrubbing and ash disposal facilities.[22]

References

Environmental Protection Agency. (September 1975). *Sampling and Analysis of Selected Toxic Substances, Task II—Ethylene Dibromide*, Final Report. Washington, DC: Office of Toxic Substances, EPA

Occupational Health and Safety Administration. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Ethylene Dibromide*, NIOSH Document No. 77-221

National Institute for Occupational Safety and Health. *Current Intelligence Bulletin No. 3: Ethylene Dibromide*, Rockville, MD (July 7, 1975) and *Current Intelligence Bulletin No. 37: Ethylene Dibromide*, Cincinnati, OH (October 26, 1981)

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 58−60

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ethylene Dibromide*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Ethylene dichloride E:0590

Molecular Formula: $C_2H_4Cl_2$

Common Formula: $ClCH_2CH_2Cl$

Synonyms: Aethylenchlorid (German); 1,2-Bichloroethane; Bichlorure d'ethylene (French); Borer Sol; Brocide; Chlorure d'ethylene (French); Destruxol Borer-Sol; 1,2-Dichlor-aethan (German); Dichloremulsion; Di-chlor-mulsion; α,β-Dichloroethane; *sym*-Dichloroethane; 1,2-Dichloroethane; Dichloro-1,2-ethane (French); Dichloroethylene; 1,2-Dicloroetano (Spanish); Dutch liquid; Dutch oil; EDC; ENT 1656; Ethane dichloride; Ethane, 1,2-dichloro-; Ethylene chloride; 1,2-Ethylene dichloride; Ethylene dichloride; Freson 150; Glycol dichloride; NCI-C00511

CAS Registry Number: 107-06-2

RTECS® Number: KI0525000

UN/NA & ERG Number: UN1184/131

EC Number: 203-458-1 [*Annex I Index No.:* 602-012-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen.; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE; Positive: *D. melanogaster*—whole sex chrom. loss; Positive: *D. melanogaster*—nondisjunction; *E. coli* polA without S9; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: CHO gene mutation.

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (Saudi Arabia) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U077, D028.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.21; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 1/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R45; F11; R22-36/37/38; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,2-Dichloroethane is a colorless, flammable liquid which has a pleasant, chloroform-like odor and a sweetish taste. Decomposes slowly: turns dark and acidic on contact with air, moisture, and light. The odor threshold is 100 ppm. Molecular weight = 98.96; Specific gravity (H_2O:1) = 1.24; Boiling point = 83.3°C; Freezing/Melting point = −35.6°C; Vapor pressure = 64 mmHg at 20°C; Flash point = 13°C (cc); Autoignition temperature = 413°C. Explosive limits: LEL = 6.2%; UEL = 16.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. In recent years, 1,2-dichloroethane is used in the production of vinyl chloride and as a lead-scavenging agent in petrol; it has found wide use in the manufacture of ethylene glycol, diaminoethylene, polyvinyl chloride, nylon, viscose rayon, styrenebutadiene rubber, and various plastics. It is a solvent for resins, asphalt, bitumen, rubber, cellulose acetate, cellulose ester, and paint; a degreaser in the engineering, textile, and petroleum industries; and an extracting agent for soybean oil and caffeine. It is also used as an antiknock agent in gasoline; a pickling agent; a fumigant; and a dry-cleaning agent. It has found use in photography, xerography, water softening; and also in the production of adhesives, cosmetics, pharmaceuticals, and varnishes.

Incompatibilities: Forms explosive mixture with air. Reacts violently with strong oxidizers and caustics; chemically active metals, such as magnesium or aluminum powder, sodium and potassium; alkali metals; alkali amides; liquid ammonia. Decomposes to vinyl chloride and HCl above 600°C. Attacks plastics, rubber, coatings. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.05 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm TWA; 100 ppm Ceiling Concentration; 200 ppm [5-min maximum peak in any 3 h]. For Construction and Shipyards: 50 ppm/200 mg/m^3 TWA.

NIOSH REL: 1 ppm/4 mg/m^3 TWA; 2 ppm/8 mg/m^3 STEL, a potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm, not classifiable as a human carcinogen as chloroethanes.

Protective Action Criteria (PAC)*

TEEL-0: 10 ppm

PAC-1: **50** ppm

PAC-2: **200** ppm

PAC-3: **300** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

NIOSH IDLH: 50 ppm.

Arab Republic of Egypt: TWA 5 ppm (2 mg/m^3), 1993; Australia: TWA 10 ppm (40 mg/m^3), 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (40 mg/m^3), 1993; Finland: TWA 10 ppm (40 mg/m^3); STEL 20 ppm (80 mg/m^3), carcinogen, 1999; France: VME 10 ppm (40 mg/m^3), continuous carcinogen, 1999; Hungary: STEL 4 mg/m^3, carcinogen, 1993; the Netherlands: MAC-TGG 7 mg/m^3, 2003; Norway: TWA 1 ppm (4 mg/m^3), 1999; the Philippines: TWA 50 ppm (200 mg/m^3), 1993; Poland: TWA 50 mg/m^3; STEL 60 mg/m^3, 1999; Russia: TWA 10 ppm, 1993; Sweden: NGV 1 ppm (4 mg/m^3), KTV 5 ppm (20 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-W 5 ppm (20 mg/m^3), carcinogen, 1999; Turkey: TWA 50 ppm (200 mg/m^3), 1993; United Kingdom: TWA 5 ppm (21 mg/m^3), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] has set MAC value of 3 mg/m^3 in ambient air in residential areas on a momentary basis and 1 mg/m^3 on a daily average basis. Several states have set guidelines or standards for ethylene dichloride in ambient air[60] ranging from 0−400 μg/m^3 (North Dakota) to 0.038 μg/m^3 (North Carolina) to 0.04 μg/m^3 (Rhode Island) to 0.2 μg/m^3 (New York) to 0.39 μg/m^3 (Massachusetts) to 20.0 μg/m^3 (Connecticut) to 148.0 μg/m^3 (Pennsylvania) to 200.0 μg/m^3 (South Carolina) to 650.0 μg/m^3 (Nevada) to 1000.0 μg/m^3 (Indiana).

Determination in Air: Use NIOSH Analytical Method (IV) #1003 for halogenated hydrocarbons or OSHA Analytical Method 3.[18]

Permissible Concentration in Water: *To protect freshwater aquatic life:* 118,000 μg/L on an acute toxicity basis and 20,000 μg/L on a chronic basis. *To protect saltwater aquatic life:* 113,000 μg/L on an acute toxicity basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 occurs at a concentration of 9.4 μg/L.[6]

The WHO has set a limit for drinking water of 0.01 mg/L (10 μg/L).[35] Russia has set a limit in water bodies used for domestic purposes variously quoted at 2.0 mg/L[43] and 0.02 mg/L.[35] EPA[48] has set a longer term health advisory of 2.6 mg/L for an adult. Several states have set guidelines or standards for ethylene dichloride in drinking water.[61] The standards set range from 2.0 μg/L (New Jersey) to 3.0 μg/L (Florida) to 10.0 μg/L (New Mexico). The guidelines range from 0.38 μg/L (New Hampshire) to 1.0 μg/L (California and Connecticut) to 3.8 (Minnesota) to 5.0 μg/L (Maine).

Determination in Water: Inert gas purge followed by chromatography with halide-specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = 1.48.

Routes of Entry: Inhalation of vapor, skin absorption of liquid, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause nausea, vomiting, headaches, drowsiness, and loss of consciousness. Overexposure to ethylene dichloride may damage the central nervous system, kidneys, liver. *Inhalation:* Levels of 10−30 ppm may cause dizziness, nausea, and vomiting. Levels up to 50 ppm may cause weakness, trembling, headaches, abdominal cramps, liver and kidney damage; and fluid buildup in lungs. May cause coma and death at high levels. *Skin:* Contact may cause irritation and skin rash and irritates the eyes. *Eyes:* May cause redness, pain, and blurred vision. Vapor can damage the cornea. *Ingestion:* Ingestion of 2 oz has resulted in nausea, vomiting, faintness, drowsiness, troubled breathing, pale skin, internal bleeding, kidney damage, and death due to respiratory failure. Other possible symptoms may include abdominal spasms, severe headache, lethargy, lowered blood pressure, diarrhea, shock, physical collapse, and coma.

Long Term Exposure: Repeated or prolonged contact can chronically irritate the skin causing dryness, redness, and a rash. Prolonged or repeated exposure may cause eye, nose, and throat irritation; nerve damage; liver and kidney damage. This substance has been determined to cause cancer of the lung, stomach, breast, and other sites in laboratory animals; and may be a human carcinogen. Can irritate the lungs and bronchitis may develop. Repeated or prolonged exposure can cause loss of appetite; nausea and vomiting; trembling and low blood sugar.

Points of Attack: Eyes, skin, kidneys, liver, central nervous system, cardiovascular system. Cancer sites in animals: forestomach, mammary gland, and circulatory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests; liver and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. NIOSH lists the following tests: expired air; liver function tests; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Teflon™ gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade® coated suits; CPF3™ suits; Responder™ suits; Trychem 1000™ suits; **4 h:** polyvinyl alcohol gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), chemically active metals (such as potassium, sodium, magnesium, and zinc), strong caustics (such as sodium hydroxide), and dimethylaminopropylamine since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylene dichloride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Ethylene Dichloride*, NIOSH Document No. 76-139

National Institute for Occupational Safety and Health. (April 19, 1978). *Ethylene Dichloride*, NIOSH Current Intelligence Bulletin No. 25. Washington, DC

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Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 50−52

US Environmental Protection Agency. (March 31, 1987). *Health Advisory: 1,2-Dichloroethane*. Washington, DC: Office of Drinking Water

US Public Health Service. (December 1988). *Toxicological Profile for 1,2-Dichloroethane*. Atlanta, GA: Agency for Toxic Substance & Disease Registry

New York State Department of Health. (2009) *Chemical Fact Sheet: 1,2-Dichloroethane*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: 1,2-Dichloroethane*. Trenton, NJ

Ethylene fluorohydrin E:0600

Molecular Formula: C_2H_5FO

Common Formula: $HOCH_2CH_2F$

Synonyms: 2-Fluoetanol (Spanish); β-Fluoroethanol; 2-Fluroethanol; TL 741

CAS Registry Number: 371-62-0

RTECS® Number: KL1575000

UN/NA & ERG Number: UN2929 (Toxic liquids, flammable, organic, n.o.s.)/131

EC Number: 206-740-2

Regulatory Authority and Advisory Bodies

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: not listed in Annex I (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethylene fluorohydrin is a colorless liquid. Molecular weight = 64.07; Boiling point = 103.5°C; Flash point = 34°C; Vapor pressure = 16 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Ethylene fluorohydrin is used as a rodenticide, insecticide, and acaricide. It is not registered as a pesticide in the United States.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.005 ppm

PAC-1: 0.015 ppm

PAC-2: 0.0267 ppm
PAC-3: 1.25 ppm

Harmful Effects and Symptoms

Short Term Exposure: Symptoms include tremors, severe muscular weakness, nausea, headache, and slight swelling of the liver. Delayed convulsant. Toxicity rating is the same as for fluoroacetate, super toxic. The probable oral lethal dose in humans is a taste (less than 7 drops) for a 70-kg (150-lb) person. The chemical is highly toxic when inhaled or absorbed through the skin. Toxicity depends on its oxidation to fluoroacetate by tissue alcohol dehydrogenase.

First Aid: Acute poisoning should be treated like poisoning by fluoroacetate. Ethylene fluorohydrin (2-fluoroethanol) is listed among the organic fluorine derivatives of fluoroacetic acid. The emergency procedures for fluoroacetic acid are move victim to fresh air and call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: For emergency situations, wear a positive-pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Toxic liquids, flammable, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including toxic fluoride, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethylene Fluorohydrin*. Washington, DC: Chemical Emergency Preparedness Program

Ethylene glycol E:0610

Molecular Formula: $C_2H_6O_2$
Common Formula: $HOCH_2CH_2OH$
Synonyms: Athylenglykol (German); 1,2-Dihydroxyethane; Dowtherm SR 1; EG; ETG; 1,2-Ethanediol; Ethylene alcohol; Ethylene dihydrate; Etilenglicol (Spanish); Fridex; Glycol; Glycol alcohol; 2-Hydroxyethanol; Ilexan E; Lutrol-9; Macrogol 400; Macrogol 400 BPC; MEG; Monoethylene glycol; NCI-C00920; Norkool; Ramp; Tescol; UCAR 17; Zerex
CAS Registry Number: 107-21-1
RTECS® Number: KW2795000
UN/NA & ERG Number: UN3082/171
EC Number: 203-473-3
Regulatory Authority and Advisory Bodies
US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE; *N. crassa—aneuploidy*; Negative: Histidine reversion—Ames test; Inconclusive: *D. melanogaster*—whole sex chrom. loss; Inconclusive: *D. melanogaster*—nondisjunction.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Ethylene glycol is a colorless, viscous, hydroscopic liquid with a sweetish taste. Often colored fluorescent yellow-green when used in automotive antifreeze. Ethylene glycol is odorless; odor does not provide any warning of inhalation exposure to hazardous concentrations. The odor threshold in air is 25 ppm. Molecular weight = 62.07; Specific gravity (H_2O:1) = 1.1; Relative vapor density (air = 1) = 2.12; Boiling point = 197°C; Freezing/Melting point = −12.8°C; Vapor pressure = 0.06 mmHg at 20°C; Flash point = 111°C; Autoignition temperature = 398°C. Explosive limit: LEL = 3.2%; UEL = 15.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene glycol is used in antifreeze (especially as car radiator antifreeze) and in the production of polyethylene terephthalate fibers and films; in hydraulic fluids; electrolytic condensers; and heat exchangers. It is also used as a solvent and as a chemical intermediate for ethylene glycol dinitrate, glycol esters, resins, and for pharmaceuticals.
Incompatibilities: Reacts with sulfuric acid, oleum, chlorosulfonic acid, strong oxidizing agents, strong bases, chromium trioxide, potassium permanganate, sodium peroxide. Hygroscopic (i.e., absorbs moisture from the air).
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: After reviewing available published literature, NIOSH provided comments to OSHA on August 1, 1988, regarding the "*Proposed Rule on Air Contaminants*" (29 CFR 1910, Docket No. H-020). In these comments, NIOSH questioned whether the PELs proposed (Ceiling 50 ppm) were adequate to protect workers from recognized health hazards.
ACGIH TLV®[1]: 100 mg/m^3 (hour) Ceiling Concentration; (aerosol only) not classifiable as a human carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 10 ppm
PAC-1: 10 ppm
PAC-2: 40 ppm
PAC-3: 60 ppm
DFG MAK: 10 ppm/26 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group C.
Australia: TWA 60 mg/m^3; STEL 120 mg/m^3, 1993; Austria: MAK 10 ppm (26 mg/m^3), [skin], 1999; Belgium: STEL 50 ppm (127 mg/m^3), 1993; Denmark: TWA 50 ppm (130 mg/m^3), 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1993; France: VLE 50 ppm (125 mg/m^3), 1999; Hungary: STEL 50 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 52 mg/m^3 (fume), 2003; MAC-TGG 10 mg/m^3 (drops), 2003; Norway: TWA 25 ppm (63 mg/m^3), 1999; Poland: MAC (TWA) 15 mg/m^3, MAC (STEL) 50 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Sweden: NGV 10 ppm (25 mg/m^3), KTV 20 ppm (50 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (125 mg/m^3), 1999; United Kingdom: TWA 10 mg/m^3, particulate; TWA 60 mg/m^3; STEL 125 mg/m^3, vapor, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV®: 100 mg/m^3 (hour) Ceiling Concentration. Several states have set guidelines or standards for ethylene glycol in ambient air[60] ranging from 0.17 mg/m^3 (Massachusetts) to 1.0 mg/m^3 (Virginia) to 1.25 mg/m^3 (North Dakota) to 2.976 mg/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (IV) #5523.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 140 μg/L based on health effects and also a lifetime health advisory of 7000 μg/L.[48] Several states have set guidelines for ethylene glycol in drinking water[61] ranging from 100 μg/L (Connecticut) to 290 μg/L (New Jersey)[59] to 5500 μg/L (Arizona, Massachusetts and Maine).
Determination in Water: Octanol−water coefficient: Log $K_{ow} = -1.9$.
Routes of Entry: Inhalation of particulate or vapor. Percutaneous absorption may also contribute to intoxication.

Harmful Effects and Symptoms

In the body, ethylene glycol is chemically broken down into toxic compounds. Ethylene glycol and its toxic by-products first affect the central nervous system (CNS), then the heart, and finally the kidneys. Ingestion of sufficient amounts can be fatal.

Short Term Exposure: Ethylene glycol irritates the eyes, skin, and respiratory tract. *Inhalation:* Mild throat irritation resulted from exposure of 28 mg/m^3. Levels above 140 mg/m^3 resulted in more marked irritation, with levels of more than 250 mg/m^3 being unbreathable. These levels are only reached at elevated temperature. *Skin:* May cause mild irritation if not promptly removed. *Eyes:* Accidental eye contact with concentrated ethylene glycol resulted in extreme swelling of the eyes, cloudy vision, and slow response to light. These symptoms lasted a month. *Ingestion:* May cause symptoms in the nervous system, heart, lungs, and kidneys. Earliest effects are usually felt in the nervous system between 1/2 and 12 h after ingestion. Symptoms from 1 liquid ounce may include nausea, vomiting, dizziness, loss of coordination, and abdominal pain. Large amounts may cause stupor, coma, convulsions, and death. Survival of this stage may lead to development of rapid heartbeat, enlarged heart and fluid in the lungs which, too, can lead to death usually after 1−3 days. Some individuals who drank 3−4 fluid ounces survived both the above stages because of prompt medical treatment, later (3−17 days) died of kidney failure.

Long Term Exposure: Occupational exposure to heated ethylene glycol has caused involuntary eye movement that may indicate nerve damage. Some individuals also reported attacks of unconsciousness lasting 5−10 min which went away when they stopped working with ethylene glycol. Ethylene glycol may affect the central nervous system and eyes. Has been shown to be a teratogen in animals. Ethylene glycol may damage the developing fetus. May cause kidney and brain damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function test. Urine oxalate level. Examination of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Natural, Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyethylene gloves, polyvinyl chloride gloves, suits, boots; Teflon™ gloves, suits, boots; Viton™ gloves, suits, Saranex™ coated suits; 4H™ and Silver Shield™ gloves, Trellchem HPS™ suits; **4 h:** Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethylene glycol must be stored to avoid contact with sulfuric acid since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents (such as perchlorates, peroxides, permanganates, chlorates, and nitrates).

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylene glycol out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of

potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Alternatively, ethylene glycol can be recovered from polyester plant wastes.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 70−74

New York State Department of Health. (January 1986). *Chemical Fact Sheet: Ethylene Glycol*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Ethylene Glycol*. Trenton, NJ

Ethylene glycol diethyl ether E:0620

Molecular Formula: $C_6H_{14}O_2$
Common Formula: $C_2H_5OCH_2CH_2OC_2H_5$
Synonyms: 1,2-Diethoxyethane; Diethoxyethane; Diethyl cellosolve; Ethyl glyme
CAS Registry Number: 629-14-1
RTECS® Number: KI1225000
UN/NA & ERG Number: UN1153/127
EC Number: 211-076-1[*Annex I Index No.:* 603-208-00-5]

Regulatory Authority and Advisory Bodies

As glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol $R{-}(OCH_2CH_2)_n{-}OR'$ where $n = 12$ or 3; R = alkyl or aryl groups; R′ = R, H, or groups which when removed, yield glycol ethers with the structure: $R{-}(OCH_2CH)_n{-}OH$. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. $R{-}(OCH_2CH_2)_n{-}OR'$; Where $n = 12$ or 3; R = alkyl C_7 or less; or R = phenyl or alkyl substituted phenyl; R′ + H, or alkyl C_7 or less; or OR′ consisting of carboxylic ester, sulfate, phosphate, nitrate, or sulfonate.

Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: F,T; Risk phrases: R61; R11; R19; R36; R62; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethylene glycol diethyl ether is a colorless liquid. Molecular weight = 118.20; Boiling point = 122°C; Freezing/Melting point = − 74°C; Flash point = 35°C; Autoignition temperature = 406°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Primary Irritant. Ethylene glycol diethyl ether is used as an aprotic solvent; in chemical manufacturing; as a solvent for detergents and in other cleaning products.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings. Able to form peroxides. Also incompatible with strong acids, aluminum, and its alloys.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Ethylene glycol diethyl ether can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. Contact can irritate the skin and eyes. High levels can cause you to feel drowsy and dizzy. Very high levels could cause you to pass out. Repeated high or single very high exposures may damage the kidneys.

Long Term Exposure: Repeated or high exposures may damage the kidneys. There is limited evidence that ethylene glycol diethyl ether may damage the developing fetus.

Points of Attack: Kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: complete blood count (CBC); kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If

this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Glove manufacturers have recommended gloves of Neoprene™ or nitrile butyl rubber construction for protection against liquid ethylene glycol diethyl ether. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethylene glycol diethyl ether, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Ethylene glycol diethyl ether must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where ethylene glycol diethyl ether is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethylene glycol diethyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene glycol diethyl ether. Wherever ethylene glycol diethyl ether is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Ethylene Glycol Diethyl Ether*. Trenton, NJ

Ethylene glycol dinitrate E:0630

Molecular Formula: $C_2H_4N_2O_6$

Common Formula: $O_2NOCH_2CH_2ONO_2$

Synonyms: EGDN; 1,2-Ethanediol dinitrate; Ethanediol dinitrate; Ethylene dinitrate; Ethylene nitrate; Glycol (dinitrate de) (French); Glycol dinitrate; Glykoldinitrat (German)

CAS Registry Number: 628-96-6

RTECS® Number: KW5600000

UN/NA & ERG Number: FORBIDDEN

EC Number: 211-063-0 [*Annex I Index No.:* 603-032-00-9]

Regulatory Authority and Advisory Bodies

Explosive Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, T + ; R3;R26/27/28; R33; Safety phrases: S1/2; S27/28; S33; S35; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethylene glycol dinitrate is a colorless to yellow, oily, odorless liquid. An explosive ingredient (60−80%) in dynamite along with nitroglycerine (40−20%). It may be detonated by mechanical shock, heat, or spontaneous chemical reaction. Molecular weight = 152.08; Specific gravity (H_2O:1) = 1.49; Boiling point = 114−116°C (explodes); Freezing/Melting point = −22.2°C; Vapor pressure = 0.05 mmHg at 20°C; Flash point = 215°C. Very slightly water soluble; solubility = 0.48%.

Potential Exposure: An explosive ingredient (60−80%) in dynamite along with nitroglycerine (40−20%). Although ethylene glycol dinitrate is an explosive in itself, it is primarily used to lower the Freezing/Melting point of nitroglycerin; together these compounds are the major constituents of commercial dynamite, cordite, and blastine gelatin. Occupational exposure generally involves a mixture of the two compounds. Ethylene glycol dinitrate is 160 times more volatile than nitroglycerin.

Incompatibilities: Highly explosive. Heating may cause violent combustion or explosion producing toxic fumes (nitrogen oxides). May explosively detonate violently from mechanical shock, friction, impact, or concussion. Not compatible with strong acids and alkalies.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.22 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.2 ppm/1 mg/m^3 Ceiling Concentration [skin].

NIOSH REL: 0.1 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.05 ppm/0.31 mg/m^3 TWA [skin].

NIOSH IDLH: 75 mg/m^3.

No TEEL available.

DFG MAK: 0.05 ppm/0.32 mg/m^3 TWA; Peak Limitation Category II(1); [skin]; BAT: 0.3 μg/L in blood; end of exposure; end-of-shift.

Australia: TWA 0.05 ppm (0.3 mg/m^3), [skin], 1993; Austria: MAK 0.05 ppm (0.3 mg/m^3), [skin], 1999; Belgium: TWA 0.05 ppm (0.31 mg/m^3), [skin], 1993; Denmark: TWA 0.02 ppm (0.12 mg/m^3), [skin], 1999; Finland: TWA 0.1 ppm (0.6 mg/m^3); STEL 0.3 ppm (2 mg/m^3), [skin], 1999; France: VME 0.17 ppm (1 mg/m^3), [skin], 1999; Japan: STEL 0.05 ppm (0.31 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 0.3 mg/m^3, [skin], 2003; Norway: TWA 0.03 ppm (0.18 mg/m^3), 1999; the Philippines: TWA 0.2 ppm (1.2 mg/m^3), [skin], 1993; Poland: TWA 0.3 mg/m^3; STEL 0.4 mg/m^3, 1999; Russia: TWA 0.05 mg/m^3, 1993; Sweden: NGV 0.03 ppm (0.2 mg/m^3), KTV 0.1 ppm (0.6 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.3 mg/m^3), KZG-W 0.1 ppm, [skin], 1999; Thailand: TWA 0.2 ppm (1 mg/m^3), 1993; Turkey: TWA 0.2 ppm (1 mg/m^3), [skin], 1993; United Kingdom: TWA 0.2 ppm (1.3 mg/m^3); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for EGDN in ambient air[60] ranging from 3.0 μg/m^3 (North Dakota) to 6.0 μg/m^3 (Connecticut) to 7.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2507 or OSHA Analytical Method 43.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <1.2.

Routes of Entry: Inhalation of dust or vapor, ingestion of dust, percutaneous absorption, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: EGDN can cause headache, dizziness, nausea, vomiting, abdominal pain; and may affect the cardiovascular system, causing a fall in blood pressure. High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia). Exposure may result in death. The effects may be delayed. Skin contact can cause a rash or burning feeling on contact. Exposure to small amounts of ethylene glycol dinitrate and/or nitroglycerin by skin exposure, inhalation, or swallowing may cause severe throbbing headaches. With large exposure, nausea, vomiting, cyanosis, palpitations of the heart, coma, cessation of breathing, and death may occur. A temporary tolerance to the headache may develop, but this is lost after a few days without exposure. On some occasions a worker may have anginal pains a few days after discontinuing repeated daily exposure.

Long Term Exposure: EGDN can damage the heart causing pain in the chest and/or increased heart rate or cause arrhythmia (irregular heartbeat). This can be fatal. High exposure may affect the nervous system. May damage the red blood cells leading to anemia.

Points of Attack: Skin, cardiovascular system, blood, liver, kidneys.

Medical Surveillance: Placement and periodic examinations should be concerned with central nervous system, blood, glaucoma, and especially history of alcoholism. Urinary and blood ethylene glycol dinitrate may be determined by gas chromatography. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), during exposure; complete blood count; electrocardiogram, expired air, during exposure; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Both EGDN and nitroglycerin are readily absorbed through the skin, lungs, and mucous membranes. It is, therefore, essential that adequate skin protection should be provided for each worker: impervious clothing where liquids are likely to contaminate and full body clothing where dust creates the problem. All clothing should be discarded at the end of the shift and prior to changing to street clothing. In case of spill or splash that contaminates work clothing, the clothes should be changed at once and the skin area washed thoroughly. Masks of the dust type or organic vapor canister type may be necessary in areas of concentration of dust or vapors. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 mg/m^3*: Sa* (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 mg/m^3*: SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 75 mg/m^3:* SAF: PD/PP (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive and Strong Oxidizer. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where EGDN is present, check to make certain that explosive concentrations do not exist. EGDN is highly explosive and can detonate violently upon heating or impact. Store in tightly closed containers in a cool, well-ventilated area away from strong acids and alkalies. All sources of ignition are prohibited. Use non-sparking tools and equipment especially when opening or closing containers. Use explosion-proof electrical equipment and fittings in all areas of handling, use, or manufacture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: DOT[19] simply lists this material as FORBIDDEN to transport.

Spill Handling: Spread sodium bisulfate over the spill area and sprinkle with water. Then flush to sewer with water.[24] Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EGDN out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Evacuate area of fire. Heat may cause violent combustion (explodes at 114°C) or explosion. Fight fires only from a secure, explosion-resistant position. This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference
New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethylene Glycol Dinitrate*. Trenton, NJ

Ethylene glycol monomethyl ether E:0640

Molecular Formula: $C_3H_8O_2$
Common Formula: $CH_3OCH_2CH_2OH$
Synonyms: Aethylengykol-monomethylaether (German); Dowanol EM; EGM; EGME; Ether monomethylique de l'ethylene-glycil (French); Ethylene glycol methyl ether; Glycol ether EM; Glycol methyl ether; Glycol monomethyl ether; Jeffersol EM; MECS; 2-Methoxyethanol; Methoxyhydroxyethane; Methyl Cellosolve® (NIOSH); Methyl ethoxol; Methyl glycol; Methyl oxitol; Poly-Solv EM; Prist
CAS Registry Number: 109-86-4
RTECS® Number: KL5775000
UN/NA & ERG Number: UN1188/127
EC Number: 203-713-7 [*Annex I Index No.:* 603-011-00-4]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA1998 Status of Pesticides: Canceled.
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 1/1/89.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; R10; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
As glycol ethers:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol $R-(OCH_2CH_2)_n-OR'$ where $n = 12$, or 3; R = alkyl or aryl groups; $R' = R$, H, or groups which when removed, yield glycol ethers with the structure: $R-(OCH_2CH)_n-OH$. Polymers are excluded from the glycol category.
Description: Ethylene glycol monomethyl ether is a colorless liquid with a slight ether-like odor. The odor threshold is 0.9−2.3 ppm. Molecular weight = 76.11; Specific gravity (H_2O:1) = 0.96; Boiling point = 124.4°C; Flash point = 39°C; Freezing/Melting point = −85°C; Vapor pressure = 0.6 mmHg; Autoignition temperature = 285°C. Explosive limits: LEL = 1.8%; UEL = 14%, both at STP. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene glycol monomethyl ether is used as a jet fuel additive; solvent for protective coating; and in chemical synthesis. Ethylene glycol ethers are used as solvents for resins used in the electronics industry, lacquers, paints, varnishes, gum, perfume; in dyes and inks; and as a constituent of painting pastes, cleaning compounds; liquid soaps; cosmetics, nitrocellulose, and hydraulic fluids.
Incompatibilities: Above flash point, explosive vapor/air mixtures may be formed. Heat or oxidizers may cause the formation of unstable peroxides. Attacks many metals. Strong oxidizers cause fire and explosions. Strong bases cause decomposition and the formation of toxic gas. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.
Permissible Exposure Limits in Air
OSHA PEL: 25 ppm/80 mg/m^3 TWA [skin].
NIOSH REL: 0.1 ppm/0.3 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.1 ppm/0.3 mg/m^3 TWA [skin]; BEI issued.
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.35 ppm
PAC-2: 2.5 ppm
PAC-3: 200 ppm
DFG MAK: 1 ppm/3.2 mg/m^3 (the sum of the concentrations of EGME and its acetate in air); Peak Limitation Category II(8) [skin]; Pregnancy Risk Group B.
NIOSH IDLH: 200 ppm.
Australia: TWA 5 ppm (16 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (15 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (16 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (16 mg/m^3), [skin], 1999; Finland: TWA 25 ppm (80 mg/m^3); STEL 40 ppm (120 mg/m^3), [skin], 1999; France: VME 5 ppm (16 mg/m^3), [skin], 1999; Hungary: TWA 15 mg/m^3; STEL 30 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (16 mg/m^3), 1999; the Philippines: TWA 25 ppm (80 mg/m^3), [skin], 1993; Poland: MAC (TWA) 15 mg/m^3, MAC (STEL) 60 mg/m^3, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (16 mg/m^3), KTV 10 ppm (30 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (15 mg/m^3), KZG-W 10 ppm (30 mg/m^3), [skin], 1999; Turkey: TWA 25 ppm (80 mg/m^3), 1993; United Kingdom: TWA 5 ppm (16 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm [skin]. The former USSR-UNEP/IRPTC[35] set a MAC of 0.3 mg/m^3 for ambient air in residential areas (on a once daily basis). Several states have set guidelines or standards for 2-methoxyethanol in ambient air[60] ranging from 21.0 μg/m^3 (Massachusetts) to 53.3 μg/m^3 (New York) to

100 μg/m^3 (Rhode Island) to 160.0 μg/m^3 (Florida and North Dakota) to 270.0 μg/m^3 (Virginia) to 320.0 μg/m^3 (Connecticut) to 381.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1403, alcohols I or OSHA Analytical Method 53 and 79.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.5$.

Routes of Entry: Inhalation of vapor, ingestion, eye and/or skin contact, plus cutaneous absorption of liquid.

Harmful Effects and Symptoms

Short Term Exposure: EGME irritates the eyes and the respiratory tract. More severe exposures may cause damage to brain, nervous system, liver and kidneys, and death. *Inhalation:* Exposure to levels above 25 ppm may cause headache, drowsiness, lethargy, weakness, and tremors. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Readily absorbed through the skin. May cause stinging and reddening upon contact; and cause or contribute to symptoms in the lungs. *Eyes:* Contact with liquid or high vapor concentrations may cause burning irritation and clouded vision. *Ingestion:* 3 liquid ounces (100 mL) has been reported to cause confusion, nausea, weakness, and rapid breathing. Symptoms were delayed 8−18 h.

Long Term Exposure: Prolonged exposure can cause anemia and lesions of blood cells. May cause symptoms listed under inhalation. Repeated exposure can cause headaches, weakness, drowsiness, personality changes, loss of weight, upset stomach, and tremors. May cause kidney damage. Extended exposures of 25−75 ppm has caused anemia and nervous system effects, such as fatigue, weakness, loss of muscle control, and mental changes. Ethylene glycol monomethyl ether has been shown to cause reproductive problems, damage to the testes, and cause birth defects in animal studies.

Points of Attack: Eyes, respiratory system, central nervous system, blood, kidneys, reproductive system, hematopoietic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests; complete blood count; kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Examination of the nervous system. NIOSH lists the following tests: complete blood count; urine (chemical/metabolite), end-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h:** butyl rubber gloves, suits, boots; Tychem 1000™ suits. **4 h:** 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 ppm:* Sa: Pd,Pp* (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Up to 200 ppm*: SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Methoxyethanol must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong caustics since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where 2-methoxyethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever 2-methoxyethanol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EGME out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides: discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides: perforation of a container of the waste from a safe distance followed by open burning.[24]

References

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Ethyleneimine E:0650

Molecular Formula: C_2H_5N

Synonyms: Aethylenimin (German); Aminoethylene; Azacyclopropane; Azirane; Aziridin (German); Aziridina (Spanish); Aziridine; Azirine; 1H-Azirine,dihydro-; Dihydro-1H-azirine; Dihydroazirine; Dimethyleneimine; Dimethylenimine; E-1; ENT 50,324; Ethyleneimine; Ethylimine; TL 337

CAS Registry Number: 151-56-4

RTECS® Number: KX5075000

UN/NA & ERG Number: UN1185/131

EC Number: 205-793-9 [*Annex I Index No.*: 613-001-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Limited Data; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999.

US EPA Gene-Tox Program, Positive: *Aspergillus*—reversion; *In vitro* cytogenetics—human; Positive: *In vitro* cytogenetics—human lymphocyte; Positive: *D. melanogaster*—reciprocal translocation; Positive: *N. crassa*—forward mutation; *N. crassa*—reversion; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Positive: *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—forward mutation; *S. cerevisiae*—homozygosis; Positive: *S. pombe*—forward mutation; Positive/limited: Carcinogenicity—mouse/rat; Positive: CHO gene mutation.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1012).

Banned or Severely Restricted (Belgium, Sweden) (UN).[13]

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Section 112(r), accidental Release Prevention/Flammable Substances (40CFR/68.130; 59 FR 4497), TQ = 10,000 lb (4550 kg).

Reportable Quantity (RQ): 1 lb(0.454 kg).

US EPA Hazardous Waste Number (RCRA No.): P054.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb(228 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, T+, N; Risk phrases R45; R46; R11; R26/27/28; R34; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethyleneimine is a colorless volatile liquid with an ammoniacal odor. Molecular weight = 43.08; Specific gravity (H_2O:1) = 0.83; Boiling point = 56.1°C; Freezing/Melting point = − 71.7°C; Vapor pressure = 160 mmHg at 20°C; Flash point = −11°C (cc); Autoignition temperature = 322°C. Explosive limits: LEL = 3.3%; UEL = 54.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Highly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Ethyleneimine is used in the production of binding agents, formation of plastics, and improving paper strength, in many organic syntheses, as an intermediate and monomer for fuel oil and lubricating refining. The polymerization products, polyethyleneimines, are used as auxiliaries in the paper industry and as flocculation aids in the clarification of effluents. It is also used in the textile industry for increasing wet strength, flame-, water-, shrink-proofing, and stiffening.

Incompatibilities: Forms explosive mixture with air. Ethyleneimine is a medium strong base. Contact with acids, aqueous acid conditions, oxidizers, aluminum, or carbon dioxide may cause explosive polymerization. Explosive silver derivatives may be formed with silver alloys (e.g., silver solder). Self-reactive with heat or atmospheric carbon dioxide. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks rubber, coatings, plastics, and chemically active metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.76 mg/m^3 at 25°C & 1 atm.

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.5 ppm/ 0.09 mg/m^3 TWA; 0.1 ppm/ 0.18 mg/m^3 [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.05 ppm

PAC-1: 0.1 ppm

PAC-2: **4.6** ppm

PAC-3: **9.9** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 2.

Australia: TWA 0.5 ppm (1 mg/m^3), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 0.5 ppm (1 mg/m^3), [skin], 1999; Finland: STEL 0.5 ppm (1 mg/m^3), [skin], carcinogen, 1999; Japan: 0.5 ppm (0.88 mg/m^3), [skin], 1999; Norway: TWA 0.5 ppm (1 mg/m^3), 1999; Russia: TWA 0.5 ppm; STEL 0.02 mg/m^3, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.5 ppm (0.9 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 0.5 ppm (1 mg/m^3), [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[43] has set a MAC of 0.001 mg/m^3 in ambient air of residential areas on either a momentary or a daily average basis. Several states have set guidelines or standards for ethyleneimine in ambient air[60] ranging from zero (North Carolina) to 3.3 μg/m^3 (New York) to 5.0 μg/m^3 (South Carolina) to 10.0 μg/m^3 (Florida and North Dakota) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3514.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 14 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.4$.

Routes of Entry: Inhalation and percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethyleneimine is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause severe illness or death. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms include tearing and burning of the eyes, sore throat, nausea, vomiting, coughing (may persist for weeks or months), and a slow healing dermatitis due to severe blistering. Ethyleneimine is classified as extremely toxic with a probable oral lethal dose of 5−50 mg/kg which is approximately 7 drops to 1 teaspoonful for a 75-kg (150-lb) person. Ethyleneimine gives inadequate warning when overexposure is by inhalation or skin absorption. It is a severe blistering agent, causing third degree chemical burns of the skin. Also, it has a corrosive effect on mucous membranes and may cause scarring of the esophagus. It is corrosive to eye tissue and may cause permanent corneal opacity and conjunctival scarring. Severe exposure may result in overwhelming pulmonary edema. Renal damage has been described. Hemorrhagic congestion of all internal organs has been observed. May affect the central nervous system, kidneys, and liver.

Long Term Exposure: May be a carcinogen in humans. May damage the developing fetus. May damage the testes. Repeated or prolonged contact with skin may skin allergy. May damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys. Cancer site in animals: lung and liver.

Medical Surveillance: OSHA Mandated Tests: *Increased Risks* check for Reduced Immunologic Competence; steroid treatment; pregnancy; cigarette smoking. NIOSH lists the following tests: electrocardiogram, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 45 min, occasionally lifting upper and lower lids. Seek medical attention immediately since eye splashes can cause severe illness or death. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Tychem 1000™ suits; **4 h:** Teflon™ gloves, suits, boots; Responder™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: Employees engaged in handling operations involving this carcinogen must be provided with, and required to wear and use, a half-mask filter-type respirator for dusts, mists, and fumes. A respirator affording higher levels of protection than this respirator may be substituted. NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyleneimine must be inhibited and stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethyleneimine is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyleneimine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyleneimine. Wherever ethyleneimine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid breathing vapors. Stay upwind; keep out of low areas. Avoid bodily contact with the material. *Do not* handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.4/2.3

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Dry chemical, alcohol foam, or carbon dioxide are useful for small fires. For large fires: water spray, fog, or foam. Do not extinguish fire unless flow can be stopped; use water in flooding quantities as a fog. Solid streams of water may be ineffective. Apply water from as far a distance as possible. If tank car or truck is involved in fire, isolate the surrounding area as shown above. May polymerize in fires with evolution of heat and container rupture. Runoff to sewer may create fire or explosion hazard. Ethyleneimine vapors are not inhibited and may form polymers in vents or flame arresters, resulting in stopping of the vents. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

Dermer, O. C., & Ham, G. E. (1969). *Ethyleneimine and Other Aziridines*. New York, NY: Academic Press

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 37−38

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethyleneimine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Ethyleneimine*. Trenton, NJ

Ethylene oxide E:0660

Molecular Formula: C_2H_4O

Synonyms: Aethylenoxid (German); Amprolene; Anprolene; Anproline; Dihydrooxirene; Dimethylene oxide; ENT 26,263; E.O.; 1,2-Epoxyaethan (German);

1,2-Epoxyethane; Epoxyethane; Ethene oxide; Ethylene (oxide d') (French); ETO; Merpol; NCI-C50088; Odido de etileno (Spanish); Oxacyclopropane; Oxane; α,β-Oxidoethane; Oxidoethane; Oxirane; Oxirane, dihydro-; Oxyfume; Oxyfume 12; Sterilizing gas ethylene oxide 100%; T-gas; UN1040

CAS Registry Number: 75-21-8; *(alt.)* 19034-08-3; 99932-75-9

RTECS® Number: KX2450000

UN/NA & ERG Number: UN1040/119

EC Number: 200-849-9 [*Annex I Index No.*: 603-023-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Limited Evidence, Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1994; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NIOSH: Potential occupational carcinogen; OSHA: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: Rodent dominant lethal; Rodent heritable translocation; Positive: Mammalian micronucleus; *N. crassa*—reversion; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Negative: Mouse specific locus; Positive: CHO gene mutation.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9104.

Banned or Severely Restricted (in agriculture) (Germany).[13]

Highly Reactive Substance and Explosive (World Bank).[15]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1047).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): U115.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), N/A.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

FDA tolerance limit, 50 ppm in ground spices.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 7/1/87; female 2/27/87; Developmental/Reproductive toxin (male) 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: Hazard Symbol: F+, T; R45; R46; R6; R12; R23; R36/37/38; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ethylene oxide is a colorless, compressed, liquefied gas or liquid (below 11°C) with a sweetish odor. The odor threshold is 50 ppm. Molecular weight = 44.06; Specific gravity (H_2O:1) = 0.82 (liquid at 10°C); Boiling point = 11°C; Freezing/Melting point = − 112°C; Vapor pressure = 1.46 atm; Relative vapor density (air = 1) = 1.49; Relative vapor density (air = 1) = 1.49; Flash point = flammable gas (−20°C, liquid); Autoignition temperature = 429°C. Explosive limits: LEL = 3.0%; UEL = 100%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3. Easily dissolved in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene oxide is a man-made chemical used in the production of glycols (ethylene glycol, polyglycols, glycol ethers, esters), nontonic surface-active agent, ethanolamines, acrylonitrile, plastics. It is also used as a fumigant for foodstuffs and textiles; an agricultural fungicide; and for sterilization, especially for surgical instruments. It is used in drug synthesis and as a pesticide intermediate.

Incompatibilities: Forms explosive mixture with air. Dangerously reactive; may rearrange chemically and/or polymerize violently with evolution of heat, when in contact with highly active catalytic surfaces, such as anhydrous chlorides of iron, tin, and aluminum; pure oxides of iron and aluminum; and alkali metal hydroxides. Even small amounts of strong acids, alkalis, or oxidizers can cause a reaction. Avoid contact with copper. Protect container from physical damage, sun, and heat. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.80 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/5 ppm [15 min excursion] TWA, cancer hazard, see 29CFR1910.1047(c).

NIOSH REL: <0.1 ppm/<0.18 mg/m^3 TWA; 5 ppm/9 mg/m^3 [10 min/day] Ceiling Concentration; Potential carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 1 ppm/1.8 mg/m^3 TWA, Suspected Human Carcinogen.

NIOSH IDLH: 800 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 5 ppm
PAC-2: 45 ppm
PAC-3: 200 ppm
DFG MAK: [skin]; Carcinogen Category 2; Germ Cell Mutagen Category 2; TRK: 1 ppm/1.83 mg/m^3; Sampling time: not fixed; 90 μg [hydroxyethylvaline]/L blood.

Arab Republic of Egypt: TWA 10 ppm (20 mg/m^3), 1993; Australia: TWA 1 ppm (2 mg/m^3), carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 1 ppm (1.8 mg/m^3), carcinogen, 1993; Denmark: TWA 1 ppm (1.8 mg/m^3), 1999; Finland: TWA 1 ppm (2.8 mg/m^3), carcinogen, 1999; Hungary: STEL 1 mg/m^3, carcinogen, 1993; the Netherlands: MAC-TGG 0.84 mg/m^3, 2003; Norway: TWA 1 ppm, 1999; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 3 mg/m^3, 1999; Russia: TWA 50 ppm; STEL 1 mg/m^3, 1993; Sweden: NGV 1 ppm (2 mg/m^3), KTV 5 ppm (9 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-W 1 ppm (2 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 50 ppm (90 mg/m^3), 1993; United Kingdom: TWA 5 ppm (9.2 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. The Czech Republic: 1 mg/m^3; Russia[35,43] set a MAC of 0.3 mg/m^3 for ambient air in residential areas on a momentary basis and 0.03 mg/m^3 on a daily average basis. Several states have set guidelines or standards for ethylene oxide in ambient air[60] ranging from zero (North Dakota) to 0.01 mg/m^3 (Rhode Island) to 0.1 μg/m^3 (North Carolina) to 4.87 μg/m^3 (Pennsylvania) to 6.67 μg/m^3 (New York) to 10.0 μg/m^3 (South Carolina) to 20.0 μg/m^3 (Connecticut, South Dakota and Virginia) to 48.0 μg/m^3 (Nevada) to 450.0 μg/m^3 (Indiana).

Determination in Air: Use NIOSH Analytical Method (IV) s #1614, Ethylene oxide; by portable GC #3800; passive monitor, OSHA Analytical Method 49, 30 (superceded by 50).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.29$.

Routes of Entry: Inhalation of gas, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Signs and symptoms of acute exposure to ethylene oxide may be severe and include dyspnea (shortness of breath), cough, pulmonary edema, pneumonia, and respiratory failure. Lethargy, headache, dizziness, twitching, convulsions, paralysis, and coma may be observed. Cardiac arrhythmias and cardiovascular collapse may also occur. Gastrointestinal effects of acute exposure may include nausea, vomiting, and abdominal pain. Ethylene oxide irritates the eyes, skin, and respiratory tract. Very high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. *Inhalation:* Exposure to 500−700 ppm for 2−3 min resulted in nausea, vomiting, headache, disorientation, fluid in the lungs, followed by seizures. Human volunteers breathing a concentration of about 2500 ppm experienced slight irritation of the respiratory tract; breathing in 12,500 ppm showed definite respiratory tract irritation within 10 s. Symptoms may not occur for hours after exposure. Other symptoms reported at unknown concentrations include headache, nausea, coughing, vomiting, difficult breathing, respiratory tact irritation, weakness, a lack of coordination, seizures, and fluid in the lungs. *Skin:* The pure liquid may cause frostbite. A 1% water solution can cause irritation and redness. A 40−80% water solution may cause extensive blister formation. Ethylene oxide may severely irritate or burn mucous membranes and moist skin. *Eyes:* May cause irritation and severe burns. May affect the eyes, causing delayed development of cataract. Eye contact may result in conjunctivitis (red, inflamed eyes) and erosion of the cornea. *Ingestion:* May cause gastric irritation and liver injury.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin allergy. ETO may affect the nervous system, kidneys, adrenal glands, skeletal muscles, and cause reproductive effects. It may be carcinogenic to humans. Exposure to low concentrations of gaseous ETO may cause irritation to the respiratory tract and eyes, loss of sense of smell, and nausea and vomiting. Repeated skin exposure can cause scaling, cracking, and redness. Exposure to 5−10 ppm for 11 years or to 1 ppm for 15 years has caused blood changes. ETO has caused cancer in several species of laboratory animals. It has also caused changes in genetic material and reproductive problems in laboratory animals. May damage the developing fetus. It may cause inheritable genetic damage in humans. There is an increased incidence of gynecological disorders and spontaneous abortions among workers in ethylene oxide production. Its role in this increase is unclear at this time. Increased incidence of leukemia and stomach cancer have been reported; however the evidence is not considered conclusive. Leukemia, brain tumors, lung tumors, and other cancers have been observed in laboratory animals.[DHHS]

Points of Attack: Eyes, skin, respiratory system, liver, central nervous system, blood, kidneys, reproductive system. *Cancer site:* peritoneum, blood or bone marrow.

Medical Surveillance: OSHA Mandated Tests: complete blood count/white blood cells/differential, red blood cells/count, hematocrit, hemoglobin. NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); complete blood count; expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); red blood cells/count; sputum cytology; white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If ethylene oxide gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Barricade® coated suits; Responder, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h:** Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas and splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: Employees engaged in handling operations involving this carcinogen must be provided with, and required to wear and use, a half-mask filter-type respirator for dusts, mists, and fumes. A respirator affording higher levels of protection than this respirator may be substituted. NIOSH: *5 ppm:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. It must be stored to avoid contact with even small amounts of acids (such as nitric or sulfuric acids); alkalis (such as sodium hydroxide or potassium hydroxide); catalytic anhydrous chlorides of iron, aluminum or tin; iron or aluminum oxide; or metallic potassium since it may react by itself, liberating much heat and causing a possible explosion. Ethylene oxide should not contact oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since an explosion could occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or sunlight. Sources of ignition, such as smoking and open flames, are prohibited where ethylene oxide is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethylene oxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene oxide. Wherever ethylene oxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Ethylene oxide requires a shipping label of "POISON, GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3 and there is no Packing Group. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: *Gas:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

Liquid: For *small spills* flush area with flooding amounts of water. For *large spills* dike spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Ethylene oxide and Ethylene oxide with Nitrogen

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.6/2.5

Fire Extinguishing: Highly flammable. *Gas:* Poisonous gases, including carbon monoxide, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: Highly flammable. Acrid and poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Although soluble in water, solutions will continue to burn until diluted to approximately 22 volumes of water to one volume of ethylene oxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.[22]

References

Bogyo, D. A., Lande, S. S., Meylan, W. M., Howard, P. H., & Santodonate, J. (Syracuse Research Corp. Center for Chemical Hazard Assessment). (March 1980). *Investigation of Selected Potential Environmental Contaminants: Epoxides*, Report 560/11-80-005. Washington, DC: US Environmental Protection Agency

National Institute for Occupational Safety and Health. (May 22, 1981). *Ethylene Oxide: Current Intelligence Bulletin No. 35*, DHHS (NIOSH), Publication No. 81-130. Cincinnati, OH

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 70−73

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethylene Oxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Ethylene Oxide*. Trenton, NJ

ATSDR, ToxFAQs. (July 1999). *Ethylene Oxide*. Atlanta, GA

Ethylene thiourea E:0670

Molecular Formula: $C_3H_6N_2S$

Synonyms: Accel 22; Akrochem ETU-22; 4,5-Dihydroimidazole-2(3H)-thione; 4,5-Dihydro-2-mercaptoimidazole; *N,N′*-Ethylenethiourea; 1,3-Ethylenethiourea; Etilentiourea (Spanish); ETU; 2-Imidazolidinethione; Imidazolidinethione; 2-Imidazoline-2-thiol; Imidazoline-2-thiol; Imidazoline-2(3H)-thione; 2-Mercapto-2-imidazoline; 2-Mercaptoimidazoline; Mercaptoimidazoline; Mercazin I; NA 22; NCI-C03372; Nocceler 22; Pennac CRA; Rhenogran ETU; Sodium-22 neoprene accelerator; Soxinol 22; Tetrahydro-2H-imidazole-2-thione; 2-Thioimidazolidine; 2-Thiol-dihydroglyoxaline; 2-Thionomidazolidine; Thiourea, *N,N′*-(1,2-ethanediyl)-; USaF EL-62; Vulkacit NPV/C2; Warecure C

CAS Registry Number: 96-45-7

RTECS® Number: NI9625000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-506-9 [*Annex I Index No.*: 613-039-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *not classifiable as carcinogenic to humans*, Group 3, 2000.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Rodent dominant lethal Positive: Host-mediated assay; Histidine reversion—Ames test Negative: Cell transform.—SA7/SHE; Sperm morphology—mouse Negative: TRP reversion Inconclusive: Mammalian micronucleus.

Banned or Severely Restricted (Sweden).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U116.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Endorcrine disruptor.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 1/1/93.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R61; R22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethylene thiourea is a white to light green, needle-like crystalline solid with a faint amine odor. Molecular weight = 102.17; Boiling point = 230−312.8°C; Freezing/Melting point = 200°C; Vapor pressure = 16 mmHg at 20°C; Flash point = 252.2°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in cold water; solubility = 2% at 30°C; highly soluble in hot. Commercial ethylene thiourea is available as a solid powder, as a dispersion in oil (which retards the formation of fine dust dispersions in work-place air), and "encapsulated" in a matrix of compatible elastomers. In this latter form, ethylene thiourea may be least likely to escape into the work-place air.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Ethylene thiourea is used extensively as an accelerator in the curing of polychloroprene (Neoprene™) and other elastomers; as a vulcanizing accelerator in rubber processing; in electroplating baths. In addition, exposure to ethylene thiourea also results from the very widely used ethylene bisdithiocarbamate fungicides. Ethylene thiourea may be present as a contaminant in the ethylene bisdithiocarbamate fungicides and can also be formed when food containing the fungicides is cooked.

Incompatibilities: Strong oxidizers, acids, acid anhydrides, acrolein.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. Use encapsulated form.

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Carcinogen Category 3B.

Finland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, carcinogen, 1993; France: carcinogen, 1993; the Netherlands: MAC-TGG 0.024 mg/m^3, 2003; Sweden: carcinogen, 1999. States which have set guidelines or standards for ethylene thiourea in ambient air[60] include North Dakota (zero level) and Pennsylvania (0.7 μg/m^3).

Determination in Air: Use NIOSH Analytical Method (IV) #5011 or OSHA Analytical Method 95.

Permissible Concentration in Water: Maine[61] has set a guideline for drinking water of 4.4 μg/L. The US EPA in a health advisory (see "References" below) has developed a no-observed-adverse-effect level (NOAEL) of 1.25 mg/kg/day based on absence of thyroid effects in male rats exposed to ETU in the diet for up to 12 months. This results in a longer term health advisory of 0.44 mg/L for an adult.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.7$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause irritation of the respiratory tract with soreness, hoarseness, cough, and phlegm. High exposure can cause sweating, thirst, nausea, an increase in the heart rate and blood pressure that can last for hours or days. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact can cause irritation of the skin and eyes, and may cause eye burns. A related chemical, ziram, can cause brain swelling and hemorrhage with muscle weakness, liver and kidney effects.

Long Term Exposure: Ethylene thiourea has been shown to be carcinogenic and teratogenic (causing malformation in offspring) in laboratory animals. May cause malformations in human babies. Ethylene thiourea may cause thyroid and liver damage. In addition, ethylene thiourea can cause myxedema (the drying and thickening of skin, together with a slowing down of physical and mental activity), goiter, and other effects related to decreased output of thyroid hormone. Maneb, a related fungicide, can cause nerve damage.

Points of Attack: Eyes, skin, thyroid, reproductive system. Cancer site in animals: liver, thyroid, and lymphatic system.

Medical Surveillance: Initial and routine employee exposure surveys should be made by competent industrial hygiene and engineering personnel. These surveys are necessary to determine the extent of employee exposure and to ensure that controls are effective. The *NIOSH Occupational Exposure Sampling Strategy Manual*, NIOSH Publication #77-173, may be helpful in developing efficient programs to monitor employee exposures to ethylene thiourea. The manual discusses determination of the need for exposure measurements, selection of appropriate employees for exposure evaluation, and selection of sampling times. Employee exposure measurements should consist of 8-h TWA exposure estimates calculated from personal or breathing zone samples (air that would most nearly represent that inhaled by the employees). Area and source measurements may be useful to determine problem areas, processes, and operations. Thyroid function tests. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: There are four basic methods of limiting employee exposure to ethylene thiourea. None of these is a simple industrial hygiene or management decision and careful planning and thought should be used prior to implementation of any of these.

Product Substitution: The substitution of an alternative material with a lower potential health and safety risk in one method. However, extreme care must be used when selecting possible substitutes. Alternatives to ethylene thiourea should be fully evaluated with regard to possible human effects. Unless the toxic effects of the alternative have been thoroughly evaluated, a seemingly safe replacement, possibly only after years of use, may be found to induce serious health effects.

Contaminant Control: The most effective control of ethylene thiourea, where feasible, is at the source of contamination by enclosure of the operation and/or local exhaust ventilation. If feasible, the process or operation should be enclosed with a slight vacuum so that any leakage will result in the flow of air into the enclosure. The next most effective means of control would be a well-designed local exhaust ventilation system that physically encloses the process as much as possible, with sufficient capture velocity to keep the contaminant from entering the work atmosphere. To ensure that ventilation equipment is working properly, effectiveness (e.g., air velocity, static pressure, or air volume) should be checked at least every 3 months. System effectiveness should be checked soon after any change in production, process or control, which might result in significant increases in airborne exposures to ethylene thiourea.

Employee Isolation: A third alternative is the isolation of employees. It frequently involves the use of automated equipment operated by personnel observing from a closed control booth or room. The control room is maintained at a greater air pressure than that surrounding the process equipment so that air flow is out of, rather than into, the room. This type of control will not protect those employees that must do process checks, adjustments, maintenance, and related operations.

Personal Protective Equipment: The least preferred method is the use of personal protective equipment. This equipment, which may include respirators, goggles, gloves, and related items, should not be used as the only means to prevent or minimize exposure during routine operations. Exposure to ethylene thiourea should not be controlled with the use of respirators except: During the time necessary to install or implement engineering or work practice controls; or in work situation in which engineering and work practice controls are technically not feasible; or for maintenance; or for operations which require entry into tanks or closed vessels; or in emergencies.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, acids, acid anhydrides, acrolein. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a furnace equipped with afterburner and scrubber.[22]

References

National Institute for Occupational Safety and Health. (April 11, 1978). *Ethylene Thiourea*, Current Intelligence Bulletin 22. Washington, DC

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 38−39 (1980) and 7, No. 3, 106−111

US Environmental Protection Agency. (August 1987). *Health Advisory: Ethylene Thiourea*. Washington, DC: Office of Drinking Water

Ethyl ether E:0680

Molecular Formula: $C_4H_{10}O$

Common Formula: $CH_3CH_2OCH_2CH_3$

Synonyms: Aether; Anaesthetic ether; Anesthesia ether; Anesthetic ether; Diaethylaether (German); Diethyl ether; Diethyl oxide; Eter etilico (Spanish); Ethane, 1,1′-oxybis-; Ether; Ether, ethyl; Ether ethylique (French); Ethoxyethane; Oxyde d’ethyle (French); Solvent ether; Sulfuric ether

CAS Registry Number: 60-29-7

RTECS® Number: KI5775000

UN/NA & ERG Number: UN1155/127

EC Number: 200-467-2 [*Annex I Index No.:* 603-022-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9; Negative: *Aspergillus*—forward mutation; Sperm morphology—mouse; Inconclusive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): U117.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), 160.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Hazard Symbol: F + , Xn; Risk phrases: R12; R19; R22; R66; R67 Safety phrases: S2; S9; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl ether is a colorless, mobile, highly flammable, volatile liquid with a characteristic pungent odor. The odor threshold is 0.63 ppm.[41] Molecular weight = 74.14; Specific gravity (H_2O:1) = 0.71; Boiling point = 34.4°C; Freezing/Melting point = −116°C; Relative vapor density (air = 1) = 2.62; Vapor pressure = 440 mmHg at 20°C; Flash point = −45°C; Autoignition temperature = 180°C. Explosive limits: LEL = 1.9%; UEL = 36.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 7%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. Ethyl ether is used as a solvent for waxes, fats, oils, perfumes, alkaloids, dyes, gums, resins, nitrocellulose, hydrocarbons, raw rubber, and smokeless powder. It is also used as an inhalation anesthetic, a refrigerant, in diesel fuels, in dry cleaning, as an extractant, and as a chemical reagent for various organic reactions.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, strong oxidizers, halogens, sulfur, sulfur compounds, causing fire and explosion hazard. Can form peroxides from air, heat, sunlight; may explode when container is unstoppered or otherwise opened. Attacks some plastics, rubber, and coatings. Being a nonconductor, chemical may accumulate static electric charges that may result in ignition of vapor.

Permissible Exposure Limits in Air

OSHA PEL: 400 ppm/1200 mg/m^3 TWA.

NIOSH REL: None. See Appendix D (NIOSH Pocket Guide).

ACGIH TLV®[1]: 400 ppm/1210 mg/m^3 TWA; 500 ppm/1560 mg/m^3 STEL.

Protective Action Criteria (PAC)

TEEL-0: 400 ppm

PAC-1: 500 ppm

PAC-2: 500 ppm

PAC-3: 1900 ppm

DFG MAK: 400 ppm/1200 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

NIOSH IDLH: 1900 ppm [LEL].

Australia: TWA 400 ppm (1200 mg/m^3); STEL 500 ppm, 1993; Austria: MAK 400 ppm (1200 mg/m^3), 1999; Belgium: TWA 400 ppm (1210 mg/m^3); STEL 500 ppm, 1993; Denmark: TWA 400 ppm (1200 mg/m^3), 1999; Finland: TWA 400 ppm (1200 mg/m^3); STEL 500 ppm (1500 mg/m^3), 1999; France: VME 400 ppm (1200 mg/m^3), VLE 500 ppm (1500 mg/m^3), 1999; Hungary: TWA 300 mg/m^3; STEL 600 mg/m^3 [skin] 1993; the Netherlands: MAC-TGG 308 mg/m^3, 2003; Norway: TWA 200 ppm (600 mg/m^3), 1999; the Philippines: TWA 400 ppm (1200 mg/m^3), 1993; Poland: MAC (TWA) 300 mg/m^3, MAC (STEL) 1500 mg/m^3, 1999; Russia: TWA 400 ppm; STEL 300 mg/m^3, 1993; Switzerland: MAK-W 400 ppm (1200 mg/m^3), KZG-W 800 ppm (2400 mg/m^3), 1999; Turkey: TWA 400 ppm (1200 mg/m^3), 1993; United Kingdom: TWA 400 ppm (1230 mg/m^3); STEL 500 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 500 ppm.

The Czech Republic[35]: TWA 500 mg/m^3; STEL 1500 mg/m^3. Russia[35] set a MAC of 1.0 mg/m^3 in the ambient air of residential areas on a once-a-day basis and 0.6 mg/m^3 on a daily average basis. Several states have set guidelines or standards for ethyl ether in ambient air[60] ranging from 0.16 mg/m^3 (Massachusetts) to 12.0−15.0 mg/m^3 (North Dakota) to 20.0 mg/m^3 (Virginia) to 24.0 mg/m^3 (Connecticut, Florida, New York) to 28.571 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1610 or OSHA Analytical Method 7.[18]

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.3 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.9$.

Routes of Entry: Inhalation of vapor, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Local: Ethyl ether vapor is mildly irritating to the eyes, nose, and throat. Contact with liquid may produce a dry, scaly, fissured dermatitis. *Systemic:* Ethyl ether has predominantly narcotic properties. Overexposed individuals may experience drowsiness, vomiting, and unconsciousness. Death may result from severe overexposure. Chronic exposure results in some persons in anorexia, exhaustion, headache, drowsiness, dizziness, excitation, and psychic disturbances. Albuminuria has been reported. Chronic exposure may cause an increased susceptibility to alcohol. There is an association between exposure to anesthetic vapors and increased miscarriages and birth defects. Diethyl ether's role in these increased risks is unclear.

Short Term Exposure: Ethyl ether irritates the eyes and respiratory tract. Inhalation can cause drowsiness, excitement, dizziness, vomiting, irregular breathing, and increased saliva. Swallowing the liquid may cause chemical pneumonitis. High exposure can affect the central nervous system, causing unconsciousness and even death.

Long Term Exposure: Repeated or prolonged contact can cause skin cracking, scaling, and extreme drying. Repeated exposure may cause an addiction.

Points of Attack: Central nervous system, skin, respiratory system, eyes.

Medical Surveillance: Preplacement or periodic examinations should evaluate the skin and respiratory tract, liver and kidney function. Persons with a past history of alcoholism may be at some increased risk due to possibility of ethyl ether addiction (known as "ether habit"). Tests for exposure may include expired breath for unmetabolized ethyl ether and blood for ethyl ether content by oxidation with chromate solution or by gas chromatographic methods. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of saltwater and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves; Barricade® coated suits; **4 h:** Teflon™ gloves, suits, boots; Responder™ suits, Trellchem HPS™ suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *1900 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl ether must be stored to avoid contact with strong oxidizers (such as bromine, chlorine, chlorine dioxide, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and sunlight. Unstable peroxides may form if diethyl ether is exposed for a long time to air or sunlight, causing explosions. Sources of ignition, such as smoking and open flames, are prohibited where ethyl ether is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl ether. Wherever ethyl ether is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an extremely flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 81−84

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Diethyl Ether*. Trenton, NJ

Ethyl formate E:0690

Molecular Formula: $C_3H_6O_2$

Common Formula: $HCOOC_2H_5$

Synonyms: Aethylformiat (German); Areginal; Ethyle (formiate d') (French); Ethyl formic ester; Ethyl methanoate; Formic acid, ethyl ester; Formic ether

CAS Registry Number: 109-94-4

RTECS® Number: LQ8400000

UN/NA & ERG Number: UN1190/129

EC Number: 203-721-0 [*Annex I Index No.*: 607-015-00-7]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; R20/22; R36/37; Safety phrases: S2; S9; S16; S24; R26; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl formate is a colorless liquid with a fruity odor. Molecular weight = 74.09; Specific gravity (H_2O:1) = 0.92; Boiling point = 54.4°C; Freezing/Melting point = −80.6; Vapor pressure = 200 mmHg at 20°C; Flash point = −20°C; Autoignition temperature = 440°C. Explosive limits: LEL = 2.8%; UEL = 16.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Solubility in water = 9% at 18°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Primary Irritant. This material is used as an emulsifier; food and feed additive; flavor, packaging material; as a solvent for cellulose nitrate and acetate; it is used as a fumigant and in the production of synthetic flavors. It is also a raw material in pharmaceutical manufacture.

Incompatibilities: Forms explosive mixture with air. Reacts violently with nitrates, strong oxidizers, strong alkalis, and strong acids. Decomposes slowly in water, forming ethyl alcohol and formic acid. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/300 mg/m^3 TWA.

NIOSH REL: 100 ppm/300 mg/m^3 TWA.

ACGIH TLV®[1]: 100 ppm/303 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 300 ppm

PAC-2: 500 ppm

PAC-3: 1500 ppm

DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category I(1);[skin]; Pregnancy Risk Group C.

NIOSH IDLH: 1500 ppm.

Australia: TWA 100 ppm (300 mg/m^3), 1993; Austria: MAK 100 ppm (300 mg/m^3), 1999; Belgium: TWA 100 ppm (303 mg/m^3), 1993; Denmark: TWA 100 ppm (300 mg/m^3), 1999; Finland: TWA 100 ppm (300 mg/m^3), 1999; France: VME 100 ppm (300 mg/m^3), 1999; the Netherlands: MAC-TGG 300 mg/m^3, 2003; Norway: TWA 50 ppm (150 mg/m^3), 1999; Poland: MAC (TWA) 100 mg/m^3, MAC (short-term exposure limit) 450 mg/m^3, 1999; Turkey: TWA 100 ppm (300 mg/m^3), 1993; United Kingdom: TWA 100 ppm (308 mg/m^3), STWL 150 ppm, 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm. Several states have set guidelines or standards for ethyl formate in ambient air[60] ranging from 3.0−4.5 mg/m^3 (North Dakota) to 5.0 mg/m^3 (Virginia) to 6.0 mg/m^3 (Connecticut) to 7.143 mg/m^3 (Nevada).

Determination in Air: Charcoal (tube) adsorption, workup with CS_2; analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1452.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Either contact or the vapor can cause skin and eye irritation. Inhalation irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ethyl formate may affect the central nervous system. Exposure can cause headache, nausea, and vomiting.

Long Term Exposure: Prolonged or repeated contact can cause skin dryness and cracking. May affect the nervous system.

Points of Attack: Eyes, respiratory system, central nervous system.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Consider chest X-ray following acute overexposure. Nervous system tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, Nitrile, and styrene−butadiene rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Up to 1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrOv (APF = 10) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases, moisture, and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket

great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray into a furnace in admixture with a flammable solvent.[24]

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethyl Formate*. Trenton, NJ

2-Ethyl hexaldehyde E:0700

Molecular Formula: $C_8H_{16}O$

Common Formula: $(C_2H_5)(C_4H_9)CHCHO$

Synonyms: Butyl ethyl acetaldehyde; 2-Ethylcaproaldehyde; Ethylhexanal; 3-Formylheptane; Hexanal, 2-ethyl-; Octyl aldehyde; β-Propyl-α-ethylacrolein

CAS Registry Number: 123-05-7 (hexaldehydes)

RTECS® Number: MN7525000

UN/NA & ERG Number: UN1191/129

EC Number: 204-596-5

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl hexaldehyde is a colorless liquid with a mild, pleasant odor. Molecular weight = 128.24; Boiling point = 163°C; Flash point = 44.4°C; Autoignition temperature = 190°C. Explosive limits: LEL = 0.85% at 93°C; UEL = 7.2% at 135°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Primary Irritant. It is used as a solvent extraction chemical; in organic synthesis; perfume formulation, disinfectant.

Incompatibilities: Forms explosive mixture with air. Violent reaction with oxidizers. Incompatible with strong acids, caustics, ammonia, amines. May ignite spontaneously when spilled on clothing or other absorbent materials. May form unstable peroxides on contact with air; under certain conditions ignites spontaneously with air.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Skin absorption, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Skin or eye contact can cause severe irritation or burns. The vapors can irritate the eyes, throat, and bronchial tubes, with coughing and difficulty breathing. Headaches and nausea may occur. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause bronchitis with cough, phlegm, and shortness of breath.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24—48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl hexaldehyde, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with ethyl hexaldehyde you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases, and combustible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This falls under "Octyl Aldehydes, Flammable," and requires a shipping label of "FLAMMABLE LIQUID." This falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl hexaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 71–72 (1981) and 3, No. 2, 47–48

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Ethyl Hexaldehyde*. Trenton, NJ

2-Ethylhexyl acrylate E:0710

Molecular Formula: $C_{11}H_{20}O_2$

Common Formula: $CH_2{=}CHCOOCH_2CH(C_2H_5)(C_4H_9)$

Synonyms: Acrilato de 2-etilhexilo (Spanish); Acrylic acid, 2-ethylhexyl ester; 2-Ethylhexyl 2-propenoate; Octyl acrylate; 2-Propenoic acid 2-ethylhexyl ester

CAS Registry Number: 103-11-7; *(alt.)* 78733-32-1; *(alt.)* 84948-57-2; *(alt.)* 93460-77-6

RTECS® Number: AT0855000

UN/NA & ERG Number: UN1993 (Combustible liquid, n.o.s.)/128

EC Number: 203-080-7 [*Annex I Index No.:* 607-107-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R37/38; R43; Safety phrases: S2; S36/37; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Ethylhexyl acrylate is a combustible, colorless liquid with a pleasant odor. Molecular weight = 184.31; Boiling point = 214°C; Freezing/Melting point = −90°C; Flash point = 82°C; Autoignition temperature = 252°C. Explosive limits: LEL = 0.8%; UEL = 6.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Those involved in the use of this monomer as a feedstock for chemical syntheses; in the manufacture of plastics; protective coatings, including water-based paints; in paper treatment; the production of emulsion polymers.

Incompatibilities: Unless inhibited, sunlight, heat, contaminants, or peroxides can cause polymerization. Violent reaction with strong oxidizers, with risk of fire and explosions. Forms explosive mixture with air. Incompatible with strong acids, aliphatic amines, alkanolamines. Vapors are uninhibited and may polymerize, blocking vents.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 10 ppm
PAC-2: 10 ppm
PAC-3: 10 ppm

DFG MAK: 5 ppm/38 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D; [skin] danger of skin sensitization.

Poland: TWA 35 mg/m^3; STEL 100 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.67$.

Routes of Entry: Skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Severely irritates the eyes and skin. Irritates the respiratory tract. High exposure may cause respiratory difficulty and collapse. CNS stimulation following ingestion.

Long Term Exposure: Repeated or prolonged contact may cause skin allergy.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area or refrigerator away from oxidizers and light. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: *Note:* Unless inhibited, this material is a polymerization hazard. May be classified as a Combustible liquid, n.o.s. This class of compounds requires no particular shipping label. It falls in Hazard Class 3 and Packing Group III. Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter, or has a flash point above 60.5°C/141°F but below 93°C/200°F.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous and irritating gases are produced in fire. Use dry chemical or carbon dioxide. Water or foam may cause frothing.[41] Vapors are uninhibited and may polymerize, blocking vents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure,

explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray into incinerator with added flammable solvent.

Reference

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 57−59 (1981) and 3, No. 2, 83−85

Ethylidene norbornene E:0720

Molecular Formula: C_9H_{12}

Synonyms: ENB; 5-Ethylidenebicyclo(2,21)hept-2-ene; 5-Ethylidene-2-norbornene (stabilized)

CAS Registry Number: 16219-75-3

RTECS® Number: RB9450000

UN/NA & ERG Number: UN1992/131

EC Number: 240-347-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 5-Ethylidene-2-norbornene is a colorless liquid with a turpentine-like odor. The odor threshold is 0.007 ppm.[41] Molecular weight = 120.21; Boiling point = 148°C; Freezing/Melting point = − 80°C; Vapor pressure = 4 mmHg; Flash point = 38.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data; Primary Irritant. 5-Ethylidene-2-norbornene is used as the third monomer in terpolymer elastomers. Those engaged in the synthesis of pharmaceuticals, pesticides, or in the preparation of specialty resins.

Incompatibilities: Forms explosive mixture with air. Reacts violently with strong oxidants. Violent reaction with oxygen and strong oxidizers. May accumulate static electrical charges, and may cause ignition of its vapors. The substance may polymerize. Inhibit peroxide formation with *tert*-butyl catechol. ENB should be stored in a nitrogen atmosphere since it reacts with oxygen.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.92 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 5 ppm/25 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 5 ppm/25 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.06 ppm

PAC-1: **0.2** ppm

PAC-2: **100** ppm

PAC-3: **500** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 5 ppm (25 mg/m^3), 1993; Belgium: STEL 5 ppm (25 mg/m^3), 1993; Denmark: TWA 5 ppm (25 mg/m^3), 1999; Finland: TWA 5 ppm (25 mg/m^3); STEL 10 ppm (50 mg/m^3), 1999; France: VLE 5 ppm (25 mg/m^3), 1999; the Netherlands: MAC 25 mg/m^3, 2003; Norway: TWA 5 ppm (25 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (25 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 ppm. Several states have set guidelines on standards for ethylidene norbornene in ambient air[60] ranging from 200.0 μg/m^3 (Virginia) to 250.0 μg/m^3 (North Dakota) to 595.0 μg/m^3 (Nevada).

Determination in Air: No test available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, nose, and respiratory tract. Contact can irritate and may burn the skin and eyes. Exposure can cause headache, confusion, nausea, and vomiting. Ingestion of the liquid may cause chemical pneumonitis. Exposure to high concentrations may cause unconsciousness and death.

Long Term Exposure: Repeated or high exposure may damage the liver, lungs, and kidneys. Ethylidene norbornene may damage the testes (male reproductive glands).

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys, urogenital syste, bone marrow.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; lung function tests. Reproductive history and possibly semen analysis with sperm count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved full-face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethylidene norbornene should be stored in a nitrogen atmosphere. Do not allow it to come in contact with oxygen because violent reactions can occur.

Shipping: This material may be classified as Flammable liquids, toxic, n.o.s. This class requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Ethylidene Norbornene*. Trenton, NJ

Ethyl isocyanate E:0730

Molecular Formula: C_3H_5NO

Common Formula: C_2H_5NCO

Synonyms: Isocyanatoethane; Isocyanic acid, ethyl ester

CAS Registry Number: 109-90-0

RTECS® Number: NQ8825000

UN/NA & ERG Number: UN2481/155

EC Number: 203-717-9

Regulatory Authority and Advisory Bodies

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl isocyanate is a clear, colorless liquid with a pungent odor. Molecular weight = 71.09; Boiling point = 60°C; Flash point = −10°C; ≤23°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Hydrolyzes in water.

Potential Exposure: Ethyl isocyanate is used to make pharmaceuticals and pesticides.

Incompatibilities: Forms explosive mixture with air. Violent reaction with water and strong oxidizers. Incompatible with acids, bases, ammonia, amines, amides, alcohols, glycols, caprolactum solution. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*
TEEL-0: 0.0025 ppm
PAC-1: 0.0075 ppm
PAC-2: **0.053** ppm
PAC-3: **0.16** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl isocyanate can irritate the eyes, skin, and respiratory tract. Skin contact can cause a rash. Exposure can irritate the nose and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Similar chemicals cause lung and skin allergies. It is not known if ethyl isocyanate does this.

Points of Attack: Skin, lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl isocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethyl isocyanate is used, handled, or stored in a manner that could create a potential fire or exposition hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl isocyanate.

Shipping: Ethyl isocyanate requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group I. A plus sign (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 2.4/3.8
Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0 + /11.0+
Night 7.0 + /11.0+

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Ethyl isocyanate*. Trenton, NJ

Ethyl mercaptan E:0740

Molecular Formula: C_2H_6S
Common Formula: C_2H_5SH
Synonyms: Ethanethiol; Ethyl hydrosulfide; Ethyl sulfhydrate; Ethyl thioalcohol; LPG ethyl mercaptan 1010; Mercaptoethane; Thioethanol; Thioethyl alcohol
CAS Registry Number: 75-08-1
RTECS® Number: KI9625000
UN/NA & ERG Number: UN2363/129
EC Number: 200-837-3 [*Annex I Index No.:* 016-022-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; F20; R50/53; Safety phrases: S2; S16; S25; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Ethyl mercaptan is a yellowish liquid (or a colorless gas above the BP) with a strong garlic or skunk-like odor. Molecular weight = 62.14; Specific gravity (H_2O:1) = 0.84; Boiling point = 35°C; Freezing/Melting point = −144.4°C; Relative vapor density (air = 1) = 2.14; Vapor pressure = 442 mmHg at 20°C; Flash point ≤−18°C; Autoignition temperature = 299.5°C. Explosive limits: LEL = 2.8%; UEL = 18.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Practically insoluble in water; solubility = 0.7%.

Potential Exposure: Compound Description: Primary Irritant. This material is used as a warning odorant for liquefied petroleum gases. It is used as an intermediate in the manufacture of many pesticides and other organic chemicals.

Incompatibilities: Forms explosive mixture with air. This material is a weak acid. Reacts with oxidizers, causing fire and explosion hazard. Reacts with strong acids evolving toxic and flammable hydrogen sulfide. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks some forms of plastics, coatings, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.54 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm/25 mg/m^3 Ceiling Concentration (General Industry); 0.5 ppm/1.3 mg/m^3 TWA (Construction and Shipyards).
NIOSH REL: 0.5 ppm/1.3 mg/m^3/15 min, Ceiling Concentration [15-min].
ACGIH TLV®[1]: 0.5 ppm/1.3 mg/m^3 TWA.
NIOSH IDLH: 500 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.5 ppm
PAC-1: **1.0** ppm
PAC-2: **120** ppm
PAC-3: **360** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 0.5 ppm/1.3 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D, *as ethanethiol*.
Australia: TWA 0.5 ppm (1 mg/m^3), 1993; Austria: MAK 0.5 ppm (1 mg/m^3), 1999; Belgium: TWA 0.5 ppm (1.3 mg/m^3), 1993; Finland: STEL 0.5 ppm (1.3 mg/m^3), 1999; France: VME 0.5 ppm (1 mg/m^3), 1999; Hungary: STEL 1 mg/m^3, 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; the Philippines: TWA 10 ppm (25 mg/m^3), 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 3 mg/m^3,

1999; Russia: STEL 1 mg/m^3 [skin] 1993; Switzerland: MAK-W 0.5 ppm (1.3 mg/m^3), KZG-W 1 ppm (2.6 mg/m^3), 1999; Thailand: TWA 10 ppm (25 mg/m^3), 1993; Turkey: TWA 10 ppm (25 mg/m^3), 1993; United Kingdom: TWA 0.5 ppm (1.3 mg/m^3); STEL 2 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm. Several states have set guidelines or standards for ethyl mercaptan in ambient air[60] ranging from 3.3 μg/m^3 (New York) to 10.0 μg/m^3 (Florida, North Dakota, South Carolina) to 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada) to 100.0 μg/m^3 (North Carolina).

Determination in Air: Collection filter (special); workup with hydrochloric acid/1,2-dichloroethane; analysis with gas chromatography/flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #2542.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible ambient goal or 13.8 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.5.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause skin and eye irritation. Inhalation can irritate the respiratory tract and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headaches, nausea, vomiting, diarrhea, muscle weakness, and tiredness. May affect the central nervous system, causing convulsions and respiratory failure. High levels may cause dizziness, lightheadedness, coma, and death.

Long Term Exposure: Repeated exposure can cause lung irritation and bronchitis. May cause liver and kidney damage. Repeated or long-term exposure may damage the red blood cells, causing anemia.

Points of Attack: Eyes, respiratory system, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood cell count (CBC). Liver and kidney function tests. Consider chest X-ray following acute overexposure. NIOSH lists the following tests: Blood Gas Analysis, electrocardiogram, expired air, pulmonary function tests, sputum cytology, white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of saltwater and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **4 h:** Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away

from ignition sources and corrosive and reactive materials. Prior to working with ethyl mercaptan you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and acids. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Use self-contained breathing apparatus during cleanup.[57] Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or liquid. Poisonous gases, including sulfur oxides and carbon monoxide, are produced in fire.

Liquid: Use dry chemical, carbon dioxide, halon, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (1093°C) followed by scrubbing with a caustic solution.[22]

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethyl Mercaptan*. Trenton, NJ

Ethyl mercuric chloride E:0750

Molecular Formula: C_2H_5ClHg

Common Formula: C_2H_5HgCl

Synonyms: Ceresan; Chloroethyl mercury; EMC; Ethylmercuric chloride; Ethylmercury chloride; Granosan®; Granozan

CAS Registry Number: 107-27-7

RTECS® Number: OV9800000

UN/NA & ERG Number: UN2025 (mercury compounds, solid, n.o.s.)/151; UN2777 (mercury-based pesticides, solid, toxic)/151

EC Number: 203-478-0 [*Annex I Index No.:* 080-00-2-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section. California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R6; R26; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 *as mercury*.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl mercuric chloride, an alkyl-organo mercury compound, is silvery white, forming leaf-like crystals. Molecular weight = 265.11; Freezing/Melting point = 192°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Organometallic, Mutagen. It is used as an organic fungicide for seed treatment.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg/m^3 STEL [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.0132 mg/m^3

PAC-1: 0.0396 mg/m^3

PAC-2: 2.64 mg/m^3

PAC-3: 2.64 mg/m^3

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3.

NIOSH IDLH: 2 mg[Hg]/m^3.

Russia[43] set a MAC of 0.005 mg/m^3 in work-place air and a MAC of 0.0009 mg/m^3 for ambient air in residential areas on a momentary basis and 0.0001 mg/m^3 on an average daily basis.

Determination in Air: No test available.

Permissible Concentration in Water: A severe marine pollutant. A MAC in water bodies used for domestic purposes has been set by Russia[43] at 0.0001 mg/L.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ethyl mercuric chloride is an extremely toxic chemical that can cause permanent brain damage weeks after exposure with little or no warning during exposure. LD_{50} = (oral-rat) 40 mg/kg. Severe poisoning can cause death. It enters the body through the lungs, skin, and contaminated hands. Poisoning causes a "pins and needles" feeling, becoming clumsy and weak; hearing loss; abnormal walking; tremors, personality changes and other brain damage. Eye contact may cause severe irritation.

Long Term Exposure: Ethyl mercuric chloride should be handled as a teratogen—with extreme caution. It may cause mutations. Handle with extreme caution. Mercury accumulates in the body. May cause kidney damage. It can take months or years for the body to get rid of excess mercury.

Points of Attack: Eyes, skin. central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests: body hair/nail; whole blood (chemical/metabolite); neurologic examination/electromyography. Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with examination of the nervous system including handwriting. Visual exam, including "visual field" exam. Hearing tests. Test for mercury in hair and blood. After suspected illness or overexposure, repeat these tests promptly, again in 4−6 weeks and then as recommended by your doctor. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate [CAS: 134-72-5].

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m^3*: Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates).

Shipping: This material falls in the class of mercury-based pesticides, solid, toxic and requires a shipping label of “POISONOUS/TOXIC MATERIALS.” This compound falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressant or special vacuums. Kits specific for cleanup of mercury spills should be available. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

For a related compound which is not regulated but which was on the US EPA Extremely Hazardous Chemical List in 1985 (dropped in 1988), see the following: US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Ethylmercuric Phosphate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Ethyl Mercuric Chloride*. Trenton, NJ

Ethyl methacrylate E:0760

Molecular Formula: $C_6H_{10}O_2$
Common Formula: $CH_2{=}C(CH_3)COOC_2H_5$

Synonyms: Ethyl 1-2-methacrylate; Ethyl α-methylacrylate; Ethyl 2-methyl-2-propenoate; Metacrilato de etilo (Spanish); 1-2-Methacrylic acid, ethyl ester; 2-Methyl-2-propenoic acid, ethyl ester; 2-Propenoic acid, 1-methyl-, ethyl ester; Rhoplex; Rhoplex AC-33 (Rohm & Haas)
CAS Registry Number: 97-63-2
RTECS® Number: OZ4550000
UN/NA & ERG Number: UN2277/130
EC Number: 202-597-5 [*Annex I Index No.:* 607-071-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA Hazardous Waste Number (RCRA No.): U118.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 160.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (10); 8240 (5).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36/37/38; R43; Safety phrases: S2; S9; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl methacrylate is a colorless liquid. Molecular weight = 114.16; Boiling point = 115−120°C; Freezing/Melting point ≤−75°C; Flash point = 20°C; Autoignition temperature = 393°C. Explosive limits: LEL = 1.8%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Primary Irritant. This chemical is used in manufacture of coatings, resins, and laquers. Widely known as “Plexiglass” (in the polymer form), ethyl methacrylate is used to make polymers, which in turn are used for building, automotive, aerospace, and furniture industries. It is also used by dentists as dental plates, artificial teeth, and orthopedic cement.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, amines, oxidizers. Corrodes some metals. Unless inhibited, violent polymerization can occur from heat, sunlight, and contact with strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 50 ppm
PAC-1: 150 ppm
PAC-2: 750 ppm
PAC-3: 750 ppm

DFG MAK: [skin] danger of skin sensitization.

Denmark: TWA 50 ppm (235 mg/m^3), 1999; Norway: TWA 50 ppm (250 mg/m^3), 1999; Russia: STEL 50 mg/m^3, 1993; Sweden: NGV 50 ppm (250 mg/m^3), KTV 75 ppm

(350 mg/m^3), 1999; the Netherlands: MAC-TGG 48 mg/m^3, 2003.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator. Exposure can irritate the eyes, skin, and respiratory tract. Very high vapor levels could cause you to feel dizzy, lightheaded, and even to pass out. Contact can irritate the eyes and skin.

Long Term Exposure: Repeated or prolonged contact with skin may cause allergy with rash and itching. May damage the nervous system. There is limited evidence that ethyl methacrylate may damage the developing fetus.

Points of Attack: Skin, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. There is evidence that fluorinated ethylene propylene materials offer protection from ethyl methacrylate for up to 3 h. Polyvinyl alcohol is also among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl methacrylate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Sources of ignition, such as smoking and open flames, are prohibited where ethyl methacrylate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl methacrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl methacrylate.

Shipping: This compound (stabilized) requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl methacrylate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Ethyl Methacrylate: Health and Environmental Effects Profile No. 101*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Methyl Methacrylate*. Trenton, NJ

Ethyl methanesulfonate E:0770

Molecular Formula: $C_3H_8O_3S$

Common Formula: $C_2H_5OSO_2CH_3$

Synonyms: EMS; ENT 26,396; Ethyl ester of methanesulfonic acid; Ethyl ester of methylsulfonic acid; Ethyl ester of methylsulphonic acid; Ethyl mesylate; Ethyl methanesulphonate; Ethyl methansulfonate; Ethyl methansulphonate; Ethyl methyl sulfonate; Half-myderan; Methanesulphonic acid ethyl ester; Methylsulfonic acid, ethyl ester; NSC 26805

CAS Registry Number: 62-50-0

RTECS® Number: PB2100000

DOT ID and ERG Number: UN1969/115

EC Number: 200-536-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen; OSHA: possible select carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U119.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl methanesulfonate is a clear liquid. Molecular weight = 124.15; Boiling point = 213°C; Vapor pressure = 0.33 mmHg at 25°C; Flash point = 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Soluble in water; solubility = 50 g/L at 27°C.

Potential Exposure: It was considered as a possible human male contraceptive. Also considered as a reversible male hemosterilant for insects and mammalian pests. Used as a research tool for mutagenesis and carcinogenesis studies.

Incompatibilities: Acids, acid fumes; nitrates.

Permissible Exposure Limits in Air

Temporary Emergency Exposure Limits (DOE)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 150 mg/m^3

Determination in Air: No test available.

Permissible Concentration in Water: Octanol−water coefficient: Log $K_{ow} = 0.091$.

Harmful Effects and Symptoms

Irritation of skin, eyes, and mucous membranes; sores and burns. $LD_{50} = 470$ mg/kg.

Long Term Exposure: A carcinogen in animals. A Mutagen; Reproductive Effector.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place or a refrigerator away from acids and acid fumes. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound may be classified as an irritating agent and requires a shipping label of "POISONOUS/TOXIC MATERIALS."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Land spill:* Build dikes to contain the flow of spilled compound and fire-fighting water, if any. Absorb the compound on bentonite, sawdust, clay, or carbon. Alternatively, add a 5% solution of sodium hydroxide. Collect the waste in barrels for later disposal or treatment. *Spill on water body:* If the spill occurs on a large flowing water body, add a 5% solution of sodium hydroxide. Collect the waste in barrels for later disposal or treatment. In case of spill on nonflowing small water body, add 5% caustic followed by carbon adsorption or biological treatment depending on the end uses of the water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nonaqueous wastes may be treated in an incinerator, boiler, or cement kiln where temperature and residence time are in excess of 1000°C and 25 s, respectively. Alternatively, the nonaqueous wastes may be disposed of in an RCRA-approved landfill. The detoxified aqueous waste may be treated using biological wastewater methods or disposed of through deep-well injection. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 2, 67−74

N-Ethylmorpholine E:0780

Molecular Formula: $C_6H_{13}NO$

Synonyms: 4-Ethylmorpholine; NEM

CAS Registry Number: 100-74-3

RTECS® Number: QE4025000

UN/NA & ERG Number: UN1993/128

EC Number: 202-885-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 4-Ethylmorpholine is a colorless liquid with an ammonia-like odor. Molecular weight = 115.20; Specific gravity (H_2O:1) = 0.90; Boiling point = 138.3°C; Freezing/Melting point = −62.8°C; Vapor pressure = 6.2 mmHg at 20°C; Flash point = 32.2°C (oc); Autoignition temperature = 275°C. Explosive limits: LEL = 0.9%; UEL = 4.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Mutagen. Primary Irritant. This material is used as a catalyst in polyurethane foam production. It is a solvent for dyes and resins. It is used as an intermediate in surfactant, dye, pharmaceutical, and rubber chemical manufacture.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, strong oxidizers. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.71 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm/94 mg/m^3 TWA [skin].

NIOSH REL: 5 ppm/23 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 5 ppm/24 mg/m^3 TWA [skin].

NIOSH IDLH: 100 ppm.

No TEEL available.

Australia: TWA 5 ppm (23 mg/m^3), [skin], 1993; Belgium: TWA 5 ppm (24 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (23.5 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (47 mg/m^3); STEL 10 ppm (50 mg/m^3), [skin], 1999; France: VME 5 ppm (23 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 23 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (23 mg/m^3), 1999; Russia: STEL 5 mg/m^3, [skin], 1993; Sweden: NGV 5 ppm (25 mg/m^3), KTV 10 ppm (50 mg/m^3), [skin], 1999; Switzerland: MAK-W 20 ppm (70 mg/m^3), KZG-W 40 ppm (140 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (24 mg/m^3); STEL 20 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV®: TWA 5 ppm [skin]. Several states have set guidelines or standards for *n*-ethylmorpholine in ambient air[60] ranging from 230 μg/m^3 (North Dakota) to 400 μg/m^3 (Virginia) to 460 μg/m^3 (Connecticut) to 548 μg/m^3 (Nevada).

Determination in Air: Adsorption on Si gel, workup with H_2SO_4 using ultrasonics; analysis by gas chromatography/flame ionization. See NIOSH (II-3) Method #S-146.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can irritate and burn the skin and eyes. Exposure to high concentration of the vapor can cause drowsiness, foggy vision, visual disturbance, corneal edema, blue−gray vision, seeing colored halos around light.

Long Term Exposure: Unknown at this time.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 50 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator). *Up to 100 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, strong oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers Store in a refrigerator under an inert atmosphere for prolonged storage.

Shipping: Flammable liquids, n.o.s., require a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and nitrogen oxides, are produced in fire. Water may be ineffective. Alcohol foam is recommended.[17] Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

Reference

New Jersey Department of Health and Senior Services. (December 2006). *Hazardous Substances Fact Sheet: n-Ethyl Morpholine*. Trenton, NJ

Ethyl phenyl dichlorosilane E:0790

Molecular Formula: $C_8H_{10}Cl_2Si$

Common Formula: $C_2H_5(C_6H_5)SiCl_2$

Synonyms: Dichloroethyl phenylsilane; Ethylphenyldichlorosilane

CAS Registry Number: 1125-27-5

RTECS® Number: VV3270000

UN/NA & ERG Number: UN2435/156

EC Number: 214-407-8

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl phenyl dichlorosilane is a colorless liquid. Fumes in humid air. Molecular weight = 205.17; Boiling point = 149°C; Flash point = 104°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Reactive with water.

Potential Exposure: Used in the manufacture of silicone polymers.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers, combustible materials, strong bases, can cause a fire or explosion hazard. Contact with water, steam, moisture forms corrosive chloride gases, including hydrogen chloride. Attacks most metals. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, nose, and throat. It is a corrosive chemical and contact can cause severe skin and eye burns leading to permanent eye damage. High levels can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Very irritating substances may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl phenyl dichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operate in pressure-demand or other positive-pressure mode.

Storage: Ethyl phenyl dichlorosilane must be stored to avoid contact with water, steam, oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), and combustible materials (such as wood, paper, and oil) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames, are prohibited where ethyl phenyl dichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phenol and chlorine, are produced in fire. Use dry chemical or carbon dioxide. *Do not use water* or foam extinguishers. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Ethyl Phenyl Dichlorosilane*. Trenton, NJ

1-Ethyl piperidine E:0800

Molecular Formula: $C_7H_{15}N$
Common Formula: $C_2H_5(C_5H_9NH)$
Synonyms: *n*-Aethylpiperidin (German); Piperidine, 1-ethyl
CAS Registry Number: 766-09-6
RTECS® Number: IN0250000
UN/NA & ERG Number: UN2386/132
EC Number: 212-161-6

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl piperidine is a flammable liquid. Molecular weight = 113.21; Boiling point = 128°C; Melting point = < -49°C; Flash point = 19°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water; solubility = 35 g/L at 25°C.

Potential Exposure: Used in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers; or acids can cause fire and explosion hazard. Incompatible with carbon dioxide.

Determination in Air: No test available.

Permissible Concentration in Water: Octanol−water coefficient: Log $K_{ow} = 2$.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation. Passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: 1-Ethyl piperidine can affect you when breathed in and by passing through your skin. Contact can cause severe eye burns, leading to permanent damage and can irritate the skin. Exposure can irritate the nose and throat. High exposure can cause increased blood pressure and heart rate; weakness and shortness of breath. Higher levels may cause seizures or death.

Long Term Exposure: Can cause lung irritation. Bronchitis may develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to 1-ethyl piperidine, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a MSHA/NIOS-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine), acids (such as hydrochloric, sulfuric, and nitric), and carbon dioxide. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3, 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Water may be ineffective. Alcohol foam is recommended.[17] Keep 1-ethyl piperidine out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, carbon dioxide, carbon monoxide, are produced in fire. Use dry chemical, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: 1-Ethyl Piperidine*. Trenton, NJ

2-Ethyl-3-propyl acrolein E:0810

Molecular Formula: $C_8H_{14}O$

Synonyms: 2-Ethyl-2-hexenal; 2-Ethylhexenal; α-Ethyl-β-*n*-propylacrolein; 2-Ethyl-3-propyl acrolein

CAS Registry Number: 645-62-5

RTECS® Number: MP6300000

UN/NA & ERG Number: UN1993/128

EC Number: 211-448-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Ethyl-3-propyl acrolein is a colorless or yellowish liquid with a sharp, powerful, irritating odor. Molecular weight = 126.22; Boiling point = 175°C; Freezing/Melting point = 100°C; Flash point = 68°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Slightly soluble in water.

Potential Exposure: Those workers involved in organic synthesis operations and use of this material as a warning agent.

Incompatibilities: Strong oxidizers, acids, caustics, ammonia, amines.

Permissible Exposure Limits in Air

Russia[43] set a MAC of 3 mg/m^3 in work-place air.

Harmful Effects and Symptoms

Short Term Exposure: This chemical is an irritant, a moderate inhalative and ingestive toxin; and is slightly toxic (LD_{50} = (oral-rat) 3000 mg/kg). It irritates eyes, skin, and mucous membranes. Causes smarting of the skin and first-degree burns on short exposure. May cause second-degree burns on long exposure.

Long Term Exposure: Very irritating substances may cause lung irritation and bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in cool, dry place and protect from air.

Shipping: DOT[19] has no specific citation for the material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam (recommended) extinguishers. Vapors are heavier than air and will collect in low areas.

Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, or dissolve in flammable solvent and spray into incinerator containing afterburner.

Reference

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 72−73 (1981) and 3, No. 2, 48−50 (1983)

Ethyl silicate E:0820

Molecular Formula: $C_8H_{20}O_4Si$

Common Formula: $(C_2H_5O)_4Si$

Synonyms: Ethyl orthosilicate; Ethyl silicate, condensed; Ethyl silicate 40; Extrema; Silibone; Silicate d'ethyle (French); Silicic acid tetraethyl ester; TEOS; Tetraethoxysilane; Tetraethyl orthosilicate; Tetraethyl silicate

CAS Registry Number: 78-10-4

RTECS® Number: VV9450000

UN/NA & ERG Number: UN1292/129

EC Number: 201-083-8 [*Annex I Index No.:* 014-005-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20; R36/37; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl silicate is a colorless, flammable liquid with a sharp odor detectable at 85 ppm. Molecular weight = 208.37; Boiling point = 168.9°C; Specific gravity (H_2O:1) = 0.93 at 25°C; Freezing/Melting point = −82.8°C; Vapor pressure = 1 mmHg at 20°C; Flash point = 54°C (cc). Explosive limits: LEL = 1.3%; UEL = 23%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slowly hydrolyzes in water.

Potential Exposure: Compound Description: Primary Irritant. Ethyl silicate is used as a binder in the production of cases and molds for investment casting of metals. The next largest application is in corrosion-resistant coatings; primarily as a binder for zinc dust paints. Miscellaneous uses include the protection of white-light bulbs; the preparation of soluble silicas; catalyst preparation and regeneration; and as a crosslinker and intermediate in the production of silicones.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers, strong acids, water.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/850 mg/m^3 TWA.

NIOSH REL: 10 ppm/85 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/85 mg/m^3 TWA.

DFG MAK: 10 ppm/86 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

NIOSH IDLH: 700 ppm.

Australia: TWA 10 ppm (85 mg/m^3), 1993; Austria: MAK 20 ppm (170 mg/m^3), 1999; Belgium: TWA 10 ppm (85 mg/m^3), 1993; Denmark: TWA 10 ppm (85 mg/m^3), 1999; Finland: TWA 10 ppm (85 mg/m^3); STEL 20 ppm (170 mg/m^3), 1999; France: VME 10 ppm (85 mg/m^3), 1999; Japan: 10 ppm (85 mg/m^3), 1999; the Netherlands: MAC-TGG 85 mg/m^3, 2003; Norway: TWA 10 ppm (85 mg/m^3), 1999; the Philippines: TWA 100 ppm (850 mg/m^3), 1993; Poland: MAC (TWA) 80 mg/m^3, MAC (STEL) 250 mg/m^3, 1999; Russia: STEL 20 mg/m^3, 1993; Switzerland: MAK-W 10 ppm (85 mg/m^3), 1999; Turkey: TWA 100 ppm (850 mg/m^3), 1993; United Kingdom: TWA 10 ppm (87 mg/m^3); STEL 30 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm.

Determination in Air: XAD-2® (tube); adsorption on resin, workup with CS_2, analysis by gas chromatography/flame ionization. NIOSH II,[3] Method S-264.

Routes of Entry: Inhalation of vapor, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin or eye contact can cause severe irritation or burns. The vapor can irritate the nose, eyes, throat, and bronchial tubes, causing cough and difficulty in breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated skin contact can cause drying and cracking. Exposure can affect the nervous system causing tremors, weakness, dizziness, and unconsciousness. High or repeated exposure may damage the liver, kidneys, lungs, and red blood cells.

Points of Attack: Eyes, respiratory system, liver, kidneys, blood, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Kidney and liver function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Remove clothing immediately if wet or contaminated to avoid flammability hazard. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm:* Sa (APF = 10) (any supplied-air respirator). *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *500 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *700 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Ethyl silicate (a silane) must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from water. Sources of ignition, such as smoking and open flames, are prohibited where ethyl silicate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of ethyl silicate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl silicate.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl silicate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and silicon oxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a more flammable solvent.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Ethyl Silicate*, Report No. RT79-607. Rockville, MD, pp. 98−105

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Ethyl Silicate*. Trenton, NJ

Ethyl thiocyanate E:0830

Molecular Formula: C_3H_5NS

Common Formula: C_2H_5SCN

Synonyms: Aethylrhodanid (German); Ethyl rhodanate; Ethyl sulfocyanate; Thiocyanatoethane; Thiocyanic acid, ethyl ester

CAS Registry Number: 542-90-5

RTECS® Number: XK9900000

UN/NA & ERG Number: UN1992/131; UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

UN/NA & ERG Number: 542-90-5

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 10,000 lb (4540 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ethyl thiocyanate is a liquid. Onion-like odor. Molecular weight = 87.15; Boiling point = 146°C; Freezing/Melting point = −86°C; Flash point 42°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used as an agricultural insecticide.

Incompatibilities: Contact with chlorates, nitrates, nitric acid, organic peroxides, peroxides, may cause a violent reaction.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 20 mg/m^3

PAC-1: 60 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 100 mg/m^3

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: The ingestion of a concentrated solution may lead to vomiting. The principal systemic reaction is probably one of central nervous depression, interrupted by periods of restlessness; abnormally fast and deep respiratory movements and convulsions. Death is usually due to respiratory arrest from paralysis of the medullary centers. In nonfatal cases injures to the liver and kidneys may appear. LD_{50} = (oral-rat) 200 mg/kg.

Long Term Exposure: Prolonged absorption may produce various skin eruptions, runny nose, and occasionally dizziness, cramps, nausea, vomiting, and mild or severe disturbances of the nervous system.

Points of Attack: Nervous system, liver, kidneys.

Medical Surveillance: Liver function tests. Kidney function tests. Examination of the nervous system.

First Aid: Treatment is as for aliphatic thiocyanates. Because cyanide is probably largely responsible for poisoning, antidotal measures against cyanide should be instituted promptly, for including moving the victim to fresh air. Call emergency medical care. If not breathing, give artificial respiration. IF breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, chlorates, nitrates, nitric acid. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This material may be classified as Flammable liquids, toxic, n.o.s. This class requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. For *large spills*, dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen and sulfur oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ethylthiocyanate*. Washington, DC: Chemical Emergency Preparedness Program

Ethyl trichlorosilane E:0840

Molecular Formula: $C_2H_5Cl_3Si$

Synonyms: Ethyl silicon trichloride; Ethyl trichloroethylsilane; Ethyl trichlorosilane; Ethyltrichlorosilane; Silane, trichloroethyl-; Silicane, trichloroethyl-; Trichloroethylsilicane

CAS Registry Number: 115-21-9

RTECS® Number: VV4200000

UN/NA & ERG Number: UN1196/155

EC Number: 204-072-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

EPCRA Section 304 Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ethyl trichlorosilane is a colorless liquid with an irritating odor. Molecular weight = 163.51; Specific gravity (H_2O:1) = 1.24 at 25°C; Boiling point = 98°C; Freezing/Melting point = −106°C; Flash point = 22°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩ (water reactive).

Potential Exposure: Compound Description: Organometallic, Primary Irritant. Used in the manufacture of silicone polymers.

Incompatibilities: Forms explosive mixture with air. Contact with water, steam, or moisture forms toxic and corrosive hydrogen chloride. Contact with strong oxidizers or strong bases may cause a violent reaction. Corrodes most common metals.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.2 ppm
PAC-1: **0.60** ppm
PAC-2: **7.3** ppm
PAC-3: **33** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact with the eyes causes irritation, pain, swelling; corneal erosion and blindness may result. Contact with the skin causes dermatitis (red, inflamed skin), severe burns, pain, and shock generally follow dermal exposure. Acute inhalation exposure may result in sneezing, choking, laryngitis, dyspnea (shortness of breath), respiratory tact irritation, and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, pulmonary edema, chronic bronchitis, and pneumonia may also occur. If ingested, symptoms include increased salivation, intense thirst, difficulty in swallowing, chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion.

Long Term Exposure: May cause kidney damage. Highly irritating substances can cause lung irritation and bronchitis.

Points of Attack: Lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. Kidney function tests. If symptom develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Ethyl trichlorosilane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames, are prohibited where ethyl trichlorosilane is handled, used, or stored. Where possible, automatically pump liquid from drums or other storage containers to process containers. Metal containers involving the transfer of 5 gallons or more of ethyl trichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl trichlorosilane. Protect containers from physical damage.

Shipping: Ethylphenyldichlorosilane requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors; do not get water inside container. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

When spilled in water

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.7/2.7

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including phosgene, are produced in fire. Use dry chemical, CO_2, or foam extinguishers. *Do not use water*. Vapor explosion hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Stay away from ends of tanks. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ethyl Trichlorosilane*. Trenton, NJ

Eugenol E:0850

Molecular Formula: $C_{10}H_{12}O_2$

Synonyms: 4-Allylcatechol-2-methyl ether; 5-Allylguaiacol; Allylguaiacol; 4-Allylguaiacol; *p*-Allylguaiacol; 1-Allyl-4-hydroxy-3-methoxybenzene; 4-Allyl-1-hydroxy-2-methoxybenzene; 4-Allyl-2-methoxyphenol; Caryophyllic acid; Clove oil; Eugenic acid; 1,3,4-Eugenol; *p*-Eugenol; Fa 100; 2-Hydroxy-5-allylanisole; 1-Hydroxy-2-methoxy-4-allylbenzene; 1-Hydroxy-4-allyl-2-methoxybenzene; 4-Hydroxy-3-methoxyallylbenzene; 1-Hydroxy-2-methoxy-4-prop-2-enylbenzene; 1-Hydroxy-2-methoxy-4-propenylbenzene; 2-Methoxy-4-allylphenol; 2-Methoxy-1-hydroxy-4-allylbenzene; 2-Methoxy-4-(2′-propenyl)phenol; 2-Methoxy-4-prop-2-enylphenol; 2-Methoxy-4-(2-propen-1-yl)phenol; 2-Methoxy-4-(2-propenyl)phenol; Phenol, 4-allyl-2-methoxy-; Phenol, 2-methoxy-4-(2-propenyl)-

CAS Registry Number: 97-53-0

RTECS Number: SJ4375000

UN/NA & ERG Number:

EC Number: 202-589-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Listed on the TSCA inventory.

Canada: WHMIS category D2B; on DSL List.

European/International Regulations: Hazard Symbol: Xn, Xi; Risk phrases: R22; R36/37/38; R42/43; Safety phrases: S2; S24/25; S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Depending on age and exposure to air, clear, colorless to pale yellow to amber-colored liquid.

Combustible. Odor is spicy, clove-like; woody; pungent, warm, spicy, clove-like taste. Molecular weight = 164.201; Vapor density = >1.0; Specific gravity = 1.0652 at 20°C; Boiling point = 254°C at 760 mmHg; Freezing/Melting point = −9.2 to −9.1°C at 760.00 mmHg; Vapor pressure = 0.01 mmHg at 20°C; 0.0226 mmHg at 25°C[HSDB]; Flash point = 104°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1; Flammability 1; Reactivity 0. Moderate water solubility = 2460 mg/L at 25°C.

Potential Exposure: Used in cosmetics; as a flavor and fragrance agent; herbicide; dog and cat repellent; insecticide; insect repellent.

Incompatibilities: Eugenol may decompose on exposure to light. Incompatible with strong alkalis, strong oxidizers, including ferric chloride and permanganates, iron, and zinc.

Permissible Exposure Limits in Air

No OELs or TEEL available.

Determination in Air: No NIOSH or OSHA method available.

Permissible Concentration in Water: Not found.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.27$.

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Symptoms of exposure include severe irritation of all tissues, dysuria, hematuria, tachycardia, pulmonary edema, potential circulatory collapse, bronchial pneumonia, abortion, unconsciousness.

Short Term Exposure: This compound is a primary irritant and sensitizer and can cause contact dermatitis. Irritation of the skin, eyes, and respiratory tract can occur. *Ingestion*: May cause gastroenteritis, vomiting, and gastric secretion glycoprotein (mucin) and may be accompanied by abdominal pain, nausea, diarrhea, and convulsions; large intake can cause gastrointestinal and liver damage. *Inhalation*: May cause bronchial irritation, dizziness, rapid and shallow breathing, pulmonary edema, a medical emergency that can be delayed. *Skin*: Contact may cause inflammation. Prolonged skin contact may cause skin sensitization and allergic dermatitis. *Eyes*: Contact may cause burns. LD_{50} = (oral-rat) 1930 mg/kg.

Long Term Exposure: This compound may be harmful by ingestion or inhalation. It is a primary irritant and sensitizer. Prolonged or repeated skin contact may cause allergic dermatitis. Capable of causing irreversible renal damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy. Liver and kidney function tests.

First Aid: *Eyes*: Check the victim for contact lenses and remove. Flush victim's eyes with water or normal saline solution for 20−30 min, lifting lower and upper eyelids occasionally. Remove contaminated clothing and shoes.Get medical attention immediately. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water and wash for at least 15 min. Remove and isolate all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician. Transport the victim to a hospital for treatment. *Inhalation*: Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. *Ingestion*: *Do not induce vomiting*. If the victim is conscious and not convulsing, give large amount of water to dilute the chemical. Never give anything by mouth to an unconscious person. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician. In all cases get medical attention immediately. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body.

Personal Protective Methods: Wear protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Recommended gloves: Ansell 5.109 (Latex); thickness: 0.18 mm; Breakthrough time: *15 min*; Edmont 29-870 (Neoprene); thickness: 0.51 mm; Breakthrough time: *135 min*; North Model F-091 (Viton); thickness: 0.41 mm; Breakthrough time: *480 min*.

Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA- or European Standard EN 149-approved respirator; or use a NIOSH/MSHA- or European Standard EN 149-approved half face respirrator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas, and SO_2) with a dust/mist filter.

Storage: Color Code—Green: General storage may be used. Store in cool, dry place in tightly sealed containers, in a refrigerator under an inert gas. Protect this chemical from heat and exposure to light. Shelf Life: 2 years or longer if properly stored.

Shipping: Not regulated.

Spill Handling: First remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. All contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: When heated to decomposition, it emits acrid smoke, irritating fumes, and toxic fumes of carbon monoxide and carbon dioxide. Fires involving this material can be controlled with a dry chemical, carbon dioxide, or Halon extinguisher. A water spray may also be used.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

Hazardous Substances Data Bank [HSDB]. US National Library of Medicine, TOXNET. *Eugenol.* <http://toxnet.nlm.nih.gov>

F

Fenamiphos F:0050

Molecular Formula: $C_{13}H_{22}NO_3PS$
Common Formula: $CH_3SC_6H_3(CH_3)OPO(OC_2H_5)NHCH(CH_3)_2$
Synonyms: *O*-Aethyl-*O*-(3-methyl-4-methylthiophenyl)-isopropylamido-phosphorsaeure ester (German); BAY 68138; Bayer 68138; ENT 27,572; Ethyl 3-methyl-4-(methylthio)phenyl(1-methylethyl)phosphoramidate; Ethyl 4-(methylthio)-*m*-tolylisopropylphosphoramidate; Fenaminphos; Fenamiphos nematicide; Isopropylamino-*O*-ethyl (4-methylmercapto-3-methylphenyl) phosphate; Isopropylphosphoramidic acid ethyl 4-(methylthio)-*m*-toyl ester; 1-(Methylethyl)-ethyl 3-methyl-4-(methylthio)phenylphosphoramidate; (1-Methylethyl) phosphoramidic acid ethyl 3-methyl-4-(methylthio)phenyl ester; Nemacur; Nemacurp; NSC-195106; Phenamiphos; Phosphoramidic acid, isopropyl-, ethyl 4-(methylthio)-*m*-tolyl ethyl ester; Phosphoramidic acid, (1-methylethyl)-, ethyl [3-methyl-4-(methylethylthio)phenyl] ester; Phosphoramidic acid, (1-methylethyl)-, ethyl 3-methyl-4-(methylthio)phenyl ester
CAS Registry Number: 22224-92-6
RTECS® Number: TB3675000
UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152
EC Number: 244-848-1 [*Annex I Index No.:* 015-123-00-5]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: Supported.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).
Reportable Quantity (RQ): 10 lb (04.54 kg).
Marine Pollutant (49CFR, Subchapter 172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.
European/International Regulations: Hazard Symbol: T+, N; Risk phrases R24; R28; R50/53; Safety phrases: S1/2; S23−S28; S36/37; SS45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Fenamiphos is an off-white to tan, waxy solid. Found commercially as a granular ingredient (5−15%) or in an emulsifiable concentrate (400 g/L). Molecular weight = 303.39; Freezing/Melting point = 40°C (technical grade) and 49.4°C (pure compound); Vapor pressure = 1×10^{-6} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.03%.
Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. Those involved in the manufacture, formulation, or application of this nematocide.
Incompatibilities: May hydrolyze under alkaline conditions. Keep away from moisture.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 0.1 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.05 mg/m^3 TWA inhalable fraction and vapor [skin]; *not classifiable as a human carcinogen*; BEI_A issued for acetylcholinesterase-inhibiting pesticides.
Protective Action Criteria (PAC)
TEEL-0: 0.05 mg/m^3
PAC-1: 0.15 mg/m^3
PAC-2: 0.9 mg/m^3
PAC-3: 40 mg/m^3
Australia: TWA 0.1 mg/m^3, [skin], 1993; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Switzerland: MAK-(week) 0.1 mg/m^3, [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for fenamiphos in ambient air[60] ranging from 1.0 $\mu g/m^3$ (North Dakota) to 1.6 $\mu g/m^3$ (Virginia) to 2.0 $\mu g/m^3$ (Connecticut).
Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.
Permissible Concentration in Water: A long-term health advisory set by EPA is 18 μg/L and a lifetime health advisory is 9 μg/L.
Determination in Water: Fish Tox = 0.33001000 ppb MATC (EXTRA HIGH). Octanol−water coefficient: Log $K_{ow} = 3.3$.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: This is a highly toxic chemical (the LD_{50} for rats is 8 mg/kg). It is a cholinesterase inhibitor with effects typical of such compounds. Acute exposure to fenamiphos may produce the following signs and symptoms: pinpoint pupils, blurred vision, headaches, dizziness, muscle spasm, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may increase following oral exposure or decrease following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. This material is highly toxic orally, by inhalation, and by absorption through the skin. Death may occur from respiratory failure. Human Tox = 2.00000 ppb (HIGH).
Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00006-0

nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Wear air-tight gas-proof goggles and face shield, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This material falls under Organophosphorus pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including oxides of nitrogen, phosphorus, and sulfur, are produced in fire. This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 52–56. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fenamiphos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (August 1987). *Health Advisory: Fenamiphos*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Fenamiphos*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Fenitrothion F:0100

Molecular Formula: $C_9H_{12}NO_5PS$
Common Formula: $(CH_3O)_2PSO{-}C_6H_3(NO_2)(CH_3)$
Synonyms: 8057HC; Accothion; Aceothion; Agria 1050; Agriya 1050; Agrothion; American Cyanamid CL-47,300; Arbogal; BAY 41831; Bayer 41831; Bayer S 5660; Cekutrothion; CL 47300; CP47114; Cyfen; Cytel; Cyten; Dicathion; *O*,*O*-Dimethyl-*O*-(3-methyl-4-nitrophenyl)-monothiophosphat (German); *O*,*O*-Dimethyl *O*-(3-methyl-4-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(3-methyl-4-nitrophenyl) thiophosphate; *O*,*O*-Dimethyl *O*-(4-nitro-3-methylphenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-nitro-3-methylphenyl) thiophosphate; *O*,*O*-Dimethyl-*O*-4-nitro-*m*-toyl phosphorothioate; Dybar; EI 47300; ENT 25,715; Falithion; Fenitex; Fenitox; Fenitrothion; Folethion; Folithion; H-35-F 87 (BVM); Keen Superkill Ant and Roach Exterminator; Killgerm tetracide insecticidal spray; Kotion; MEP (Pesticide); Metathion; Metathione; Metation; Methylnitrophos; Micromite; Monsanto CP 47114; Nitrophos; Novathion; Nuvand; Nuvanol; Oleosumifene; OMS 43; Ovadofos; Pennwalt C-4852; Phenitrothion; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(3-methyl-4-nitrophenyl) ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(4-nitro-*m*-tolyl) ester; S 112A; S 5660; SMT; Sumithion; Thiophosphate de *O*,*O*-dimethyle et de *O*-(3-methyl-4-nitrophenyle) (French); Turbair grain storage insecticide; Verthion
CAS Registry Number: 122-14-5
RTECS® Number: TG0350000
UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152
EC Number: 204-524-2 [*Annex I Index No.:* 015-054-00-0]
Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Rodent dominant lethal; Host-mediated assay; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA, 1998 Status of Pesticides: RED Completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Fenitrothion is a volatile brownish-yellow oil. Molecular weight = 277.25; Boiling point = (decomposes) at 140°C; Freezing/Melting point = 0.28°C; Vapor pressure = 5.3×10^{-5} mbar at 20°C; Flash point = 157°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this insecticide. It is a selective acaricide and a contact and stomach insecticide. Used to control chewing and sucking insects on rice, orchard fruit, vegetables, cereals, cotton, and in forests. Also protects against flies, mosquitoes, and cockroaches.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

No TEEL available.

Japan: 1 mg/m^3 [skin] 1999; Poland: MAC (TWA) 0.02 mg/m^3, MAC (STEL) 0.1 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3 [skin] 1993. Russia[43] set a MAC of 0.008 mg/m^3 for ambient air in residential areas on a momentary basis and 0.001 mg/m^3 on a daily average basis.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[43] set a MAC of 0.25 mg/L in water bodies for domestic purposes and of zero in water bodies used for fishery purposes.

Determination in Water: Fish Tox = 63.62386000 ppb (INTERMEDIATE). Octanol−water coefficient: Log $K_{ow} = 3.25$.

Routes of Entry: Inhalation, through the skin, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. Nausea is often the first symptom, followed by vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, dizziness, weakness, tightness in the chest, loss of muscle coordination, slurring of speech, muscle twitching (particularly the tongue and eyelid), respiratory difficulty, blurring or dimness of vision, pinpoint pupils, profound weakness, mental confusion, disorientation, and drowsiness. This compound is an organophosphate insecticide. It is a highly toxic cholinesterase inhibitor that acts on the nervous system. Does not cause delayed neurotoxicity and contact produces little irritation. The effects may be delayed. Keep exposed victim under medical observation. Human Tox = 9.10000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions and respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Also consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under medical observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous flow-mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a "POISONOUS/TOXIC MATERIALS" label. They fall in Hazard Class 6.1 and in Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal

environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including oxides of sulfur and phosphorus, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move containers from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (for large amounts); alkaline hydrolysis and landfill (for small amounts).[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 88−92

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Fensulfotion F:0110

Molecular Formula: $C_{11}H_{17}O_4PS_2$

Synonyms: BAY 25141; Bayer 25141; Bayer S767; Chemagro 25141; Dasanit; *O*,*O*-Diaethyl-*O*-4-methylsulfinyl-phenyl-monothiophosphat (German); *O*,*O*-Diethyl *O*-[*p*-(methylsulfinyl)phenyl] phosphorothioate; *O*, *O*-Diethyl *O*-[*p*-(methylsulfinyl)phenyl] thiophosphate; DMSP; ENT 24,945; Entphosphorothioate; Ester; Fensulfotiona (Spanish); Phosphorothioic acid, *O*,*O*-diethyl *O*-[*p*-(methylsulfinyl)phenyl]; S 767; Terracur P

CAS Registry Number: 115-90-2

RTECS® Number: TF3850000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 204-114-3 [*Annex I Index No.:* 015-090-00-7]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA1998 Status of Pesticides: Canceled.

Very Toxic Substance (World Bank).[15]

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test EPA; Negative: *D. melanogaster* sex-linked lethal EPA; Negative: *In vitro* UDS—human fibroblast; TRP reversion EPA; Negative: *S. cerevisiae*—homozygosis EPA; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S23; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Fensulfothion is a yellow oil. Molecular weight = 308.37; Boiling point = 138−141°C at 0.01 mmHg; Vapor pressure = 0.0001 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Those involved in the manufacture, formulation, or application of this insecticide used to control parasitic, sedentary, and free-living nematodes.

Incompatibilities: Strong oxidizers; may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents, such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.01 mg/m^3 TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI$_A$ issued for Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)
TEEL-0: 0.01 mg/m^3
PAC-1: 0.03 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 12.5 mg/m^3
Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; France: VME 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Switzerland: MAK-W 0.1 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for fensulfothion in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 6.96732000 pbb (INTERMEDIATE).

Routes of Entry: Inhalation, through the skin, ingestion. eyes.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin and eyes. Exposure can cause rapid, fatal organophosphate poisoning. The acute oral LD_{50} value for rats is 5−10 mg/kg which is highly to extremely toxic. It is a cholinesterase inhibitor. This material may cause nausea, vomiting, abdominal cramps, diarrhea, headache, giddiness, vertigo, weakness, lack of muscle control, tearing, slurring of speech, difficult breathing, convulsions, excessive salivation, tightness in chest, and death from respiratory arrest. Death results primarily from respiratory arrest stemming from failure of the respiratory center, paralysis of respiratory muscles, and intensive bronchoconstriction. Human Tox = 1.75000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases; strong oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This material is classed as an organophosphorus pesticide, liquid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including oxides of sulfur and phosphorus, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fensulfothion*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Fensulfothion*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Fenthion F:0120

Molecular Formula: $C_{10}H_{15}O_3PS_2$

Synonyms: AI3-25540; BAY 29493; Baycid; Bayer 29493; Bayer 9007; Bayer S-1752; Baytex; Caswell No.456F; *m*-Cresol, 4-(methylthio)-, *O*-ester with *O*,*O*-dimethyl phosphorothioate; DALF; *O*,*O*-Dimethyl *O*-4-(methylmercapto)-3-methylphenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-(methylmercapto)-3-methylphenyl thiophosphate; *O*,*O*-Dimethyl *O*-(3-methyl-4-methylmercaptophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-[3-methyl-4-(methylthio) phenyl] ester, phosphorothioic acid; *O*,*O*-Dimethyl *O*-[3-methyl-4-(methylthio)phenyl] phosphorothioate; *O*,*O*-Dimethyl *O*-(4-methylthio-3-methylphenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-methylthio-3-methylphenyl) thiophosphate; *O*,*O*-Dimethyl *O*-[4-(methylthio)-*m*-tolyl] phosphorothioate; DMTP; ENT 25,540; Entex; EPA pesticide chemical code 053301; Fenthion 4E; Fenthionon; Fentiona (Spanish); Lebaycid; Mercaptophos; 4-Methylmercapto-3-methylphenyldimethylthiophosphate; MPP; MPP (in Japan); NCI-C08651; OMS 2; Phenthion; Phosphorothioic acid, *O*,*O*-dimethyl *O*-[3-methyl-4-(methylthio)phenyl] ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-[4-(methylthio)-*m*-tolyl] ester; Queletox; S 1752; Spotton; Thiophosphate de *O*,*O*-dimethyle et de *O*-(3-methyl-4-methylthiophenyle) (French); Tiguvon; Tolodex

CAS Registry Number: 55-38-9

RTECS® Number: TF9625000

UN/NA & ERG Number: UN3018/152

EC Number: 200-231-9 [*Annex I Index No.:* 015-048-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

US EPA Gene-Tox Program, Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Regulations: Hazard Symbol: T, N; Risk phrases: R21/22; R23; R48/25; R68; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Fenthion is a colorless liquid (when pure) with a weak, garlic-like odor. The technical grade is a yellow to brown oil. Molecular weight = 278.34; Boiling point = (decomposes) below the BP at 210°C; Freezing/Melting point = 6.1°C; Vapor pressure: 0.0003 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Very slightly soluble in water; solubility = 0.006%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, or application of this agricultural chemical and pesticide; insecticide.

Incompatibilities: Oxidizers, bases, alkaline insecticides.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None. Appendix D (NIOSH Pocket Guide).

ACGIH TLV®[1]: 0.05 mg/m^3 inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued for Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 40 mg/m^3

DFG MAK: 0.2 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2) [skin].

Australia: TWA 0.2 mg/m^3, [skin], 1993; Austria: MAK 0.2 mg/m^3, [skin], 1999; Belgium: TWA 0.2 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Japan: 0.2 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Poland: MAC (TWA) 0.2 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for fenthion in ambient air[60] ranging from 2.0 μg/m^3 (North Dakota) to 3.2 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Mexico[35] set a MAC of 0.03 μg/L in coastal waters and of 0.0003 mg/L (0.3 μg/L) in estuaries. Russia[35] set a MAC of 1.0 μg/L in water bodies used for domestic purposes and of zero in water used for fishery purposes.

Determination in Water: Fish Tox = 10.60669000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Fenthion can affect you when breathed in and quickly enters the body by passing through the skin. Fatal poisoning can occur from skin contact. It is highly toxic. It may damage the developing fetus. Exposure can cause rapid fatal organophosphate poisoning with headaches, sweating, nausea and vomiting, muscle twitching, coma, and death. Sometimes effects are delayed for 1–2 days. Poisoning can happen from skin contact, even if no irritation is felt. Human Tox = 4.90000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Fenthion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If exposure and/or symptoms have occurred, the person should be under medical observation for several days, as some symptoms may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.2 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, alkalies and alkaline pesticides. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This material may be classed under Organophosphorus pesticides, liquid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Fenthion itself does not burn readily. Poisonous gases are produced in fire, including oxides of phosphorus and sulfur. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis and landfill for small quantities; incineration with flue gas scrubbing for large amounts.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 56−61 (1983). New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Fenthion*. Trenton, NJ

Ferbam F:0130

Molecular Formula: $C_9H_{18}FeN_3S_6$

Common Formula: $Fe[(CH_3)_2NCS_2]_3Fe$

Synonyms: Aafertis; AI3-14689; Bercema Fertam 50; Carbamic acid, dimethyldithio-, iron salt; Caswell No.458; Dimethylcarbamo dithioic acid, iron complex; Dimethylcarbamodithioic acid, iron(3+) salt; Dimethyldithiocarbamic acid, iron salt; Dimethyldithiocarbamic acid, iron(3+) salt; Eisendimethyldithiocarbamat (German); Eisen(III)-tris(*N*,*N*-dimethyldithiocarbamat) (German); ENT 14,689; EPA pesticide chemical code 034801; Ferbam 50; Ferbam, iron salt; Ferbeck; Fermate ferbam fungicide; Fermocide; Ferradour; Ferradow; Ferric dimethyl dithiocarbamate; Fuklasin ultra; Hexaferb; Hokmate; Iron dimethyldithiocarbamate; Iron(III) dimethyldithiocarbamate; Iron, tris(dimethylcarbamodithioato-*S,S′*-)-; Iron, tris(dimethylcarbamodithioato-*S,S′*)-, (OC-6-11)-; Iron tris(dimethyldithiocarbamate); Iron, tris (dimethyldithiocarbamato)-; Karbam black; Karbam carbamate; Knockmate; Niacide; Stauffer ferbam; Sup'r-Flo Ferbam flowable; Trifungol; (OC-6-11)-Tris(dimethylcarbamodithioato-*S,S′*)iron; Tris(dimethylcarbamodithioato-*S,S′*) iron; Tris(*N*,*N*-dimethyldithiocarbamato)iron(III); Tris (dimethyldithiocarbamato)iron; Vancide FE95

CAS Registry Number: 14484-64-1; *(alt.)* 301-05-3; *(alt.)* 13494-27-4; *(alt.)* 64070-92-4

RTECS® Number: NO8750000

UN/NA & ERG Number: UN2771/151

EC Number: 238-484-2 [*Annex I Index No.:* 006-051-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

US EPA, FIFRA 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U396.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R36/37/38; R50/53; Safety phrases: S2; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ferbam is a combustible, odorless dark brown to black powder or granular solid. Molecular weight = 416.51; Freezing/Melting point = >180°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those involved in the production, formulation, and application of this dithiocarbamate; used as a fungicide, rubber accelerator, and plastics pro-degradant.

Some dithiocarbamates have been used as rubber components.

Incompatibilities: Strong oxidizers, strong bases. Heat alkalies (lime); moisture can cause decomposition. Decomposes on prolonged storage.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (total dust) TWA.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3, inhalable fraction, TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 800 mg/m^3

No TEEL available.

DFG MAK: Danger of skin sensitization (dithiocarbamates used as rubber components).

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 10 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Norway: TWA 1 mg[Fe]/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, 1999; Turkey: TWA 15 mg/m^3, 1993; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for ferbam in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: No criteria set. Degradation produces ethylene thiourea.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferbam can affect you when breathed in. Breathing ferbam can irritate the nose and throat. Ferbam can cause skin and eye irritation. High exposure to ferbam may affect the nervous system and thyroid, and causes dizziness, confusion, loss of coordination, seizures, paralysis, and coma.

Long Term Exposure: Repeated or prolonged contact with skin may cause allergy with skin rash and itching. Exposure to ferbam may damage the kidneys and liver. Ferbam may damage the developing fetus.

Points of Attack: Eyes, skin, respiratory system, gastrointestinal tract.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: kidney function tests. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 50 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator)*. Up to 100 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 250 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 500 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100) or SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTiE* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter)*; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 800 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Ferbam is incompatible with strong oxidizers (such as chlorine, bromine, and fluorine). Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases and from heat and moisture. Ferbam can decompose upon long-term storage.

Shipping: Dithiocarbamate pesticides, solid, toxic, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferbam may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Ferbam is hydrolyzed by alkali and is unstable to moisture, lime, and heat. Ferbam can be incinerated.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Ferbam.* Trenton, NJ

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 56−58 (1981) and 8, No. 6, 57−63 (1988)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Ferric ammonium citrate F:0140

Molecular Formula: $C_{12}H_{18}FeN_2O_{14}$

Common Formula: $FeC_6H_5O_7 \cdot (NH_4)_2C_6H_5O_7$

Synonyms: Ammonium ferric citrate; Ammonium iron(III) citrate; Citrato ferrico amonico (Spanish); FAC; Ferric ammonium citrate, brown; Ferric ammonium citrate, green; Iron(III) ammonium citrate; Soluble ferric citrate

CAS Registry Number: 1185-57-5

RTECS® Number: GE7540000

DOT ID and ERG Number: UN3077/171

EC Number: 214-686-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ferric ammonium citrate forms reddish brown flakes or grains or a brownish-yellow powder. It has a slight ammonia odor. There is also a green form that is odorless. Molecular weight = 709.44; Specific gravity = 1.8 at 20°C; Boiling point = decomposes. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: Ferric ammonium citrate is used in blueprinting, photography, medical treatment, and as an animal food additive.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg[Fe]/m^3 TWA.

ACGIH TLV®[1]: 1 mg[Fe]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 1.81 mg/m^3

PAC-1: 5.44 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferric ammonium citrate can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Ingestion can cause abdominal pain, diarrhea, and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever."

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye.

Points of Attack: Eyes, skin, respiratory system, liver, gastrointestinal tract.

Medical Surveillance: Liver function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4–12 h following exposure: it may last less than 36 h.

Note to physician: In case of fume inhalation, treat pneumonitis. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light. Sources of ignition, such as smoking and open flames, are prohibited where ferric ammonium citrate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids containing ferric ammonium citrate in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferric ammonium citrate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including ammonia and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Ferric Ammonium Citrate*. Trenton, NJ

Ferric ammonium oxalate F:0150

Molecular Formula: $C_6H_{18}FeN_3O_{15}$

Common Formula: $Fe(NH_4)_3(C_2O_4)_3 \cdot 3H_2O$

Synonyms: Ammonium ferric oxalate trihydrate; Ammonium ferrioxalate; Ammonium trioxalatoferrate(3+); Ammonium trioxalatoferrate(III); Ethanedioic acid, ammonium iron(3+) salt; Ethanedioic acid, ammonium iron(III) salt; Oxalato ferrico amonico (Spanish); Oxalic acid, ammonium iron(3+) salt (3: 3:1); Oxalic acid, ammonium iron(III) salt (3: 3:1); Triammonium tris-(ethanedioato(2-)-*o*,*o*′)ferrate(3-1)

CAS Registry Number: 14221-47-7; 2944-67-4

RTECS® Number: LI8932000

DOT ID and ERG Number: Not regulated

EC Number: 238-090-0 (triammonium trioxalatoferrate); 220-952-2 (triammonium iron(3 +) trioxalate)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ferric ammonium oxalate is a green crystalline, solid with a granular or salt-like appearance. Color depends on level of iron present. Molecular weight = 374.06; 428.06. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Ferric ammonium oxalate is used in photography and making blueprints.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg[Fe]/m^3 TWA.

ACGIH TLV®[1]: 1 mg[Fe]/m^3 TWA.

No TEEL available.

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation of dust, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferric ammonium oxalate can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Ingestion can cause abdominal pain, diarrhea, and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever;" irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea; vomiting.

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. May cause fibrosis of the lungs. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, lungs, gastrointestinal tract.

Medical Surveillance: Liver function tests. Kidney function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m³*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light.

Shipping: Not a regulated chemical.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferric ammonium oxalate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides, and ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Ferric Ammonium Oxalate*. Trenton, NJ

Ferric chloride F:0160

Molecular Formula: Cl_3Fe

Common Formula: $FeCl_3$

Synonyms: Anhydrous ferric chloride; Chlorure perrique (French); Cloruro ferrico anhidro (Spanish); Flores martis; Iron chloride; Iron(3 +) chloride; Iron(III) chloride; Iron sesquichloride; Iron trichloride; Perchlorure de fer (French); PF etchant

CAS Registry Number: 7705-08-0

RTECS® Number: LJ9100000

UN/NA & ERG Number: UN1773 (anhydrous)/157; UN2582 (solution)/154

EC Number: 231-729-4

Regulatory Authority and Advisory Bodies

FDA—over-the-counter drug.

US EPA Gene-Tox Program, Negative: *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Iron, water-soluble salts, n.o.s.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ferric Chloride is a black-brown, dark-green, or black crystalline solid. Molecular weight = 162.20; Boiling point = decomposes at 315°C; Freezing/Melting point = (decomposes) 316°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility = 63%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data. Iron chloride is used to treat sewage and industrial waste. It is also used as an etchant for photoengraving and rotogravure, in textiles, photography, as a disinfectant, as a feed additive.

Incompatibilities: Aqueous solutions are a strong acid. Violent reaction with bases, allyl chloride, sulfuric acid, water. Shock- and friction-sensitive explosive material forms with potassium, sodium, and other active metals. Attacks metals when wet.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg[Fe]/m^3 TWA.

ACGIH TLV®[1]: 1 mg[Fe]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 2.9 mg/m^3

PAC-1: 2.9 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation of dust, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferric chloride is corrosive to the eyes, skin, and respiratory tract. Eye contact may cause permanent damage. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause 'metal fume fever;" irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea; vomiting; Ingestion may cause severe irritation to mouth and throat, weak and rapid pulse, low blood-pressure, nausea, bloody vomiting, violent diarrhea, shock, dark purple skin discoloration, and coma. Animal studies suggest that death may result from 2½ oz for a 150-lb person.

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones. Excessive intake of iron compounds may result in increased accumulation of iron in body, especially the liver, spleen, and lymphatic system. Inhalation of iron dusts may cause mottling of the lung. Iron chloride may reduce the fertility of both males and females.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, lungs, gastrointestinal tract.

Medical Surveillance: Liver function tests. Kidney function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, give milk and get medical attention. Do not induce vomiting. The symptoms of metal fume fever may be delayed for 4—12 h following exposure: it may last less than 36 h.

Note to physician: Gastric lavage should be performed followed by saline catharsis and anodyne. Administer deferoxamine, I.V. Watch for late stricture. Serum, plasma, or urinary iron levels may be employed to estimate the amount ingested.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ and PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powdered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplier-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Iron chloride must be stored in tightly closed containers to avoid contact with sulfuric acid, sodium, potassium, allyl chloride, and water, since violent reactions occur and toxic vapors may be produced.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: *Solution:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Powder (anhydrous): Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Neutralize with lime or soda ash and bury in an approved landfill.[22]

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 42−45

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Iron (III) Chloride*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Iron Chloride*. Trenton, NJ

Ferric nitrate F:0170

Molecular Formula: C_3FeO_9

Common Formula: $Fe(CO_3)_3$

Synonyms: Ferric(3+) nitrate; Ferric(III) nitrate; Ferric nitrate, Nonhydrate; Iron nitrate; Iron(3+) nitrate, anhydrous; Iron(III) nitrate, anhydrous; Iron trinitrate; Nitrato ferrico (Spanish); Nitric acid, iron(3+) salt; Nitric acid, iron (III) salt

CAS Registry Number: 10421-48-4

RTECS® Number: QU8915000

UN/NA & ERG Number: UN1466/140

EC Number: 233-899-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Iron, water-soluble salts, n.o.s.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ferric nitrate is a pale violet, green, or grayish-white, odorless solid in lumpy crystals (like salt). Molecular weight = 241.88; Boiling point = decomposes; Freezing/Melting point = 35°C; 47°C (nonhydrate). Hazard

Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 3, Oxidizer. Highly soluble in water.

Potential Exposure: It is used in textile dyeing, tanning, and weighting silk.

Incompatibilities: An oxidizer. Keep away from reducing agents, oxidizable materials, and combustibles including metal powders, sulfur, and organic materials. Aqueous solution is corrosive to metals.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg[Fe]/m^3 TWA.

ACGIH TLV®[1]: 1 mg[Fe]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 4.33 mg/m^3

PAC-1: 40 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 500 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferric nitrate can affect you when breathed in. Exposure can irritate the eyes, nose, throat, and skin. Large amounts of iron in the body can cause nausea, stomach pain, constipation, and black bowel movements. Ingestion can cause abdominal pain, diarrhea, and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause “metal fume fever;” irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea; vomiting.

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. May cause lung fibrosis. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, lungs, gastrointestinal tract.

Medical Surveillance: If illness occurs or overexposure is suspected, medical attention is recommended. Blood test for serum iron can detect excess body iron. If increased, consider liver function tests. Examination of the eyes. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organic materials and other combustible materials or aluminum powder. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of “OXIDIZER.” It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including nitrogen oxides, nitric acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ferric Nitrate.* Trenton, NJ

Ferric sulfate F:0180

Molecular Formula: $Fe_2O_{12}S_3$

Common Formula: $Fe_2(SO_4)_3$

Synonyms: Diiron trisulfate; Greenmaster autumn; Iron persulfate; Iron sesquisulfate; Iron sulfate (2:3); Iron(3+) sulfate; Iron(III) sulfate; Iron tersulfate; Maxicrop Moss Killer; Sulfato ferrico (Spanish); Sulfuric acid, iron(3+) salt (3:2); Sulfuric acid, iron(III) salt (3:2); Vitax micro gran; Vitax Turf tonic

CAS Registry Number: 10028-22-5

RTECS® Number: NO8505000

UN/NA & ERG Number: UN3077/171

EC Number: 233-072-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Iron, water-soluble salts, n.o.s.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ferric sulfate is a grayish-white powder or yellow lumpy crystals. Molecular weight = 399.88; Boiling point = (decomposes); Freezing/Melting point = (decomposes) 480°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: This material is used in pigments, textile dyeing, water treatment, and metal pickling.

Incompatibilities: Hydrolyzed slowly in aqueous solution. Incompatible with magnesium, aluminum. Corrosive to copper and its alloys, mild and galvanized steel. Light sensitive.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg[Fe]/m^3 TWA.

ACGIH TLV®[1]: 1 mg[Fe]/m^3 TWA; 0.1 mg/m^3 TWA *as persulfates.*

Protective Action Criteria (PAC)

TEEL-0: 3.58 mg/m^3

PAC-1: 3.58 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 75 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation of nose and throat, coughing and difficulty in breathing. 0.075 mg/m^3 for 2 h did not cause any change in breathing functions. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever;" irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea; vomiting. *Skin:* Contact causes irritation. Remove promptly. *Eyes:* Contact causes irritation. *Ingestion:* May cause irritation of mouth and stomach, nausea, vomiting, diarrhea, drowsiness, liver damage, coma, and death. The estimated lethal dose is 30 kg (1 oz).

Long Term Exposure: Excessive intake of iron compounds may result in increased accumulations of iron in the body, especially the liver, spleen, and lymphatic system. May cause nausea, vomiting, stomach pain, constipation, and black bowel movements. Inhalation of iron dusts may cause mottling of the lungs. Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, lungs, gastrointestinal tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for iron level (serum iron). Liver function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m*^{3} of iron, use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, moisture, aluminum, magnesium, copper and its alloys, zinc, galvanized and mild steels.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids containing ferric sulfate in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including sulfur oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Treat with soda ash or dilute NaOH. Separate any precipitate and landfill. Flush solution to sewer.[22]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 45−47 (1983) and 7, No. 2, 75−79 (1987)

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Ferric Sulfate*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Iron (III) Sulfate*. Albany, NY: Bureau of Toxic Substance Assessment

Ferrocene F:0190

Molecular Formula: $C_{10}H_{10}Fe$

Synonyms: Biscyclopentadienyl iron; Di-2,4-cyclopentadien-1-yl iron; Dicyclopentadienyl iron; Iron bis(cyclopentadiene); Iron dicyclopentadienyl

CAS Registry Number: 102-54-5

RTECS® Number: LK0700000

UN/NA & ERG Number: UN1325 (flammable solid, organic)/133

EC Number: 203-039-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; category D1B, B4; On DSL List.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Ferrocene, a metallocene, is a bright orange salt-like crystals from alcohol with a camphor odor. Molecular weight = 186.05; Boiling point = 249°C (sublimes); Freezing/Melting point = 173°C. Decomposes at 465°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Organometallic, Mutagen. Used as additive in fuel oil; antiknock agent in gasoline fuel; used in making rubber, silicone resins, high-temperature polymers and lubricants; intermediate for high-temperature polymers; as a smoke suppressant and catalyst.

Incompatibilities: Violent reaction with ammonium perchlorate, tetranitromethane, mercury(II) nitrate. Incomparable with oxidizers. Decomposes at $\geq$465°C.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA (total dust); 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3 TWA (total dust); 5 mg/m^3 TWA, respirable fraction.

ACGIH TLV®[1]: 10 mg/m^3 TWA.

No TEEL available.

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, [skin], 1999; France: VME 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Switzerland: MAK-W 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3.

Determination in Air: Use OSHA Analytical Method IDI-125G.[58] (Ferrocene is approximately 30% iron). See also NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 530 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory system. Eye contact can cause irritation. Dust may irritate the air passages, with possible cough, phlegm, and tightness in the chest. Dicyclopentadienyl iron is classified as a slightly toxic material, but the toxicological properties have not been extensively investigated. LD_{50} = (oral-rat) 1320 mg/kg (slightly toxic).

Long Term Exposure: There is limited evidence that this chemical may damage the testes. Repeated exposure to iron-containing compounds can damage the liver and other body organs. Heavy or repeated exposure may cause mood changes such as irritability. Repeated exposure may cause lung damage.

Repeated high exposures may cause mood changes such as irritability. Dicyclopentadienyl iron may cause mutations. Exposure may affect liver and lung functions.

Points of Attack: Lungs. In animals: liver, red blood cell, testicular changes. (NIOSH).

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Liver function tests. Lung function tests. Complete blood count (CBC). Serum iron level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. While wearing a filter, cartridge, or canister respirator, if you can smell, taste, or otherwise detect Dicyclopentadienyl iron, or in the case of a full face-piece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. Be sure to consider all potential exposures in your workplace. You may need a combination of filters, profilers, cartridges, or canisters to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, ammonium perchlorate, tetranitromethane, mercury(II) nitrate, and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Flammable solids, organic, n.o.s. require a shipping label of “FLAMMABLE MATERIALS.” It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dicyclopentadienyl iron is a flammable solid. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 67−68 (as Ferrocene)

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Dicyclopentadienyl Iron*. Trenton, NJ

Ferrous ammonium sulfate F:0200

Molecular Formula: $Fe_2H_8N_2O_4S$

Common Formula: $Fe_2(NH_4)_2SO_4$; $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$; $O_8S_2 \cdot H_8N_2 \cdot Fe$

Synonyms: Ammonium iron sulfate; Ammonium iron sulphate; Iron ammonium sulfate; Iron ammonium sulphate; Mohr’s salt; Sulfato ferroso amonico (Spanish); Sulfuric acid, ammonium iron(2+), salt (2: 2:1); Sulphate ammonium sulfate hexahydrate; Sulphate ammonium sulphate; Sulphate ammonium sulphate hexahydrate

CAS Registry Number: 10045-89-3 (anhydrous); 7783-85-9 (hexahydrate)

RTECS® Number: WS5850000

UN/NA & ERG Number: Not regulated.

EC Number: 233-151-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Iron, water-soluble salts, n.o.s.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (anhydrous).

Description: Ferrous ammonium sulfate is a pale green or blue-green solid (powder or lumpy crystals). Molecular weight = 392.14. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: This substance is used in photography, analytical chemistry, and in dosimeters.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg/m^3 TWA.

ACGIH TLV®[1]: 1 mg/m^3 TWA.

Protective Action Criteria (PAC) 10045-89-3
TEEL-0: 5.09 mg/m^3
PAC-1: 15.3 mg/m^3
PAC-2: 25.4 mg/m^3
PAC-3: 125 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferrous ammonium sulfate can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Large amounts of iron in the body can cause nausea and stomach pain, constipation, and black bowel movements. This is more common with swallowed iron. Repeated high exposures may damage the liver. Exposure may irritate the lungs.

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, gastrointestinal tract.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure has occurred, the following may be useful: blood tests for iron level (serum iron). Liver function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids containing ferrous ammonium sulfate in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Ferrous Ammonium Sulfate*. Trenton, NJ

Ferrous chloride F:0210

Molecular Formula: Cl_2Fe

Common Formula: $FeCl_2$

Synonyms: Iron(II) chloride (1:2); Iron dichloride; Iron protochloride; Lawrencite; Sulphate chloride tetrahydrate

CAS Registry Number: 7758-94-3

RTECS® Number: NO5400000

UN/NA & ERG Number: NA1759 (corrosive solid)/154

EC Number: 231-843-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Iron, water-soluble salts, n.o.s.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ferrous chloride is a pale greenish salt-like crystal or power. Molecular weight = 126.75; Specific gravity (H_2O:1) = 1.93 at 20°C; Boiling point = 1012°C; Freezing/Melting point = 675.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: It is used in textile dyeing, metallurgy, pharmaceutical industry, and sewage treatment.

Incompatibilities: Solution attacks metals. Contact with ethylene oxide may initiate polymerization. Contact with potassium or sodium forms an impact-sensitive material.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg/m^3 TWA.

ACGIH TLV®[1]: 1 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 2.27 mg/m^3

PAC-1:2.27 mg/m^3

PAC-2: 2.27 mg/m^3

PAC-3: 200 mg/m^3

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferrous chloride can affect you when breathed in. Repeated or high level exposures may lead to too much iron in the body and possible liver damage. Exposure can irritate the nose and throat. Ferrous chloride is a corrosive chemical and contact can irritate and may burn the eyes and skin.

Long Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, gastrointestinal tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum iron test. Liver function test. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium, sodium metals, or ethylene oxide.

Shipping: Corrosive solids must be labeled “CORROSIVE”, and fall into Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including hydrogen chloride and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Ferrous Chloride*. Trenton, NJ

Ferrous sulfate F:0220

Molecular Formula: FeO_4S

Common Formula: $FeSO_4$

Synonyms: Copperas; Duretter; Duroferon; Exsiccated sulphate sulfate; Exsiccated sulphate sulphate; Feosol; Feospan; Fer-In-Sol; Ferralyn; Ferro-gradumet; Ferrosulfat (German); Ferrosulfate; Ferrosulphate; Ferro-Theron; Fersolate; Green vitriol iron monosulfate; Iron protosulfate; Iron sulfate (1:1); Iron(2+) sulfate; Iron(2+) sulfate (1:1); Iron(II) sulfate; Iron vitriol; Irospan; Irosul; Slow-Fe; Sulfato ferroso (Spanish); Sulfuric acid iron salt (1:1); Sulfuric acid, iron(2+) salt (1:1); Sulfuric acid, iron(II) salt (1:1); Sulphate sulphate (1:1); Sulsulphate

CAS Registry Number: 7720-78-7 (anhydrous); 7782-63-0 (heptahydrate)

RTECS® Number: NO8500000

UN/NA & ERG Number: Not regulated.

EC Number: 231-753-5 [*Annex I Index No.:* 026-003-00-7]; [*Annex I Index No.*: 026-003-01-4] (heptahydrate)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*includes heptahydrate*): Hazard Symbol: Xn; Risk phrases: R22; R36/38; Safety phrases: S2; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ferrous sulfate is a greenish or yellowish solid in fine or lumpy crystals. Molecular weight = 151.91; Freezing/Melting point = 65°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1. Slowly soluble in water.

Potential Exposure: It is used as a fertilizer, food or feed additive, in herbicides, process engraving, dyeing, and water treatment. A by-product of various chemical and metal-treating operations.

Incompatibilities: Aqueous solution is acidic. Contact with alkalies form iron. Keep away from alkalies, soluble carbonates, gold and silver salts, lead acetate, lime water, potassium iodide, potassium and sodium tartrate, sodium borate, tannin.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg/m^3 TWA.
ACGIH TLV®[1]: 1 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 2.72 mg/m^3
PAC-1: 8.16 mg/m^3
PAC-2: 13.6 mg/m^3
PAC-3: 50 mg/m^3
Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg [Fe]/m^3.

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G.[58]

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC of 0.5 mg/L for iron in water bodies used for domestic purposes and a MAC of 0.05 mg/L in sea water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ferrous sulfate can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. *Ingestion*: Less than 5 g (1/6 oz) can cause drowsiness, irritability, weakness, abdominal pain, nausea, vomiting, and black, bloody stools. Delayed symptoms include fluid in the lungs, liver abnormalities, shock, coma, intestinal blockage, and breakdown of the stomach and intestinal lining. Death has resulted from ingestion of less than an ounce.

Long Term Exposure: Excessive intake of iron compounds may result in increased accumulation of iron in body, especially in the liver, spleen, and lymphatic system. Inhalation of iron dusts may cause mottling of the lungs. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system, liver, gastrointestinal tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum iron test. Liver function test. Kidney function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Gastric lavage with large amounts of 5% sodium phosphate or water. Follow this with a large amount of 1% sodium bicarbonate over a 3-h period.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 45–47 (1983) and 7, No. 1, 55–60 (1987)

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Ferrous Sulfate*. Trenton, NJ

Ferrovanadium dust F:0230

Molecular Formula: FeV

Synonyms: Ferro “V”

CAS Registry Number: 12604-58-9

RTECS® Number: LK2900000

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

An OSHA specifically regulated substance.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ferrovanadium, a noncombustible solid; the dust may be an explosion hazard. It consists of dark, odorless solid particles (*particulate*): dispersed in air. An alloy having the composition of 50–80% vanadium with iron, carbon, trace silicon, manganese, chromium, nickel, etc. Molecular weight = 106.8; Freezing/Melting point = 1482–1521°C; Minimum explosive concentration (MEC) = 1.3 g/m^3.[NIOSH] Insoluble in water.

Potential Exposure: Ferrovanadium is added to steel to produce fineness of grain, toughness, torsion properties, and resistance to high temperatures.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg[V]/m^3 TWA; 3 mg[V]/m^3 STEL [REL applies to ferrovanadium, vanadium metal, and vanadium carbide].

ACGIH TLV®[1]: 1 mg[V]/m^3 TWA; 3 mg/m^3 STEL.

NIOSH IDLH: 500 mg/m^3.

No TEEL available for ferrovanadium.

DFG MAK: 1 mg[V]/m^3, inhalable fraction; Carcinogen Category: 2; Germ cell mutagen group: 2; (DFG 2005).

Australia: TWA 1 mg/m^3; STEL 3 mg/m^3 (*dust*), 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3; STEL 3 mg/m^3 (*dust*), 1993; Denmark: TWA 1 mg/m^3 (*dust*), 1999; Finland: TWA 0.5 mg/m^3 (*dust*), 1999; France: VM 0.05 mg[V_2O_5]/m^3, 1999; Japan: 1 mg/m^3 (*dust*), 1999; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 1 mg/m^3 (*dust*), 1993; Russia: STEL 1 mg/m^3 (*dust*), 1993; Switzerland: MAK-W 1 mg/m^3 (*dust*), 1999; Turkey: TWA 1 mg/m^3 (*dust*), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 mg/m^3. Several states have set guidelines or standards for ferrovanadium dust in ambient air[60] ranging from 10.0–30.0 μg/m^3 (North Dakota) to 16.0 μg/m^3 (Virginia) 20.0 μg/m^3 (Connecticut) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Methods #ID-121, #ID-125G.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of eyes and respiratory system. Inhalation can cause irritation with coughing and wheezing.

Long Term Exposure: Repeated exposure can cause bronchitis, pneumonitis, with cough, phlegm, and/or shortness of breath.

Points of Attack: Respiratory system, eyes.

Medical Surveillance: Chest X-ray; pulmonary function tests. An OSHA regulated substance. See NIOSH Publication No. 2005-110, December 2004.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof

chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *Up to 10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. *Up to 25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode)*; or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter).* *Up to 50 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode)*; or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter)*; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Dust is an explosion hazard. Prior to working with this material, you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible solid, but dust may be an explosion hazard. Use extinguishers suitable for metal fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal in a sanitary landfill.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Vanadium*, NIOSH Document No. 77-222. Washington, DC

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Ferrovanadium*. Trenton, NJ

Fibrous glass F:0240

Synonyms: Fiber Glas®; Fiberglass; Glass fibers; Glass wool; Manmade mineral fibers; Mineral wool fiber; Synthetic vitreous fibers; Slag wool

CAS Registry Number: 65997-17-3; *(alt.)* 94551-77-6

RTECS® Number: LK3651000

EC Number: 266-046-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (special purpose glass fibers): Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; (*glass filiment; glass wool fibers; rock wool fibers*) Human No Adequate Data; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; NTP (*synthetic vitreous fibers, glass wool fibers*): Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical (glasswool fibers (airborne particles of respirable size): Cancer 7/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fibrous glass is the name for a manufactured fiber in which the fiber-forming substance is glass. Glasses are a class of materials made from silicon dioxide with oxides of various metals and other elements that solidify from the molten state without crystallization. Typically, glass filaments >3 μm in diameter or glass "wool" with diameters down to 0.05 μm and length >1 μm. A fiber is considered to be a particle with a length-to-diameter ratio of 3:1 or greater. The volume of small diameter fiber production has not been determined. Fibers with diameters less than 1 μm are estimated to comprise less than 1% of the fibrous glass market. Specific gravity (H_2O:1) = 2.5. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. The major uses of fibrous glass are in thermal, electrical, and acoustical insulation; weatherproofing, plastic reinforcement; filtration media; and in structural and textile materials.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (total dust) TWA; 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 5 mg/m^3 total fibrous glass or 3 fibers/cc TWA (fibers with diameter ≤3.5 μm and length ≥10 μm).

ACGIH TLV®[1] (*synthetic vitreous fibers, continuous filament glass fibers; synthetic vitreous fibers, glass wool fibers; synthetic vitreous fibers, special purpose glass fibers)*: 1 f/cc, respirable fibers. Confirmed animal carcinogen with unknown relevance to humans.

Continuous filament glass fibers or *special purpose glass fibers*: 1 f/cc, respirable fibers 1 f/cc, respirable fibers length >5 μm; aspect ratio ≥3:1, as determined by the membrane filter method at 400−450 × magnification (4-mm objective), using phase-contrast illumination); not classifiable as a human carcinogen.

No TEEL available.

North Dakota[60] has set a guideline of 0.10 mg/m^3 for fibrous glass dust in ambient air.

Determination in Air: Use NIOSH Analytical Method (IV) #7400, asbestos and other fibers.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Different dimensions of fibrous glass will produce different biologic effects. Large diameter (greater than 3.5 μm) glass fibers have been found to cause skin, eye, and upper respiratory tract irritation, a relatively low frequency of fibrotic changes, and a very slight indication of an excess mortality due to nonmalignant respiratory disease. Smaller diameter (less than 3.5 μm) fibrous glass has not been conclusively related to health effects in humans, but glass fibers of this dimension have only been regularly produced since the 1960s. Smaller diameter fibers have the ability to penetrate the alveoli. This potential is of concern and is the primary reason that fibers 3.5 μm or smaller are subject to special controls. Experimental studies in animals have demonstrated carcinogenic effects with the long (greater than 10 μm) and thin fibers (usually less than 1 μm in diameter). However, these studies were performed by implanting fibrous glass in the pleural or peritoneal cavities. The data from studies with these routes of exposure cannot be directly extrapolated to conditions of human exposure. On the basis of available information, NIOSH does not consider fibrous glass to be a substance that produces cancer as a result of occupational exposure. The data on which to base this conclusion are limited. Fibrous glass does not appear to possess the same potential as asbestos or for causing health hazard. Glass fibers are not usually of the fine submicron diameters as are asbestos fibers, and the concentrations of glass fibers in work-place air are generally orders of magnitude less than for asbestos. In one study, glass fibers were found to be cleared from the lungs more readily than asbestos.

Short Term Exposure: Irritates eyes, skin, nose, throat. Inhalation can cause dyspnea (breathing difficulty).

Long Term Exposure: A suspected carcinogen but there is no consistent evidence of chronic health effects in exposed workers.

Points of Attack: Eyes, skin, respiratory system

Medical Surveillance: NIOSH recommends that workers subject to fibrous glass exposure have comprehensive preplacement medical examinations with emphasis on skin susceptibility and prior exposure in dusty trades. Subsequent annual examinations should give attention to the skin and respiratory system with attention to pulmonary function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, and move to fresh air.

Personal Protective Methods: Protective clothing shall be worn to prevent fibrous glass contact with skin especially hands, arms, neck, and underarms. Safety goggles or face shields and goggles shall be worn during tear-out or blowing operations, or when applying fibrous glass materials overhead. They should be used in all areas where there is a likelihood that airborne glass fibers may contact the eyes. Engineering controls should be used wherever feasible to maintain fibrous glass concentrations at or below the prescribed limits. Respirators should only be used when engineering controls are not feasible; for example, in certain nonstationary operations where permanent controls are not feasible.

Respirator Selection: NIOSH: *up to 5 × REL*: Qm (APF = 25) (any quarter-mask respirator). *Up to 10 × REL:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 × REL:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 50 × REL*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie

(APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1000 × REL:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000): SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. *Dust only*: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

Fire Extinguishing: Noncombustible fibers. Use extinguisher suitable for surrounding fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Fibrous glass waste and scrap should be collected and disposed of in a manner which will minimize its dispersal into the atmosphere. Emphasis should be placed on covering waste containers, proper storage of materials, and collection of fibrous glass dust. Cleanup of fibrous glass dust should be performed using vacuum cleaners or wet cleaning methods. Dry sweeping should not be performed.

References

National Institute for Occupational Safety and Health. (1976). *Occupational Exposure to Fibrous Glass: A Symposium*, NIOSH Document No. 76-151

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Fibrous Glass*, NIOSH Document No. 77-152

National Institute for Occupational Safety and Health. (1975). *Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica*, NIOSH Document No. 75-120. Washington, DC

New Jersey Department of Health and Senior Services. (November 1985). *Hazardous Substances Fact Sheet: Fibrous Glass*. Trenton, NJ

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Glass Wool*. Trenton, NJ

Fluenetil F:0250

Molecular Formula: $C_{16}H_{15}FO_2$

Synonyms: (1,1′-Biphenyl)-4-acetic acid, 2-fluoroethyl ester; 4-Biphenylacetic acid, 2-fluoroethyl ester; Fluenyl; β-Fluorethyl 4-biphenylacetate; Lambrol

CAS Registry Number: 4301-50-2

RTECS® Number: DV8335000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: [*Annex I Index No.:* 607-078-00-0]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; Safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluenetil is a crystalline solid. Molecular weight = 258.31. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: This material has been used as an acaricide and insecticide. Its main use was as a dormant spray for orchard fruit. It is no longer made. Not registered as a pesticide in the United States.

Incompatibilities: Nitrates. Moisture may cause material to hydrolyze.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 6 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Fluenetil is highly toxic. LD_{50} = (oral-rat) 6 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from nitrates and moisture.

Shipping: Toxic solids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a combustible solid. Poisonous gases, including fluorine, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluenetil*. Washington, DC: Chemical Emergency Preparedness Program.

Fluoboric acid F:0260

Molecular Formula: HBF_4

Synonyms: Acide fluoroborique (French); Acido fluoborico (Spanish); Borate(1-), tetrafluoro-, hydrogen; Borofluoric acid; Fluboric acid; Fluoro-boric acid; Fluoroborsaeure (German); Hydrofluoboric acid; Hydrogen tetrafluoroborate; Kester 5569 Solder-NU; Prepared bath 2137; Starter 2000; Starter 2137; Tetrofluoroboric acid; Tetrofluoro hydrogen borate

CAS Registry Number: 16872-11-0

RTECS$^{®}$ Number: ED2685000

UN/NA & ERG Number: UN1775/154

EC Number: 240-898-3 [*Annex I Index No.:* 009-010-00-X]

Regulatory Authority and Advisory Bodies

Safe Drinking Water Act (as F): Regulated chemical (47 FR 9352); MCL, 4.0 mg/L; MCLG, 4.0 mg/L; SMCL, 2.0 mg/L.

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S26; S27; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Fluoboric acid is a colorless liquid which does not exist as a free, pure substance. Used as an aqueous solution. Molecular weight = 87.82; Boiling point = 130°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Used as a catalyst for acetal synthesis and cellulose esters; a metal surface cleaning agent; an aluminum electrolytic finishing agent; a stripping solution for the removal of solder and plated metals; and an intermediate in making fluoroborate salt.

Incompatibilities: A strong acid. Reacts violently with chemically active metals; strong bases, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

As inorganic fluoride

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Several states have set guidelines or standards for fluorine in ambient air[60] ranging from zero (North Carolina) to 4.0 μg/m^3 (Connecticut) to 6.7 μg/m^3 (New York) to 20.0 μg/m^3 (Florida) to 30.0 μg/m^3 (Virginia) to 20.0–40.0 μg/m^3 (North Dakota) to 48.0 μg/m^3 (Nevada).

Determination in Air: No tests available.

Permissible Concentration in Water: Russia[43] set a MAC of 1.5 mg/L in water bodies used for domestic purposes. See also the entry on "Fluorides."

Routes of Entry: Inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Highly corrosive. Contact can cause severe skin burns and eye irritation and burns with possible eye damage. Inhalation can irritate the lungs, causing coughing and shortness of breath. High exposure can cause headache, weakness, convulsions, collapse, and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure can cause nausea, vomiting, diarrhea, loss of appetite and weight, hair loss, skin rash, and bone and teeth changes (fluorosis). May cause kidney damage, anemia, and lung irritation with the possible development of bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system, kidneys, blood.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF

(APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chemically active metals and strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This chemical requires a shipping label of "CORROSIVE." DOT/UN Hazard Class 8. Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical powder extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride, fluorine, and boron oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Fluoboric Acid.* Trenton, NJ

Fluometuron F:0270

Molecular Formula: $C_{10}H_{11}F_3N_2O$

Common Formula: $C_6H_4(CF_3)NHCON(CH_3)_2$

Synonyms: C 2059; CIBA 2059; Cotoran; Cotoran Multi 50WP; Cottonex; *N*,*N*-Dimethyl-*N*′-[3-(trifluoromethyl) phenyl]urea; 1,1-Dimethyl-3-(3-trifluoromethylphenyl)urea; Fluometuron; Herbicide C-2059; Lanex; Meturone; NCI-C08695; Pakhtaran; 3-(5-Trifluormethylphenyl)-, dimethyl-harnstoff (German); *n*-(*m*-Trifluoromethylphenyl)-*N*′,*N*′-dimethylurea; *n*-(3-Trifluoromethylphenyl)-*N*′,*N*′-dimethylurea; 3-(*m*-Trifluoromethylphenyl)-1,1-dimethylurea; 3-(3-Trifluoromethylphenyl)-1,1-dimethylurea; Urea, *N*,*N*-Dimethyl-*N*′-[3-(trifluoromethyl)phenyl]-; Urea, 1,1-dimethyl-3-(α,α,α-trifluoro-*m*-tolyl)-

CAS Registry Number: 2164-17-2

RTECS® Number: YT1575000

UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151

EC Number: 218-500-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluometuron is a white crystalline solid often used in liquid solution that may be flammable. Molecular weight = 232.23; Freezing/Melting point = 163−165°C; Vapor pressure = 9.4×10^{-7} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: This material is used as a herbicide.

Incompatibilities: Liquid solutions are incompatible with oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: A no-observed-adverse-effect-level (NOAEL) of 0.0125 mg/kg/day has been calculated by EPA. On this basis a long-term health advisory of 5.3 mg/L and a lifetime health advisory of 0.09 mg/L have been calculated.

Determination in Water: Fish Tox = 77.05449000 ppb (INTERMEDIATE). Octanol−water coefficient: Log $K_{ow} = 2.3$.

Routes of Entry: Inhalation, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation. Inhalation can irritate the respiratory tract. Symptoms of exposure include increased leukocyte content in circulation of blood. The material is a mild cholinesterase inhibitor. LD_{50} = (oral-rat) 6400 mg/kg (insignificantly toxic). Human Tox = 7.00000 ppb (HIGH).

Long Term Exposure: May cause skin allergy. Mild cholinesterase inhibitor; cumulative effect is possible. Repeated exposure may cause changes in the red blood cell count. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Liver function tests. Complete blood count (CBC). Evaluation by a qualified allergist.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Consult a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the airway is open, lay on side, and keep head lower than body and transport immediately to medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Do not induce vomiting without a physician's advice.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from exposure to ultraviolet light. Keep liquid away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Phenyl urea pesticides, solid, toxic, require a label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone and avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Dry material:* Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen fluoride and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Combustible solution: Poisonous gases, including nitrogen oxides and fluorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Fluometuron*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Fluometuron*. Trenton, NJ

Fluoranthene F:0280

Molecular Formula: $C_{16}H_{10}$

Synonyms: 1,2-Benzacenaphthene; Benzo(jk)Fluorene; Fluoranteno (Spanish); Idryl; 1,2-(1,8-Naphthalenediyl) Benzene; 1,2-(1,8-Naphthylene)Benzene

CAS Registry Number: 206-44-0

RTECS® Number: LL4025000

UN/NA & ERG Number: UN3077/171

EC Number: 205-912-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U120.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.068; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Fluoranthene is a polycyclic hydrocarbon and a colorless crystalline solid. Molecular weight = 202.26; Boiling point = about 375°C; Freezing/Melting point = 111°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Virtually insoluble in water.

Potential Exposure: Fluoranthene, a polynuclear aromatic hydrocarbon (PAH), is produced from the pyrolytic processing of organic raw materials, such as coal and petroleum at high temperatures. It is also known to occur naturally as a product of plant biosynthesis. Fluoranthene is ubiquitous in the environment and has been detected in US atmospheric air, in foreign and domestic drinking waters, and in foodstuffs. It is also present in cigarette smoke. Individuals living in areas which are heavily industrialized, and in which large amounts of fossil fuels are burned, would be expected to have greatest exposure from ambient sources of fluoranthene. In addition, certain occupations (e.g., coke oven workers, steelworkers, roofers, automobile mechanics) would also be expected to have elevated levels of exposure relative to the general population. Exposure to fluoranthene will be considerably increased among tobacco smokers or those who are exposed to smokers in closed environments (i.e., indoors).

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 25 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: Category 1, human carcinogen.
NIOSH IDLH: 80 mg/m^3.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: The only existing standard which takes fluoranthene into consideration is a drinking water standard for PAHs. The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAHs not exceeding 0.2 μg/L. This recommended standard is based upon the analysis of the following six PAHs in drinking water: fluoranthene, Benzo(a) pyrene, Benzo(ghi)perylene, benzo(b)fluoranthene, benzo(k) fluoranthene, and indeno(1,2,3-cd) pyrene.

More recently EPA has established[6] ambient water criteria as follows: *To protect freshwater aquatic life:* 3980 μg/L based on acute toxicity. *To protect saltwater aquatic life:* 40 μg/L based on acute toxicity and 16 μg/L based on chronic toxicity. *To protect human health:* 42 μg/L. Kansas[61] has set a guideline of 0.029 μg/L for fluoranthene in drinking water.

Determination in Water: Methylene chloride extraction followed by high-pressure liquid chromatography with fluorescence as UV detection, or gas chromatography (EPA Method 610), or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long Term Exposure: There is concern about the toxicity of fluoranthene because it is widespread in the human environment and belongs to a class of compounds (polynuclear aromatic hydrocarbons) that contain numerous potent carcinogens. Experimentally, fluoranthene does not exhibit properties of a mutagen or primary carcinogen but it is a potent co-carciongen. In the laboratory, fluoranthene has also demonstrated toxicity to various freshwater and marine organisms. This finding, coupled with the cocarcinogenic properties of the compound, points out the need to protect humans and aquatic organisms from the potential hazards associated with fluoranthene in water.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of “CLASS 9.” It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Contain and isolate spill to limit spread. Construct clay/bentonite swale to divert uncontaminated portion of watershed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Fluoranthene: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Fluoranthene: Health and Environmental Effects Profile No. 103*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 2, 80−84

Fluorene F:0290

Molecular Formula: $C_{13}H_{10}$

Synonyms: *o*-Biphenylenemethane; *o*-Biphenylmethane; α-Diphenylenemethane; Diphenylenemethane; 9H-Fluorene; Fluoreno (Spanish); 2,2′-Methylenebiphenyl

CAS Registry Number: 86-73-7

RTECS® Number: LL5670000

UN/NA & ERG Number: Not regulated.

EC Number: 201-695-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluorene, when pure, is found as dazzling-white flakes or small, crystalline plates. It is fluorescent when impure. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 166.23; Boiling point = 293°C (decomposes); Freezing/Melting point = 116−117°C; Flash point = 151°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Fluorene is used in resins, dyes, and is a chemical intermediate.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene soluble aerosol); Confirmed Human Carcinogen.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: In view of the carcinogenicity of polynuclear aromatic hydrocarbons, the concentration in water is preferably zero as noted by EPA.[6]

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Fluorene can irritate and burn the eyes and skin.

Long Term Exposure: No chronic effects are known at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and source of ignition.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Eller P.M., & Cassinelli M.E. (Eds.). (1998). *NIOSH Manual of Analytical Methods* (NMAM®) (4th ed.). 2nd Supplement. Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Fluorene*. Trenton, NJ

Fluorides F:0300

Molecular Formula: F_yM_x

Synonyms: Fluoride(1-); Fluoride ion; Fluoride ion(1-); Perfluoride

CAS Registry Number: 16984-48-8 (fluoride)

RTECS® Number: LM6290000

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: Regulated chemical (47 FR 9352); MCL, 4.0 mg/L; MCLG, 4.0 mg/L; SMCL, 2.0 mg/L.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as fluoride compounds.

Note: Several specific fluoride compounds are regulated by US EPA, OSHA and International regulatory bodies.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Of the general formula M_xF_y, appearance, odor and properties vary with specific compounds.

Potential Exposure: Fluorides are used as an electrolyte in aluminum manufacture; a flux in smelting nickel, copper, gold, and silver; as a catalyst for organic reactions, a wood preservative; fluoridation agent for drinking water; a bleaching agent for cane seats; in pesticides, rodenticides, and as a fermentation inhibitor. They are utilized in the manufacture of steel, iron, glass, ceramics, pottery, enamels, in the coagulation of latex, in coatings for welding rods, and in cleaning graphite, metals, windows, and glassware. Exposure to fluorides may also occur during preparation of fertilizer from phosphate rock by addition of sulfuric acid. Air pollution by fluoride dusts and gases has done substantial damage to vegetation and to animals in the vicinity of industrial fluoride sources. However, the contribution of ambient air to human fluoride intake is only a few hundredths of a milligram per day, an amount that is insignificant in comparison with other sources of fluoride. Operations that introduce fluoride dusts and gases into the atmosphere include grinding, drying, and calcining of fluoride-containing minerals; acidulation of the minerals; smelting; electrochemical reduction of metals with fluoride fluxes or melts, as in the aluminum and steel industry; kiln firing of brick and other clay products; and the combustion of coal.

Incompatibilities: Fluorides form explosive gases on contact with strong acids or acid fumes.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Several states have set guidelines or standards for fluorides in ambient air[60] ranging from 2.85 μg/m^3 (Iowa) to 25.0 μg/m^3 (North Dakota) to 34.0 μg/m^3 (Massachusetts) to 40.0 μg/m^3 (Virginia).

Determination in Air: Gaseous fluorides collected by impinger using caustic, particulates by filter. Analysis is by ion-specific electrode per NIOSH Analytical Method 7902.[18]

Permissible Concentration in Water: The EPA has set a standard of 4 mg/L for fluoride[61] and the state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Fluorides can affect you when breathed in. Fluorides can irritate and may damage the eyes. Skin contact can cause irritation, rash, or burning sensation. High repeated exposure can cause nausea, vomiting, loss of appetite, and bone and teeth changes. Extremely high levels could be fatal. Breathing can irritate the nose and throat, and cause nausea, headaches, and nosebleeds. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Very high exposure can cause fluoride poisoning with stomach pain, weakness, convulsions, collapse, and death. These effects do not occur at the level of fluorides used in water for preventing cavities in teeth.

Long Term Exposure: Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite, diarrhea, or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Eyes, respiratory system; central nervous system, skeleton, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with large amounts of soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: In areas with excessive gas or dust levels for any type of fluorine, worker protection should be provided. Respiratory protection by dust masks or gas masks with an appropriate canister or supplied air respirator should be provided. Goggles or full-face masks should be used. In areas where there is a likelihood of splash or spill, acid-resistant clothing including gloves, gauntlets, aprons, boots, goggles, or face shield should be provided to the worker. Personal hygiene should be encouraged, with showering following each shift and before changing to street clothes. Work clothes should be changed following each shift, especially in dusty areas. Attention should be given promptly to any burns from fluorine compounds due to absorption of the fluorine at the burn site and the possibility of developing systemic symptoms from absorption from burn sites.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if* *not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)[†] [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)[†] [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

[†]May need acid gas sorbent.

Storage: Storage color will depend on compound. Prior to working with fluorides you should be trained on its proper handling and storage. Fluorides must be stored to avoid contact with strong acids (i.e., hydrochloric, sulfuric, and nitric) since violent reactions can occur. Fluorides form explosive gases on contact with nitric acid. Store in tightly closed containers in a cool, well-ventilated area away from water.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solid material: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not use water*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reaction of aqueous waste with an excess of lime, followed by lagooning, and either recovery or land disposal of the separated calcium fluoride.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluoride*, NIOSH Document No. 76-103

National Academy of Sciences. (1971). *Medical and Biologic Effect of Environmental Pollutants: Fluoride*. Washington, DC

New Jersey Department of Health and Senior Services. (January 1986). *Hazardous Substances Fact Sheet: Fluoride*. Trenton, NJ

Fluorine F:0310

Molecular Formula: F_2

Synonyms: Fluor (French, German, Spanish); Fluorine-19; Fluorures acide (French); Saeure fluoride (German)

CAS Registry Number: 7782-41-4

RTECS® Number: LM6475000

UN/NA & ERG Number: UN1045 (gas)/124; UN9192 (liquid)/167

EC Number: 231-954-8 [*Annex I Index No.:* 009-001-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration); *Theft hazard* 15 (≥6.17% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454 kg).

US EPA Hazardous Waste Number (RCRA No.): P056.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, T + ,C; Risk phrases: R8; R26; R35; Safety phrases: S1/2; S9; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Fluorine is a yellow compressed, gas with a characteristic pungent odor. The odor threshold is 0.035 ppm.[41] Molecular weight = 38.00; Boiling point = −188.3°C; Freezing/Melting point = −219.4°C; Relative vapor density (air = 1): 1.31; Vapor pressure = >1 atm; Vapor pressure = >1 atm at 25°C. Reaction with water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Elemental fluorine is used in the conversion of uranium tetrafluoride to uranium hexafluoride, in the synthesis of organic and inorganic fluorine compounds, and as an oxidizer in rocket fuel.

Incompatibilities: Water, nitric acid, oxidizers, organic compounds. Reacts violently with reducing agents, ammonia, all combustible materials, metals (except the metal containers in which it is shipped). Reacts violently with H_2O to form hydrofluoric acid and ozone.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.55 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.2 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.2 mg/m^3 TWA.

ACGIH TLV®[1]: 1 ppm/1.6 mg/m^3 TWA; 2 ppm/3.1 mg/m^3.

NIOSH IDLH: 2 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: **1.7** ppm

PAC-2: **5** ppm

PAC-3: **13** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: No numerical value established. Data may be available.

Arab Republic of Egypt: TWA 0.1 ppm (0.2 mg/m^3), 1993; Australia: TWA 1 ppm (2 mg/m^3); STEL 2 ppm, 1993; Austria: MAK 0.1 ppm (0.2 mg/m^3), 1999; Belgium: TWA 1 ppm (1.6 mg/m^3); STEL 2 ppm, 1993; Denmark: TWA 0.1 ppm (0.2 mg/m^3), 1999; Finland: STEL 0.1 ppm (0.26 mg/m^3), 1999; France: VLE 1 ppm (2 mg/m^3), 1999; Hungary: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, 1993; Norway: TWA 0.1 ppm (0.2 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.2 mg/m^3), 1993; Poland: MAC (TWA) 0.05 mg/m^3, MAC (STEL) 0.4 mg/m^3, 1999; Sweden: NGV 0.1 ppm (0.2 mg/m^3), KTV 0.3 ppm (0.5 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.15 mg/m^3), KZG-W 0.2 ppm (0.3 mg/m^3), 1999; Thailand: TWA 0.1 ppm (0.2 mg/m^3), 1993; Turkey: TWA 0.1 ppm (0.2 mg/m^3), 1993; United Kingdom: STEL 1 ppm (1.6 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2 ppm. Several states have set guidelines or standards for fluorine in ambient air[60] ranging from zero (North Carolina) to 4.0 μg/m^3 (Connecticut) to 6.7 μg/m^3 (New York) to 20.0 μg/m^3 (Florida) to 30.0 μg/m^3 (Virginia) to 20.0−40.0 μg/m^3 (North Dakota) to 48.0 μg/m^3 (Nevada).

Determination in Air: No test available.

Permissible Concentration in Water: Russia[43] set a MAC of 1.5 mg/L in water bodies used for domestic purposes. See also the entry on "fluorides."

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Small amounts of gas in air can have a strong caustic effect on the cornea, eyelids, nose. Inhalation:* Corrosive. Inhalation of fluorine causes coughing, choking, and chills. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. A symptomatic period of 1−2 days followed by fever, cough, tightness in chest, and cyanosis indicate pulmonary edema. Inhalation of extremely high levels may cause suffocation. It is also reported that volunteers exposed to levels of 10 ppm for up to 15 min reported no irritation. Levels of 25−75 ppm caused increasing irritation. Exposure to levels of 100 ppm for 1 min caused strong respiratory irritation. *Skin:* Corrosive to the skin. It is also reported that exposure to levels between 90 and 240 ppm produced slight irritation of the skin and a "sticky" feeling of face. Contact with liquid fluorine may cause chemical burns and frostbite. *Eyes:* Corrosive to the eyes; can lead to permanent eye damage. Contact with the liquid may cause frostbite. It is also reported that mild irritation was reported at exposure to levels of 25 ppm for 5 min. Levels of 100 ppm for 1 min produced marked irritation. *Ingestion:* No reported exposures by this route.

Long Term Exposure: Prolonged exposure can cause fluorine to concentrate in the bones, causing osteosclerosis which may be disabling. The teeth can become mottled. Repeated exposure can cause nosebleeds, nausea, vomiting, loss of appetite, diarrhea, and kidney damage. These effects do not occur when fluorine is used to treat drinking water to prevent cavities. It is also reported that levels of 0.1 ppm intermittently, over a prolonged period produced no ill effects.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. Liver and kidney function tests. DEXA bone density scan (dual energy X-ray absorptiometry).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Prevent skin contact (liquid). **8 h:** Barricade™ coated suits; Responder™ suits. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact-resistant goggles when working with fumes, gases, or vapors. When working with liquids, wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *Up to 5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]; *Up to 250 ppm:* SaF: Pd,Pp (APF = 2000) Any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Danger: Do NOT use a gas mask with activated carbon filters containing activated carbon filters in atmospheres of high concentrations of fluorine gas. The activated carbon may spontaneously ignite.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Fluorine must be stored to avoid contact with most oxidizable materials because it frequently causes them to start on fire. It will frequently ignite bromine, iodine, sulfur, alkaline metals (such as sodium and potassium), and a number of organic chemicals (such as benzene and ethyl alcohol). It should not contact nitric acid because an explosive gas will be produced. Contact with hydrogen or amorphous silicon dioxide will cause an explosion. Store in containers, such as cylinders, in a cool, well-ventilated area away from heat, water, and steam. Heat can cause cylinders to burst. Contact with water or steam can produce heat and corrosive and poisonous gases.

Shipping: Compressed fluorine requires a shipping label of "POISON GAS, OXIDIZER, CORROSIVE." It falls in Hazard Class 2.3, Hazard Zone A. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid fluorine is spilled, clear the area and allow it to evaporate. Vapors are heavier than air and will collect in low areas. *Do not use water* or wet method. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with

time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Fluorine and fluorine, compressed

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.9/3.1

Fire Extinguishing: Nonflammable but reacts chemically with any material capable of burning. Poisonous gases are produced in fire. Fluorine can ignite combustible materials and may increase the severity of an ongoing fire. Use extinguisher appropriate to the burning material. Do not spray water directly on leaking fluorine as poisonous gases are produced. Keep sealed fire-exposed cylinder cool by spraying with water. For small fire, used dry chemical or carbon dioxide. For large fire, use water spray, fog, or foam. For massive fire in cargo area, use unmanned hose holder or monitor nozzles. A few whiffs of the gas or vapor could cause death. Gas, vapor of liquid could be fatal on penetrating the firefighters' normal full protective clothing. Only special protective clothing designed to protect against fluorine should be used; the normal full protective clothing available to the average fire department will not provide adequate protection. Do not direct water onto fluorine leaks as the fire may be intensified. Do *NOT* spray water on leaking cylinder (to prevent corrosion of cylinder). Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.

Disposal Method Suggested: Fluorine can be combusted by means of a fluorine-hydrocarbon air burner followed by a caustic scrubber and stack. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 68−70 (1981) and 3, No. 4, 50−53 (1983)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluorine*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Fluorine*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Fluorine*. Trenton, NJ

Fluoroacetamide F:0320

Molecular Formula: C_2H_4FNO

Common Formula: CH_2FCONH_2

Synonyms: AFL 1081; Compound 1081; FAA; Fluorakil 100; 2-Fluoroacetamide; Fluoroacetic acid amide; Fussol; Megatox; Monofluoroacetamide; Navron; Rodex; Yanock

CAS Registry Number: 640-19-7

RTECS® Number: AC1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 211-363-1 [*Annex I Index No.:* 616-002-00-5]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (several countries) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

US EPA Hazardous Waste Number (RCRA No.): P057.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: Hazard Symbol: T+; Risk phrases R24; R28; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluoroacetamide is a colorless, crystalline solid. Molecular weight = 77.07; Freezing/Melting point = 107−109°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. This material is an organofluorine rodenticide; insecticide proposed mainly for use on fruits to combat scale insects, aphids, and mites. Use is largely restricted to licensed pest control operators.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No OSHA, NIOSH, or ACGIH standards set for organic fluorides.

Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 5.8 mg/m^3
PAC-3: 5.8 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Signs and symptoms may be extremely severe and range from nausea, vomiting, and diarrhea to convulsions, coma, and heart failure. Other symptoms include hyperactivity, respiratory depression, or arrest; cyanosis (blue tint to the skin and mucous membranes); and ventricular fibrillation. This material is super toxic; probable oral lethal dose in humans is less than 5 mg/kg or a taste (less than 7 drops) for a 150-lb person. Chemically inhibits oxygen metabolism by cells with critical damage occurring to the heart, brain, and lungs, resulting in heart failure, respiratory arrest, convulsions, and death.

Warning: Effects usually appear within 30 min of exposure but may be delayed as long as 20 h. Caution is advised. Vital signs should be monitored closely.

Points of Attack: Heart, brain, and kidneys.

Medical Surveillance: See entry on "Fluorides."

First Aid: Acute exposure to fluoroacetamide may require decontamination and life support for the victim. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies, such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination. *Inhalation:* Move victim to fresh air. Evaluate vital signs. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen. Rush to a health-care facility. *Eye Exposure:* Remove any contact lenses at once and flush eyes with lukewarm water for 15 min. *Skin Exposure:* Follow steps under inhalation above. Wash exposed skin areas 3 times with soap and water. Rush to health-care facility. *Ingestion:* Evaluate vital signs, including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Rush to health-care facility. Obtain authorization and/or further instructions from the local hospital for performance of other invasive procedures.

Warning: Effects usually appear within 30 min of exposure but may be delayed as long as 20 h. Caution is advised. Vital signs should be monitored closely.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including fluorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluoroacetamide*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Fluoroacetic acid F:0330

Molecular Formula: $C_2H_3FO_2$

Common Formula: FCH_2COOH

Synonyms: Acide monofluoracetique (French); Acido fluoroacetico (Spanish); Cymonic acid; FAA; Fluoroacetate; 2-Fluoroacetic acid; Fluoroethanoic acid; Gifblaar poison; HFA; MFA; Monofluoressigsaeure (German); Monofluoroacetate; Monofluoroacetic acid

CAS Registry Number: 144-49-0

RTECS® Number: AH5950000

UN/NA & ERG Number: UN2642/154

EC Number: 205-631-7 [*Annex I Index No.:* 607-081-00-7]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R28; R50; Safety phrases: S1/2; S20: S22: S26: S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Fluoroacetic acid is a colorless crystalline solid. Molecular weight = 78.05; Boiling point = 165°C; Freezing/Melting point = 35°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Drug. This material is used as a rodenticide.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.075 mg/m^3

PAC-1: 0.25 mg/m^3

PAC-2: 0.47 mg/m^3

PAC-3: 2 mg/m^3

Permissible Concentration in Water: No standards set for the acid but see the entry for its sodium salt under "Sodium fluoroacetate."

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. The major symptoms of fluoroacetic acid poisoning include severe epileptiform convulsions alternating with coma and depression; death may result from asphyxiation during convulsion or from respiratory failure. Cardiac irregularities, such as ventricular fibrillation and sudden cardiac arrest, nausea, vomiting, excessive salivation, numbness, tingling sensations, epigastric pain, mental apprehension, muscular twitching, low blood pressure, and blurred vision may also occur. This material is very toxic, LD_{50} = (oral-rat) 4.7 mg/kg (extremely toxic), and may affect the cardiovascular system, central nervous system, and kidneys, and may cause cardiac and renal failure. This may cause death.

Long Term Exposure: See information for "Short-Term Exposure."

Points of Attack: Central nervous system, heart, kidneys, lungs.

Medical Surveillance: Kidney function tests. EKG. Lung function tests. Examination of the nervous system. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of central nervous system, cardiac, and renal failure do not become manifest until a few hours have passed. Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material. Stop leak if you can do so without risk. Stay upwind; keep out of low areas. Use water spray to reduce vapors. For *small spills*, take up with sand or other noncombustible absorbent material and place into containers for later disposal. For *large spills*, dike spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Wear self-contained, positive pressure breathing apparatus and full protective clothing. Move container from fire area. Cool containers that are exposed to flames with water from the side until well after fire is out. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent. Spray the solution into a furnace equipped with an afterburner.[24]

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluoroacetic Acid*. Washington, DC: Chemical Emergency Preparedness Program

Fluoroacetyl chloride F:0340

Molecular Formula: C_2H_2ClFO

Common Formula: FCH_2COCl

Synonyms: Acetyl chloride, fluoro-; TL 670

CAS Registry Number: 359-06-8

RTECS® Number: AO6825000

UN/NA & ERG Number: UN3123 (Toxic liquids, water-reactive, n.o.s.)/139

EC Number: 206-623-6

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluoroacetyl chloride is a liquid. Molecular weight = 96.49. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 2. Reacts with water.

Potential Exposure: May be used in organic synthesis.

Incompatibilities: Chlorides or fluorides may ignite combustibles (i.e., wood, paper, oil, etc.) or react violently with water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 10 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Highly toxic by inhalation. Corrosive to skin and irritating to eyes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic liquids, water-reactive, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS, DANGEROUS WHEN WET." They fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors (may react violently with water). *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a combustible solid and water-reactive. Extinguish with dry chemical, carbon dioxide. Spray cooling water on unopened containers that are exposed to flames until well after fire is out. Move container from fire area if you can do so without risk. Do not get water in container, as material may react violently with water. Poisonous gases are produced in fire, including phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluoroacetyl Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Fluorobenzene F:0350

Molecular Formula: C_6H_5F
Synonyms: Benzene fluoride; Benzene, fluoro-; MFB; Monofluorobenzene; Phenyl fluoride
CAS Registry Number: 462-06-6
RTECS® Number: DA0800000
UN/NA & ERG Number: UN2387/130
EC Number: 207-321-7
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Fluorobenzene is a colorless liquid. Molecular weight = 96.11; Boiling point = 85°C; Flash point = −15°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.

Potential Exposure: Fluorobenzene is used as an insecticide and as a reagent for plastic or resin polymers.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 125 mg/m^3
PAC-1: 350 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Fluorobenzene can irritate the eyes, nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. A closely related chemical, chlorobenzene, can damage the liver and kidneys with high or repeated exposure. It is unknown if fluorobenzene causes these effects. Overexposure could cause headache, nausea, and make you dizzy.

Long Term Exposure: May cause liver and kidney damage. Repeated exposure may damage the lungs and affect the nervous system.

Points of Attack: Lungs, liver, kidney, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: periodic lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: tests for kidney and liver function. Examination of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Where there is potential for exposures to fluorobenzene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Fluorobenzene must be stored to avoid contact with oxidizers since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where fluorobenzene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of fluorobenzene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of fluorobenzene.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide and fluorine, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Fluorobenzene*. Trenton, NJ

Fluorotrichloromethane F:0360

Molecular Formula: CCl_3F

Synonyms: Algofrene type 1; Arctron 9; CFC-11; Electro-CF 11; Eskimon 11; F 11; FC 11; Fluorocarbon 11; Fluorochloroform; Freon 11; Freon HE; Freon MF; Frigen 11; Genetron 11; Halocarbon 11; Isceon 131; Isotron 11; Ledon 11; Methane, fluorotrichloro; Methane, trichlorofluoro-; Monoflurotrichloromethane; NCI-C04637; Propellant 11; R 11; Refrigerant 11; Trichlorofluoromethane; Trichloromonofluoromethane; Ucon fluorocarbon 11; Ucon refrigerant 11

CAS Registry Number: 75-69-4; *(alt.)* 83589-40-6

RTECS® Number: PB6125000

DOT ID and ERG Number: UN3077/171

EC Number: 200-892-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); no evidence: mouse; inadequate studies: rat.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, appendix A), Class I, Ozone Depletion Potential = 1.0.

US EPA Hazardous Waste Number (RCRA No.): U121.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.020; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Fluorotrichloromethane is a colorless liquid or gas with a chlorinated solvent odor. The odor threshold is 5.0 ppm. Molecular weight = 137.36; Specific gravity (H_2O:1) = 1.47 (Liquid at 23.9°C); Boiling point = 24°C; Freezing/Melting point = − 111°C; Relative vapor density (air = 1) = 4.74; Vapor pressure = 690 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Soluble in water; solubility = 0.1% at 23.9°C.

Potential Exposure: Compound Description: Tumorigen, Human Data; Hormone. This material is used as a refrigerant, aerosol propellant, foaming agent, and as a blowing agent in production of polyurethane foams.

Incompatibilities: Chemically active and powdered metals: aluminum, barium, sodium, potassium, calcium, powdered aluminum, zinc, magnesium.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/5600 mg/m^3 TWA.

NIOSH REL: 1000 ppm/5600 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1000 ppm/5620 mg/m^3 Ceiling Concentration, Not Classifiable as a Human carcinogen, *as trichloromonofluoromethane.*

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 1000 ppm

PAC-2: 1500 ppm

PAC-3: 2000 ppm

DFG MAK: 1000 ppm/5700 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C, *as trichloromonofluoromethane.*

Australia: TWA 1000 ppm (5600 mg/m^3), 1993; Austria: MAK 1000 ppm (5600 mg/m^3), 1999; Belgium: STEL

1000 ppm (5620 mg/m^3), 1993; Denmark: TWA 500 ppm (2810 mg/m^3), 1999; Finland: TWA 1000 ppm (5600 mg/m^3); STEL 1250 ppm (7000 mg/m^3), 1993; Hungary: STEL 40 mg/m^3, 1993; Japan: 1000 ppm (5600 mg/m^3), 1999; Norway: TWA 500 ppm (2800 mg/m^3), 1999; the Philippines: TWA 1000 ppm (5600 mg/m^3), 1993; Poland: MAC (TWA) 500 mg/m^3, MAC 5600 mg/m^3, 1999; Russia: STEL 1000 ppm (1000 mg/m^3), 1993; Sweden: NGV 500 ppm (3000 mg/m^3), KTV 750 ppm (4500 mg/m^3), 1999; Switzerland: MAK-W 1000 ppm (5600 mg/m^3), 1999; Turkey: TWA 1000 ppm (5600 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (5710 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1000 ppm. Russia set a MAC of 100 mg/m^3 in ambient air in residential areas on a once-daily basis and 10 mg/m^3 on a daily average basis. Several states have set guidelines or standards for F-11 in ambient air[60] ranging from 13.0 mg/m^3 (Virginia) to 56.0 mg/m^3 (North Dakota) to 112.0 mg/m^3 (Connecticut) to 133.33 mg/m^3 (Nevada) to 560 mg/m^3 (North Carolina). Beyond this, general concern about destruction of the ozone layer above the earth has prompted restrictions on chlorofluorocarbon use and venting to the atmosphere. Substitute materials are being developed to reduce emissions drastically.

Determination in Air: Charcoal adsorption, workup with CS$_2$, analysis by gas chromatography/flame ionization. See NIOSH Analytical Method (IV) #1006.[18]

Permissible Concentration in Water: For the protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L. In January 1981 EPA (46FR2266) removed F-11 from the priority toxic pollutant list. Several states have developed guidelines for F-11 in drinking water[61] ranging from 1.0 μg/L (Arizona) to 2300 μg/L (Maine) to 3400 μg/L (California) to 3500 μg/L (Wisconsin) to 8000 μg/L (Kansas) to 8750 μg/L (Maryland).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{\mathrm{ow}} = 2.5$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin and eyes. Overexposure can cause lightheadedness, dizziness, incoherence, tremors, cardiac arrhythmia, asphyxiation, cardiac arrest. This can occur without other warning symptoms. The liquid may cause frostbite.

Long Term Exposure: Repeated or prolonged contact with skin may cause dryness and cracking. Can irritate the lungs, causing coughing and/or shortness of breath.

Points of Attack: Skin, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider Holter monitor (a special 24-h EKG to look for irregular heartbeat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Trichlorofluoromethane must be stored to avoid contact with chemically active metals, such as aluminum or lithium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Poisonous gases, including hydrogen fluoride, hydrogen chloride, and phosgene, are produced in fire. Use extinguishing agents suitable for surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Trichlorofluoromethane and Dichlorodifluoromethane: Health and Environmental Effects Profile No. 167*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 92−95

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: Trichlorofluoromethane*. Trenton, NJ

Fluorouracil F:0370

Molecular Formula: $C_4H_3FN_2O_2$

Synonyms: Adrucil; AI3-25297; Arumel; 2,4-Dioxo-5-fluoropyrimidine; Effluderm (free base); Efudex; Efudix; Efurix; Fluoroblastin; Fluoroplex; 5-Fluoro-2,4(1H,3H)-pyrimidinedione; 5-Fluoropyrimidine-2,4-dione; 5-Fluoro-2,4-pyriminedione; 5-Fluorouracil; Fluorouracile; Fluorouracilo; Fluorouracilum; 5-Fluoruracil (German); Fluracilum; Fluri; Fluril; Fluro Uracil; FT-207; 5-FU; FU; Kecimeton; NSC 19893; 2,4(1H,3H)-Pyrimidinedione, 5-fluoro-; Queroplex; RO 2-9757; Timazin; U-8953; Ulup; Uracil, 5-fluoro-

CAS Registry Number: 51-21-8

RTECS® Number: YR0350000

UN/NA & ERG Number: Not regulated

EC Number: 200-085-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin 1/1/89.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fluorouracil is a white crystalline solid which is practically odorless. Molecular weight = 130.09; Freezing/Melting point = 282−283°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: This material is used as an antineoplastic drug, for cancer treatment and as a chemosterilant for insects.

Incompatibilities: Oxidizers, strong bases, heat.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 19 mg/m^3
PAC-3: 100 mg/m^3

Routes of Entry: Ingestion, skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the eyes and skin. Can cause headache, fatigue, dizziness, mental confusion, nausea, vomiting, diarrhea, and abdominal pain. Minimum toxic dose in humans is approximately 450 mg/kg (total dose) over 30 days for the ingested drug. Intravenous minimum toxic dose in humans is a total dose of 6 mg/kg over 3 days. Depression in white blood cells occurred after intravenous administration of a total dose of 480 mg/kg over 32 days. Occasional neuropathy and cardiac toxicity have been reported. Do not use during pregnancy. Patients with impaired hepatic or renal function, with a history of high-dose pelvic irradiation or previous use of alkylating agents, should be treated with extreme caution. Patients with nutritional deficiencies and protein depletion have a reduced tolerance to fluorouracil.

Long Term Exposure: May decrease fertility in males and females. May cause skin allergy. Very high exposure may affect the heart. Loss of appetite and nausea are earliest symptoms, with other symptoms of diarrhea, inflammation or sores in the mouth, gastric burning, and intestinal discomfort. More serious symptoms are due to the suppression of bone marrow, with a decrease in white cell count and blood platelets, and anemia. Hair loss, nail changes, dermatitis, pigmentation, and atrophy of skin also occur. Sunlight can exacerbate these effects.

Points of Attack: Blood, heart, skin.

Medical Surveillance: Complete blood count (CBC), EKG, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool place, possibly a refrigerator. Store at 59°F–86°F/15°C–30°C. Keep away from oxidizers, strong bases, and heat.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Spill or leak; shut off ignition sources; no flares, smoking, or flames in hazard area. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch spilled material. *Small spills*: Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, or alcohol, or polymer foam extinguishers. Poisonous gases, including nitrogen oxides, hydrogen fluoride, and carbon monoxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only

respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 6, 64−73

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fluorouracil*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: 5-Fluorouracil*. Trenton, NJ

Fluosilicic acid F:0380

Molecular Formula: F_6H_2Si

Common Formula: H_2SiF_6

Synonyms: Dihyrogen hydrofluorosilicate; Hexafluorosilicate(2-) dihydrogen; Hexafluorosilicic acid; Hexafluosilicic acid; Hydrofluosilicic acid; Hydrogen hexafluorosilicate; Hydrosilicofluoric acid; Sand acid; Silicofluoric acid

CAS Registry Number: 16961-83-4; *(alt.)* 1309-45-1

RTECS® Number: VV8225000

UN/NA & ERG Number: UN1778/154

EC Number: 241-034-8 [*Annex I Index No.*: 009-011-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S26; S27; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Fluorosilicic acid is a transparent, colorless fuming liquid. Molecular weight = 144.11; Boiling point = about 100°C (decomposes); Freezing/Melting point ≤ −20°C. It is not flammable. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: A solution of fluorosilicic acid is used for sterilization in the brewing and bottling industry, electrolytic refining of lead, electroplating, hardening cement, and for removing mold and others.

Incompatibilities: The aqueous solution is a strong acid. Reacts with water or steam to produce toxic and corrosive fumes of hydrogen fluoride. Incompatible, and may react violently with bases, aliphatic amines, alkanolamines, alkylene oxides, aromatic amines, amides, ammonia, ammonium hydroxide, calcium oxide, epichlorohydrin, isocyanates, oleum, organic anhydrides, sulfuric acid, strong oxidizers, vinyl acetate, water. Attacks glass, concrete, and ceramics. The anhydrous form dissociates almost instantly into silicon tetrafluoride and hydrogen fluoride.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

NIOSH IDLH: 250 mg[F]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 3.16 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 316 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Russia[43] has set MAC values for ambient air in residential areas as 0.03 mg/m^3 on a momentary basis and 0.01 mg/m^3 on a daily average basis.[43]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Medical observation is recommended. *Inhalation:* May cause difficult breathing and burning of the mouth, throat and nose, which may result in bleeding. These may be felt at 7.5 mg/m^3. Nausea, vomiting, profuse sweating and excess thirst may occur at higher levels. *Ingestion:* Corrosive. Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. 5−40 mg may cause nausea, diarrhea, and vomiting. More severe symptoms of burning and painful abdomen; sores in mouth, throat, and digestive tract; tremors, convulsions, and shock will occur around a dose of 1 g. Death may result in ingestion of 2−5 g.

Long Term Exposure: Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 mg/m^3 or higher. May cause mottling of the bones or teeth at this level, resulting in fluorosis. May cause lung damage.

Points of Attack: Bones, lungs.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. DEXA bone densitometry scan.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Inject intravenously 10 mL of 10% calcium gluconate solution. Gastric lavage with lime water of 1% calcium chloride.

Personal Protective Methods: Use only with an effective and properly maintained exhaust ventilation or with a fully enclosed process. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Remove any clothing that you think may have become chemically soiled and wash before reuse. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry area that is well ventilated. Protect from damage. Avoid acids. Concentrated solution can be stored in glass but lead is preferred.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Enter only with protective clothing and devices. Treat with soda ash or slaked lime. Dilute with water. Use an industrial vacuum cleaner to remove the spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Material itself is not flammable. *Do not use water*. Use CO_2 or dry chemicals on surrounding fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to a large amount of soda ash in solution.[24] Discharge to sewer with large volumes of water.

Reference

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Fluosilicic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

Flurazepam F:0390

Molecular Formula: $C_{21}H_{23}ClFN_3O$

Synonyms: 7-Chloro-1-[2-(diethylamino)ethyl]-5-(2-fluorophenyl)-1H-1,4-benzodiazepin-2(3H)-one; Dalmane®; Felmane; Noctosom; Ro-5-6901/3; Stauroderm

CAS Registry Number: 17617-23-1

RTECS® Number: DF2368050

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 241-591-7

Regulatory Authority and Advisory Bodies

US Department of Justice controlled substance [CFR 21 Part 1308.4 (Depressants)].

WGK (German Aquatic Hazard Class): No value assigned.

Description: Flurazepam is a pale yellow crystalline solid. Molecular weight = 387.88; Freezing/Melting point = 79.5°C. Solubility in water = 500 mg/L.

Potential Exposure: A Drug. Flurazepam is used as a sedative in capsules or liquid form.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Flurazepam can affect you when breathed in. Flurazepam is used as a medical depressant drug. When taken in that way, it can cause drowsiness and difficulty with coordination, concentration, and balance. It can also cause irritability, anxiety, weakness, headache, upset stomach, and joint pains. Effects may last for 1−3 days. It is not known for certain if these effects occur from occupational exposure. Drinking alcohol after exposure may worsen the symptoms caused by flurazepam. Person taking lithium (a medication), could have a serious reaction with flurazepam exposure.

Long Term Exposure: Exposure to flurazepam may cause jaundice, skin rash, and a low white blood cell count. Similar compounds are known teratogens. Suddenly discontinuing exposure after high exposure for 3 months may cause shakiness, irritability, and convulsions.

Points of Attack: Blood, liver, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood flurazepam level. Complete blood count (CBC). Liver function tests. Evaluation by a qualified allergist.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids.

Skin Contact: Remove contaminated clothing. Wash contaminated skin with water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. If you are required to work in a "sterile" environment you require special training.

Shipping: This material falls into the DOT category of Medicine, solid, toxic, n.o.s. This category requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire, including chlorine, fluorine, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 1986). *Hazardous Substances Fact Sheet: Flurazepam*. Trenton, NJ

Fonofos F:0400

Molecular Formula: $C_{10}H_{15}OPS_2$

Common Formula: $C_6H_5SPS(OC_2H_5)C_2H_5$

Synonyms: *O*-Aethyl-*S*-phenyl-aethyl-dithiophosphonat (German); Capfos; Cudgel; Difonate; Double down; Dyfonate; Dyphonate; ENT 25,796; *O*-Ethyl *S*-phenyl ethyldithiophosphonate; *O*-Ethyl *S*-phenyl (RS)-ethylphosphonodithioate; *O*-Ethyl *S*-phenyl ethylphosphonodithioate; Fonophos*;* *n*-2790; Phosphonodithioic acid, ethyl-*O*-ethyl, *S*-phenyl ester

CAS Registry Number: 944-22-9

RTECS® Number: TA5950000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-408-0 [*Annex I Index No.:* 015-091-00-2]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Histidine reversion—Ames test; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

US EPA, FIFRA 1998 Status of Pesticides: Unsupported.

Banned or Severely Restricted (in agriculture) (Malaysia, East Germany) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Note: Classified for restricted use for direct supervision of a certified applicator.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fonofos is a pale yellow liquid with a pungent, mercaptan-like odor. Molecular weight = 246.34; Boiling point = 130°C at 0.1 mm; Freezing/Melting point = 30°C; Vapor pressure = 0.0003 mmHg at 20°C; Flash point = 94°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Those involved in the manufacture, formulation, and application of this soil insecticide which is used for control of corn rootworms, wireworms, cutworms, symphylans, and other soil pests.

Incompatibilities: Strong acids, alkalies.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued for acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 1.3 mg/m^3

PAC-3: 200 mg/m^3

Australia: TWA 0.1 mg/m^3, [skin], 1993; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have developed guidelines or standards for fonofos in ambient air[60] ranging from 1.0 $\mu g/m^3$ (North Dakota) to 2.0 $\mu g/m^3$ (Connecticut, Nevada and Virginia).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: The EPA has developed health advisories for fonofos as follows: long-term health advisory is 70 μg/L and lifetime health advisory is 14 μg/L (See "References" below).

Determination in Water: Fish Tox = 3.50002000 ppb (HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, vertigo, sensation of tightness in chest, blurring of vision, ocular pain, loss of muscle coordination, slurring of speech, muscle twitching, drowsiness, excessive secretion of respiratory tract mucus, and convulsions. This material is a cholinesterase inhibitor. It can cause severe symptoms and death from respiratory arrest. LD_{50} = (oral-rat) 3 mg/kg (extremely toxic). Exposure above the airborne exposure limit may result in death. The effects may be delayed. Medical observation is recommended. Human Tox (ppb): 10.00000 (INTERMEDIATE).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Fonofos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool area.

Shipping: Fonofos is an organophosphorus pesticide, liquid, toxic, n.o.s. This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur and phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, fog, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This phosphono compound is reported to be satisfactorily decomposed by hypochlorite. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fonofos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (August 1987). *Health Advisory: Fonofos*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Fonofos*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Formaldehyde F:0410

Molecular Formula: CH_2O
Common Formula: HCHO
Synonyms: Aldehyde formique (French); BFV; Dynoform; FA; Fannoform; Formaldehido (Spanish); Formalin; Formalin 40; Formalina (Spanish); Formaline (German); Formalin-loesungen (German); Formalith; Formic aldehyde; Formol; Fyde; Hercules 37M6-8; Hoch; Ivalon; Karsan; Low dye-fast dry ink; Lysoform; Magnifloc 156C flocculant; Meethanal; Methyl aldehyde; Methylene glycol; Methylene oxide; Morbicid; NCI-C02799; Oxomethane; Oxymethylene; Polyoxymethylene glycols; Steriform; Superlysoform; Tetraoxymethylene; Trioxane
CAS Registry Number: 50-00-0; *(alt.)* 8005-38-7; *(alt.)* 8006-07-3; *(alt.)* 8013-13-6; *(alt.)* 112068-71-0
RTECS® Number: LP8925000
UN/NA & ERG Number: UN2209 (solutions, with not <25% formaldehyde)/132; UN1198 (flammable solutions)/132
EC Number: 200-001-8 [*Annex I Index No.:* 605-001-00-5]
Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Carcinogenicity: NTP (*gas*): 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human Limited Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1995; EPA: Limited evidence of carcinogenicity based on epidemiologic studies; NIOSH: Potential occupational carcinogen; OSHA: potential workplace carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: *N. crassa*—reversion; *E. coli* polA without S9; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—reversion; Inconclusive: *In vitro* UDS—human fibroblast; Inconclusive: CHO gene mutation.

Banned or Severely Restricted (several countries) (UN).[13]

Toxic Substance (World Bank).[15]

US EPA, FIFRA 1998 Status of Pesticides: Supported.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1048).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U122.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: 23/24/25; R34; R40; R43; Safety phrases: S1/2; S26; S36/37/39; S45; S51 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Formaldehyde is a colorless, pungent gas. The odor threshold is 0.8 ppm.[41] Formalin is an aqueous solution that is 37% formaldehyde by weight; inhibited solutions (added to prevent polymerization) usually contain 6−12% methyl alcohol. Molecular weight = 30.30; Specific gravity (H_2O:1) = 0.78; (formalin) 1.08 at 25°C; Boiling point (gas) = −19.5°C. The 37% commercial solution BP = 101°C; Freezing/Melting point = −92.2°C; Relative vapor density (air = 1) = 1.04; Vapor pressure = >1 atm; Flash point = Flammable gas; (formalin) 85°C; (commercial 37% solution, 15% methanol) 50°C; Autoignition temperature = 430°C. Explosive limits (gas): LEL = 7.0%; UEL = 73.0%. NFPA 704 M Hazard Identification (gas): Health 3, Flammability 4, Reactivity 0; (37% solution, 15% methanol): Health 3, Flammability 2, Reactivity 2. Good solubility in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Formaldehyde has found wide industrial usage as a fungicide, germicide, and in disinfectants and embalming fluids. It is also used in the manufacture of artificial silk and textiles, latex, phenol, urea, thiourea and melamine resins, dyes and inks, cellulose esters and other organic molecules, mirrors, and explosives. It is also used in the paper, photographic, and furniture industries. It is an intermediate in drug manufacture and is a pesticide intermediate.

Incompatibilities: Pure formaldehyde may polymerize unless properly inhibited (usually with methanol). Forms explosive mixture with air. Incompatible with strong acids, amines, strong oxidizers, alkaline materials, nitrogen dioxide, performic acid, phenols, urea. Reaction with hydrochloric acid forms bis-chloromethyl ether, a carcinogen. Formalin is incompatible with strong oxidizers, alkalis, acids, phenols, urea, oxides, isocyanates, caustics, anhydrides.

Permissible Exposure Limits in Air

OSHA PEL: 0.75 ppm TWA; 2 ppm STEL, suspected carcinogen, see 29CFR1910.1048(c).

NIOSH REL: 0.016 ppm TWA; 0.1 ppm Ceiling Concentration [15 min.]; potential carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] 0.3 ppm/0.37 mg/m^3; sensitizer; Ceiling Concentration, Suspected Human Carcinogen.

NIOSH IDLH: 20 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.3 ppm

PAC-1: **0.90** ppm

PAC-2: **14** ppm

PAC-3: **56** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.3 ppm/0.37 mg/m^3 TWA; Peak Limitation Category I(2) a momentary value of 1 ppm/1.2 mg/m^3 should not be exceeded; [skin: danger of sensitization]; Carcinogen Category 4; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 2 ppm (3 mg/m^3), 1993; Australia: TWA 1 ppm (1.5 mg/m^3); STEL 2 ppm, carcinogen, 1993; Austria: MAK 0.5 ppm (0.6 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 1 ppm (1.2 mg/m^3); STEL 2 ppm, carcinogen, 1993; Denmark: TWA 0.3 ppm (0.4 mg/m^3), 1999; France: VME 0.5 ppm, VLE 1 ppm, carcinogen, 1999; Hungary: STEL 0.6 mg/m^3, carcinogen, 1993; the Netherlands: MAC-TGG 1.5 mg/m^3, 2003; Norway: TWA 0.5 ppm (0.6 mg/m^3), 1999; the Philippines: TWA 5 ppm (6 mg/m^3), 1993; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1 mg/m^3, 1999; Russia: TWA 0.5 ppm; STEL 0.5 mg/m^3, [skin], 1993; Sweden: NGV 0.5 ppm (0.6 mg/m^3), TGV 1 ppm (1.2 mg/m^3), [skin], 1999; Switzerland: MAK-(W) 0.5 ppm (0.6 mg/m^3), KZG-(W) 1 ppm (1.2 mg/m^3), 1999; Thailand: TWA 3 ppm; STEL 5 ppm, 1993; Turkey: TWA 5 ppm (6 mg/m^3), 1993; United Kingdom: TWA 2 ppm (2.5 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.3 ppm (sensitizer). Russia has also set MAC values of 0.035 mg/m^3 for ambient air in residential areas on a momentary basis and 0.012 mg/m^3 on a daily average basis,[43] also cited as 0.003 mg/m^3.[35] Several states have set guidelines or standards for formaldehyde in ambient air[60] ranging from zero (North Carolina and North Dakota) to 0.77 μg/m^3 (Massachusetts) to 5.0 μg/m^3 (New York) to 7.2 μg/m^3 (Pennsylvania) to 7.5 μg/m^3 (South Carolina) to 12.0 μg/m^3 (Connecticut, South Dakota and Virginia) to 18.0 μg/m^3 (Indiana) to 71.0 μg/m^3 (Nevada) to 75.0 μg/m^3 (Washington).

Determination in Air: Use NIOSH (IV), Method #2016, #2541, #3500, #3800. OSHA Analytical Method ID-205, ID-52.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 41.4 μg/L based on health effects. Russia set a MAC of 0.01 mg/L,[43] in water bodies used for domestic purposes also quoted as 0.05 mg/L.[35] Further, they have set a MAC of 0.25 mg/L in water bodies used for fishery purposes. Several states have set guidelines for formaldehyde in drinking water[61] ranging from 0.7 μg/L (New Jersey)[59] to 10.0 μg/L (Maryland) to 30.0 μg/L (California and Maine).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Acute exposure to formaldehyde may result in burns to the skin, eyes, and mucous membranes, lacrimation (tearing), nausea, vomiting (may be bloody), abdominal pain, and diarrhea. Difficulty in breathing, cough, pneumonia, and pulmonary edema may occur. Sensitized people may experience asthmatic reactions, even when exposed briefly. Hypotension (low blood pressure) and hypothermia (reduced body temperature) may precede cardiovascular collapse. Lethargy, dizziness, convulsions, and coma may be noted. Nephritis (inflammation of the kidneys), hematuria (bloody urine), and liver toxicity have been reported. Exposure at concentrations well above the PEL may cause death. The effects may be delayed. *Note:* There is considerable individual variation in sensitivity to formaldehyde.

Inhalation: Irritation of the nose and throat can occur after an exposure of 0.25−0.45 ppm. Levels between 0.4 and 0.8 ppm can give rise to coughing and wheezing, tightness of the chest, and shortness of breath. Sudden exposures to concentrations of 4 ppm may lead to irritation of lung and throat severe enough to give rise to bronchitis and laryngitis. Breathing may be impaired at levels above 100 ppm and serious lung damage may occur at 50 ppm. *Skin:* Direct contact with the liquid can lead to irritation, itching, burning and drying. It is also possible to develop an allergic reaction to the compound following exposure by any route. *Eyes:* Exposure to airborne levels of formaldehyde of 0.4 ppm has brought on tearing and irritation. Small amounts of liquid splashed in the eye can cause damage to the cornea. Eye irritation was reported at levels between 0.05 and 2.0 ppm. *Ingestion:* As little as 1 liquid ounce has resulted in death to humans. Smaller amounts can damage the throat, stomach, and intestine resulting in nausea, vomiting, abdominal pain, and diarrhea. Accidental exposure may also cause loss of consciousness, lowered blood pressure, kidney damage and, if the person is pregnant, the possibility of the fetus being aborted.

Long Term Exposure: Inhalation can result in respiratory congestion with associated coughing and shortness of breath. Repeated skin contact can lead to drying and scaling. Some individuals may experience allergic reactions after initial contact with the chemical. Subsequent contact may cause skin rashes and asthma; and reactions may become more severe if exposure persists. Long-term inhalation of high levels of formaldehyde vapor (14 ppm) in rats resulted in an elevated incidence of cancer of the nose. Genetic damage from exposure has been shown in bacteria and some insects. Whether it affects humans is uncertain. May be carcinogenic to humans.

Points of Attack: Eyes, respiratory system. *Cancer site:* nasal cavity.

Medical Surveillance: OSHA Mandated Medical Tests: pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), forced expiratory flow rate. NIOSH lists the following tests: pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), forced expiratory flow rate; whole blood (chemical/metabolite); chest X-ray; pulmonary function tests: pre- and postshift photopatch testing; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Prevention of intoxication may be easily accomplished by supplying adequate ventilation and protective clothing. Barrier creams may also be helpful. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Formalin (as formaldehyde): Prevent skin contact. **8 h:** butyl rubber (gloves, suits, boots), nitrile rubber (gloves, suits, boots), Viton™ (gloves, suits), Saranex™ coated suits, Barricade™ coated suits; CPF3™ suits; **4 h:** Teflon™ (gloves, suits, boots), 4H™ and Silver Shield™ gloves, Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Formaldehyde (1910.1048)*: *≤7.5 ppm (10 × PEL)*: Full-face-piece respirator with cartridges or canisters specifically approved for protection against formaldehyde. A half-mask respirator with cartridges specifically approved for protection against formaldehyde can be substituted for the full-face-piece respirator providing that effective gas-proof goggles are provided and used in combination with the half-mask respirator. *≤75 ppm (100 × PEL)*: (1) Full-face mask respirator with chin-style or chest- or back-mounted type with industrial size canister specifically approved for protection against formaldehyde or (2) type C supplied-air respirator, demand type or continuous-flow type, with full face-piece, hood, or helmet. *>75 ppm (100 × PEL)* or unknown concentrations (emergencies): (1) Self-contained breathing apparatus with positive-pressure full-face-piece or (2) combination supplied-air, full-face-piece positive-pressure respirator with auxiliary self-contained air supply.

Firefighting: Self-contained breathing apparatus with positive-pressure in full face-piece. *Escape* (1) Self-contained breathing apparatus in demand or pressure-demand mode or (2) full-face mask respirator with chin-style or front- or back-mounted type industrial size canister specifically approved for protection against formaldehyde.

Storage: Color Code-—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Formaldehyde must be stored to avoid contact with oxidizers (such as permanganates, nitrates, peroxides, chlorates, and perchlorates) and alkaline materials since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flames.

Sources of ignition, such as smoking and open flames, are prohibited where formaldehyde is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers. Procedures for handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Formaldehyde, solutions, with not <25% formaldehyde require a label of "CORROSIVE." Formaldehyde, solutions, flammable, require a label of "CORROSIVE, FLAMMABLE LIQUID." Nonflammable solutions are in Hazard Class 8 and flammable solutions are in Hazard Class 3; both are in Packing Group III.

Spill Handling: Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors; do not get water inside container. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Use fluorocarbon water spray, cellosize, and hycar to diminish vapors. Use sodium carbonate, ammonium hydroxide, or sodium sulfite to neutralize spill. Use universal gel, fly ash, universal sorbent material, or cement powder to absorb the spill. Keep formaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or a combustible liquid. Poisonous gases are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Do not get water inside container. Spray cooling water on containers exposed to flames until well after fire is out. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in solution of combustible solvent.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

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New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Formaldehyde*. Trenton, NJ

Formaldehyde cyanohydrin F:0420

Molecular Formula: C_2H_3NO
Common Formula: $HOCH_2CN$
Synonyms: Cyanomethanol; Formaldehido cianhidrina (Spanish); Glycolonitrile glyconitrile; Glycolic nitrile; α-Hydroxyacetonitrile; 2-Hydroxyacetonitrile; Hydroxyacetonitrile; α-Hydroxymethylcyanide; Hydroxymethylinitrile; Methylene cyanohydrine
CAS Registry Number: 107-16-4
RTECS® Number: AM0350000
UN/NA & ERG Number: UN3276 (nitriles, toxic, n.o.s.)/151; UN2810 (Toxic liquid, organic, n.o.s.)/153
EC Number: 203-469-1
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9040.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Formaldehyde cyanohydrin is a colorless, odorless oily liquid with a sweetish taste. Molecular weight = 57.06; Boiling point = 186°C (slight decomposition); Freezing/Melting point $\leq -72°C$; Flash point $\geq 93°C$. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 2. Soluble in water.
Potential Exposure: Compound Description: Primary Irritant. This material is used in the manufacture of intermediates in pharmaceutical production and as a component of synthetic resins as a chemical intermediate for organic compounds, and as a solvent.
Incompatibilities: Alkalis and exposure to heat. Traces of alkalis promote violent polymerization.
Permissible Exposure Limits in Air
NIOSH REL: (nitriles) 2 ppm/5 mg/m^3 Ceiling Concentration, not to be exceeded in any 15-min work period.
Protective Action Criteria (PAC)
TEEL-0: 0.125 ppm
PAC-1: 0.35 ppm
PAC-2: 2.57 ppm
PAC-3: 4 ppm
Sweden: NGV 1 ppm (5 mg/m^3), KTV 2 ppm (10 mg/m^3), [skin], 1993; Turkey: TWA 1 ppm (5 mg/m^3); STEL 2 ppm, [skin], 1993.
Determination in Air: No test available.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates eyes, skin, respiratory system. The symptoms are similar to cyanide poisoning. Odor of bitter almonds on patient's breath may or may not be present. Headache, dizziness, weakness, giddiness, confusion, convulsions, vertigo, dyspnea (breathing difficulty), abdominal pain, nausea, and vomiting may follow exposure. Respiration may initially be rapid, then slow and labored, followed by coma and convulsions. This material is extremely toxic. Exposure by any route should be avoided; may have fatal consequences; death from asphyxiation may occur similar to that resulting from hydrogen cyanide.
Long Term Exposure: Repeated exposure may cause personality changes of depression, anxiety, or irritability. Prolonged or repeated exposure may damage the nervous system, affect respiratory system, cardiovascular system.
Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system.
Medical Surveillance: Blood test for cyanide. Examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. *Speed in removing material from skin is of extreme importance.* Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles.*
Respirator Selection: NIOSH: *up to 20 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 50 ppm:*

Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 100 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 250 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator[52] under an inert atmosphere and away from all alkaline materials. Where possible, automatically pump liquid from storage containers to process containers.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS” It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Build dikes to contain flow as necessary. Use water spray to disperse vapors and dilute standing pools of liquid. Avoid breathing vapors. Keep upwind. Avoid bodily contact with the material. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

Toxic liquid, organic, n.o.s.; when used as a weapon

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.1/1.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 3.0
Night 4.6

Nitriles, toxic, liquid, n.o.s.

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including cyanides and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or halon extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Formaldehyde Cyanohydrin*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Glycolonitrile*. Trenton, NJ

Formamide F:0430

Molecular Formula: CH_3NO
Common Formula: $HCONH_2$
Synonyms: Carbamaldehyde; Formic acid amide; Methanamide
CAS Registry Number: 75-12-7
RTECS® Number: LQ0525000
EC Number: 200-842-0 [*Annex I Index No.:* 616-052-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: Not listed. Carcinogenesis studies; test completed (peer review), October 2000.

US EPA Gene-Tox Program, Negative: Cell transform.—RLV F344 rat embryo.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA).[32]

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R61; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Formamide is a colorless, viscous liquid with a faint ammonia odor. Molecular weight = 45.05; Specific gravity (H_2O:1) = 1.13; Boiling point = (decomposes) 210.5°C; Freezing/Melting point = 2.5°C; Vapor pressure = 0.1 mmHg at 30°C; Flash point = 154°C.[17] Autoignition temperature ≥500°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Good solubility in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Formamide is a powerful solvent. It is also used as an intermediate in pharmaceutical manufacture. It may be pyrolyzed to give HCN.

Incompatibilities: Forms hydrocyanic acid with water solutions. Hygroscopic (absorbs moisture from air). Incompatible with nonoxidizing mineral acids, strong acids, ammonia, cresols, iodine, isocyanates, oleum, phenols, pyridine, sulfur trioxide, oxidizers, iodine, pyridine. Formamide decomposes on heating at 180°C forming ammonia, water, carbon monoxide, and hydrogen cyanide. Attacks metals, such as aluminum, iron, copper, brass, lead, and natural rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.85 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 10 ppm/15 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 10 ppm/18 mg/m^3 TWA [skin].
Protective Action Criteria (PAC)
TEEL-0: 10 ppm
PAC-1: 20 ppm
PAC-2: 125 ppm
PAC-3: 1250 ppm
DFG MAK: [skin]; No numerical value established.

Australia: TWA 10 ppm (15 mg/m^3), [skin], 1993; Belgium: TWA 10 ppm (18 mg/m^3), [skin], 1993; Finland: TWA 20 ppm (37 mg/m^3); STEL 30 ppm (55 mg/m^3), [skin], 1999; France: VME 20 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 16 mg/m^3, 2003; Norway: TWA 10 ppm (18 mg/m^3), 1999; Russia: STEL 3 mg/m^3, 1993; Switzerland: MAK-W 10 ppm (18 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm [skin]. Several states have set guidelines or standards for formamide in ambient air[60] ranging from 100 μg/m^3 (New York) to 300 μg/m^3 (Florida) to 300−450 μg/m^3 (North Dakota) to 480 μg/m^3 (Virginia) to 600 μg/m^3 (Connecticut) to 714 μg/m^3 (Nevada) to 750 μg/m^3 (South Carolina).

Determination in Air: No test available.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 414 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Formamide irritates the skin, eyes, and mucous membranes. Contact may cause eye burns. Exposure can cause skin irritation and a rash. May affect the central nervous system.

Long Term Exposure: Formamide may also damage the testes (male reproductive glands). There is limited evidence that formamide is a teratogen in animals and may have toxic effects upon human reproduction.

Points of Attack: Eyes, skin, respiratory system, central nervous system, reproductive system.

Medical Surveillance: There is no special test for this chemical. However if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 20 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and other incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep formamide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam extinguishers. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent and dispose by burning in a furnace equipped with an alkali scrubber for the exit gases.[22]

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 44–45

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Formamide*. Trenton, NJ

Formetanate hydrochloride F:0440

Molecular Formula: $C_{11}H_{16}ClN_3O_2$

Common Formula: $C_{11}H_{15}N_3O_2 \cdot HCl$

Synonyms: Carzol; Carzol SP; Dicarzol; *m*-([(Di-methylamino)methylene]amino)phenylcarbamate, hydrochloride; 3-Dimethylaminomethyleneaminophenyl-*N*-methylcarbamate, hydrochloride; *N*,*N*-Dimethyl-*N*′-([(methylamino)carbonyl]oxy)phenylmethanimidamide monohydrochloride; ENT 27,566; EP-332; Formetanate hydrochloride; Morton EP332; NOR-AM EP 332; Schering 36056; SN 36056

CAS Registry Number: 23422-53-9

RTECS® Number: FC2514000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 245-656-0 [*Annex I Index No.:* 006-052-00-0]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P198.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 100 lb (45.4 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as formetanate.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26; R28; R43; R50/53; Safety phrases: S1/2; S24; S28; S37/39; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Formetanate hydrochloride is a white or yellowish, crystalline solid or powder with a faint odor. Molecular weight = 257.75; Freezing/Melting point = 200°C–202°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Food Additive. Those involved in the manufacture, formulation, and application of this plant insecticide, acaricide, and miticide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 3.5 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 18 mg/m^3
PAC-3: 18 mg/m^3

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Diarrhea, nausea, vomiting, excessive salivation, headache, pinpoint pupils, and uncoordinated muscle movements are all common symptoms. Extremely toxic to humans. Not absorbed through contact with skin. Inhalation or ingestion may cause poisoning. Inhibits cholinesterase activity; so effects are in relation to action on nervous system and can result in death.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This material falls under Carbamate pesticides, solid, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind and keep out of low areas. Do not touch spilled material or breathe the dust, vapors, or fumes from burning materials. Do not handle broken packages without protective equipment. Wash away any material that may have contacted the body with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire, as the material itself does not burn or burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide, or dry chemical. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Formetanate HCl*. Washington, DC: Chemical Emergency Preparedness Program

Formic acid F:0450

Molecular Formula: CH_2O_2
Common Formula: HCOOH
Synonyms: Acide formique (French); Acido formico (Spanish); ADD-F; AI3-24237; Amasil; Ameisensaeure (German); Aminic acid; Bilorin; Collo-Bueglatt; Collo-Didax; Formisoton; Formylic acid; Hydrogen carboxylic acid; Methanoic acid; Myrmicyl
CAS Registry Number: 64-18-6
RTECS® Number: LQ4900000
UN/NA & ERG Number: UN1779/153
EC Number: 200-579-1 [*Annex I Index No.:* 607-001-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): U123.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R35; Safety phrases: S1/2; S23; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Formic acid is a colorless, flammable, fuming liquid, with a pungent odor. Molecular weight = 46.03; Specific gravity = 1.22 (90% solution); Boiling point = 106.7°C (90% solution); Vapor pressure = 35 mmHg at 20°C; Flash point = 69°C; (90% solution) 50°C; Autoignition temperature = 434°C. Explosive limits: LEL = 18%; UEL = 57%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Formic acid is a strong reducing agent and is used as a decalcifier. It is used in pharmaceuticals, in dyeing textiles and finishing color-fast wool, electroplating, coagulating latex rubber, regeneration old rubber, and dehairing, plumping, and tanning leather. It is also used in the manufacture of acetic acid, airplane dope; allyl alcohol; cellulose formate; phenolic resins; and oxalate; and it is used in the laundry, textile, insecticide, refrigeration, and paper industries as well as in drug manufacture.

Incompatibilities: Forms explosive mixture with air. A medium strong acid and a strong reducing agent. Violent reaction with oxidizers, furfuryl alcohol, hydrogen peroxide, nitromethane. Incompatible with strong acids, bases, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Decomposes on heating and on contact with strong acids forming carbon monoxide. Attacks metals such as aluminum, cast iron and steel and also many plastics, rubber and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.88 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/9 mg/m^3 TWA.

NIOSH REL: 5 ppm/9 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/9.4 mg/m^3 TWA; 10 ppm/19 mg/m^3 STEL.

NIOSH IDLH: 30 ppm.

Protective Action Criteria (PAC)*
TEEL-0: 3 ppm
PAC-1: **3** ppm
PAC-2: **25** ppm
PAC-3: **250** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/9.5 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 5 ppm (9 mg/m^3), 1993; Australia: TWA 5 ppm (9 mg/m^3), 1993; Austria: MAK 5 ppm (9 mg/m^3), 1999; Belgium: TWA 5 ppm (9.4 mg/m^3), 1993; Denmark: TWA 5 ppm (9 mg/m^3), 1999; France: VLE 5 ppm (9 mg/m^3), 1999; Hungary: TWA 5 mg/m^3; STEL 8 mg/m^3, 1993; the Netherlands: MAC-TGG 9 mg/m^3, 2003; Norway: TWA 5 ppm (9 mg/m^3), 1999; the Philippines: TWA 5 ppm (9 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 15 mg/m^3, 1999; Russia: TWA 5 ppm; STEL 1 mg/m^3 [skin] 1993; Sweden: TWA 3 ppm (5 mg/m^3); STEL 15 ppm (45 mg/m^3) [skin] 1999; Switzerland: MAK-W 5 ppm (9 mg/m^3); STEL 10 ppm (18 mg/m^3), 1999; United Kingdom: TWA 5 ppm (9.6 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm. Several states have set guidelines or standards for formic acid in ambient air[60] ranging from 30 μg/m^3 (New York) to 90 μg/m^3 (Florida and North Dakota) to 150 μg/m^3 (Virginia) to 180 μg/m^3 (Connecticut) to 214 μg/m^3 (Nevada) to 225 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2011 or OSHA Analytical Method ID-186 SG.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 124 μg/L based on health effects.

Determination in Water: Octanol−water partition coefficient: Log $P_{ow} = 0.41$.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Formic acid is very corrosive to the eyes, skin, and respiratory tract. *Inhalation:* Workers exposed to 15 ppm experience nausea. Other symptoms include irritation of the nose, throat, and lungs, coughing, runny nose, and tearing eyes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Concentrated solutions may cause severe irritation, burning and blistering. Accidental exposure has resulted in death. *Eyes:* May cause irritation and tearing. Concentrated solutions may cause severe chemical burns. *Ingestion:* Corrosive. May affect the energy metabolism, causing acidosis. May cause salivation, vomiting, burning sensation in the mouth, vomiting of blood, diarrhea, and pain. In severe cases, a person may go into shock and develop difficulty in breathing. Death may result. Animal data suggest that ingestion of about 3 oz may be fatal to a 150-lb individual.

Long Term Exposure: Prolonged or repeated exposure to formic acid may cause skin irritation and allergy with rash and itching. May affect the kidneys. May cause genetic changes in living cells.

Points of Attack: Respiratory system, lungs, skin, kidneys, liver, eyes.

Medical Surveillance: Consideration should be given to possible irritant effects on the skin, eyes, and lungs in any placement or periodic examinations. Lung function tests. Kidney function tests checking for blood and urine. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h:** butyl rubber (gloves, suits, boots), Neoprene™ rubber (gloves, suits, boots), Saranex™ coated suits, Barricade™ coated suits; Responder™ suits, Trellchem HPS™ suits; **4 h:** polyvinyl chloride (gloves, suits, boots), Teflon™ (gloves, suits, boots). Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Keep in sealed containers in well-ventilated area. Protect from heat or flame and materials listed above under "Incompatibilities." Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added solvent.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Formic Acid, Health and Environmental Effects Profile No. 105*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 39−41 (1980) and 3, No. 4, 53−56 (1983)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Formic Acid*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Formic Acid*. Trenton, NJ

Formothion F:0460

Molecular Formula: $C_6H_{12}NO_4PS_2$

Common Formula: $(CH_3O)_2PSSCH_2CON(CH_3)CHO$

Synonyms: Aflix; Anthio; Antio; Carbamoylmethyl phosphorodithioate; CP 53926; *O*,*O*-Dimethyldithiophosphorylacetic acid *n*-methyl-*N*-formylamide; *O*,*O*-Dimethyl *S*-(*N*-formyl-*N*-methylcarbamoylmethyl) phosphorodithioate; *O*,*O*-Dimethyl-*S*-(3-methyl-2,4-dioxo-3-aza-butyl)-dithiophosphat (German); *O*,*O*-Dimethyl-*S*-(*N*-methyl-*N*-formyl-carbamoylmethyl)-dithiophosphat (German); *O*,*O*-Dimethyl *S*-(*N*-methyl-*N*-formylcarbamoylmethyl) dithiophosphate; *O*, *O*-Dimethyl *S*-(*N*-methyl-*N*-formylcarbamoylmethyl) phosphorodithioate; *O*,*O*-Dimethyl phosphorodithioate *n*-formyl-2-mercapto-*N*-methylacetamide *S*-ester; ENT 27,257; Formotion (Spanish); *S*-[2-(Formylmethylamino)-2-oxoethyl] *O*,*O*-dimethyl phosphorodithioate; *n*-Formyl-*N*-methylcarbamoylmethyl *O*,*O*-dimethyl phosphorodithioate; *S*-(*N*-Formyl-*N*-methylcarbamoylmethyl) *O*,*O*-dimethyl phosphorodithioate; *S*-(*N*-Formyl-*N*-methylcarbamoylmethyl) dimethyl phosphorodithiolothionate; S 6900; SAN 244 I; SAN 6913 I; SAN 71071; Spencer S-6900; VEL 4284

CAS Registry Number: 2540-82-1

RTECS® Number: TE1050000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 219-818-6 [*Annex I Index No.:* 015-057-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Formothion is an odorless, yellowish viscous oil or crystalline mass. Molecular weight = 257.28; Freezing/Melting point = 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. An insecticide and acaricide on crops and ornamentals. It is not produced commercially in the United States at this time.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.27 mg/m^3

PAC-3: 500 mg/m^3

Russia[35,43] set a MAC of 0.5 mg/m^3 in work-place air and a MAC of 0.01 mg/m^3 in ambient air in residential areas on a momentary basis and 0.006 mg/m^3 on a daily average basis.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.004 mg/L in water bodies used for domestic purposes (4 μg/L).

Routes of Entry: Inhalation, absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Early symptoms of poisoning include: headache, dizziness, weakness, perspiring, nausea, vomiting, and sensation of tightness in chest. Chronic low doses may produce symptoms similar to influenza. Formothion is one of the least toxic systemic organophosphates. Formothion is a compound of low to moderate toxicity. It causes the depression of cholinesterase leading to accumulation of acetylcholine in the nervous system, which is believed to be responsible for the symptoms. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, profound weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline materials. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This falls under organophosphorus pesticides, liquid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; keep leak contained, if you can do so without risk. Use water spray to reduce vapor. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel, place material into clean, dry containers and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. When heated to decomposition, it emits very toxic fumes of nitrogen oxides, phosphorus oxides, and sulfur oxides. This compound is an organophosphorus insecticide. Some of these materials may burn but none of them ignite readily. Fire and runoff from fire control water may produce irritating or poisonous gases. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Formothion*. Washington, DC: Chemical Emergency Preparedness Program

Fosthietan F:0470

Molecular Formula: $C_6H_{12}NO_3PS_2$

Synonyms: AC 64475; Acconem; CL64475; (Diethoxyphosphinylimino)-1,3-dithietane; Diethoxyphosphinylimino-2-dithietanne-1,3 (French); 1,3-Dithietan-2-ylidenephosphoramidic acid diethyl ester; Geofos; NEM-A-TAK

CAS Registry Number: 21548-32-3

RTECS® Number: NJ6490000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 244-437-7 [*Annex I Index No.:* 015-124-00-0]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: Hazard Symbol: T+; Risk phrases: R27/28; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fosthietan is a pale yellow oil with a mercaptan-like odor. Molecular weight = 241.28; Specific gravity (water = 1) = 1.3 g/cm^3 at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Moderately soluble in water.

Potential Exposure: This material is used as a nematocide and insecticide. Not registered as a pesticide in the United States.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.75 mg/m^3
PAC-1: 2.5 mg/m^3
PAC-2: 4.7 mg/m^3
PAC-3: 4.7 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 4.67 mg/kg. This compound is a liquid organophosphorus insecticide. Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline material. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal.

Fire Extinguishing: This chemical may burn but does not ignite readily. Poisonous gases, including nitrogen, phosphorus, and sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fosthietan*. Washington, DC: Chemical Emergency Preparedness Program

Fuberidazole F:0480

Molecular Formula: $C_{11}H_8N_2O$

Synonyms: Baycor; Bayer 33172; Baytan; Bitertanol, fuberidazole; Fuberidatol; Fuberisazol; Fubridazole; 2-(2-Furanyl)-1H-benzimidazole; Furidazol; Furidazole; 2-(2′-Furyl)-benzimidazole; 2-(2-Furyl)benzimidazole; ICI Baytan; Neovoronit; Sibutol; Sibutrol; Voronit; Voronite; W VII/117

CAS Registry Number: 3878-19-1

RTECS® Number: DD9010000

UN/NA & ERG Number: UN2588/151

EC Number: 223-404-0 [*Annex I Index No.:* 613-016-00-3]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; Safety phrases: S2; S22; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fuberidazole is a crystalline powder. Molecular weight = 184.21; Melting point = 285°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Very slightly soluble in water.

Incompatibilities: Incompatible with acid halides, anhydrides, epoxides, halogenated organics, isocyanates, peroxides, phenols (acidic).

Potential Exposure: Fuberidazole, a benzimidazole, uses include cereal seed dressing and fungicidal, nonmercurial seed dressing with special action against fusarium. Not registered as a pesticide in the United States.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.3 mg/m^3

PAC-3: 12.5 mg/m^3

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Fuberidazole is classified as moderately toxic. Its probable oral lethal dose in humans is 0.5−5 g/kg or between 1 oz and 1 pint for a 70-kg (150-lb) person. LD_{50} = (oral-rat) 1100 mg/kg[9]; LC_{50} = (rat) 0.33 mg/L.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA); or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: A benzimidazole pesticide. Pesticides, solid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a combustible solid. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Fuberidazole*. Washington, DC: Chemical Emergency Preparedness Program

Fumaric acid F:0490

Molecular Formula: $C_4H_4O_4$

Synonyms: Allomaleic acid; Boletic acid; (*E*)-Butenedioic acid; *trans*-Butenedioic acid; 2-Butenedioic acid (*E*); Butenedioic acid, (*E*)-; 1,2-Ethenedicarboxylic acid, *trans*-; *trans*-1,2-Ethylenedicarboxylic acid; 1,2-Ethylenedicarboxylic acid, (*E*); Lichenic acid; NSC-2752; U-1149

CAS Registry Number: 110-17-8

RTECS® Number: LS9625000

UN/NA & ERG Number: Not regulated

EC Number: 203-743-0 [*Annex I Index No.*: 607-146-00-X]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36; Safety phrases: S2; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Fumaric acid is a colorless to white, odorless crystalline powder. Fruity-acidic taste. Molecular weight = 116.08; Specific gravity (H_2O:1) = 1.625; Sublimation temperature = 200°C; Freezing/Melting point = 287°C; Flash point = 230°C; Autoignition temperature = 737°C; Also listed as >156°F/>69°C; Autoignition temperature (dust cloud) = 740°C. Hazard Ranking (based on NFPA 704 M Hazard Identification): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = <1%.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Fumaric acid is used in production of resins, polyesters, plasticizers, and alkyl surface coatings, as a food additive, as an antioxidant in resins, and to make dyes.

Incompatibilities: Dust cloud from powder or granular form mixed with air can explode. Reacts with strong oxidizers. Incompatible with sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin. Decomposes above 350°C forming irritating fumes of maleic anhydride.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3

PAC-1: 100 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: No test available.

Routes of Entry: Inhalation. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract.

Long Term Exposure: Repeated exposure may cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials listed above.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including maleic anhydride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Fumaric Acid*. Trenton, NJ

Furan F:0500

Molecular Formula: C_4H_4O

Synonyms: Divinylene oxide; Furano (Spanish); Furfuran; NCI-C56202; Oxacyclopentadiene; Oxole; Tetrole

CAS Registry Number: 110-00-9

RTECS® Number: LT8524000

UN/NA & ERG Number: UN2389/128

EC Number: 203-727-3 [*Annex I Index No.:* 603-105-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1997.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

US EPA Hazardous Waste Number (RCRA No.): U124.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

California Proposition 65 Chemical: Cancer 10/1/93.

European/International Regulations: Hazard Symbol: F+, T, N; Risk phrases: R45; R12; R19; R20/22; R38; R48/22; R68; R52/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Furan is a colorless liquid; turns brown on standing. Strong ether-like odor. Molecular weight = 68.08; Boiling point = 32°C; Freezing/Melting point = −85.65°C; Flash point = −36°C. Explosive limits: LEL = 2.3%; UEL = 14.3%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. Furan is used as a chemical intermediate in the production of herbicides and pharmaceuticals; for making tetrahydrofuran; in formation of lacquers; as a solvent for resins in organic synthesis, especially for pyrrole, thiophene.

Incompatibilities: Forms explosive mixture with air. Violent reaction with acids, oxidizers. Unless stabilized with an inhibitor, air exposure forms unstable peroxides.

Permissible Exposure Limits in Air

AIHA WEEL: Worker exposure by all routes should be minimalized to the fullest extent possible.

Protective Action Criteria (PAC)*

TEEL-0: 1.25 ppm

PAC-1: 4 ppm

PAC-2: **6.8** ppm

PAC-3: **19** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

Russia: STEL 0.5 mg/m^3, [skin] 1993.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.33$.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the skin and eyes. Vapors can irritate the respiratory tract and are a central nervous system depressant. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, dizziness, shortness of breath, unconsciousness, and suffocation. The vapors are narcotic. Acute exposure to furan by inhalation may involve both reversible and irreversible changes. Acute exposure by ingestion or skin absorption, as well as chronic exposure, are associated with high toxicity.

Long Term Exposure: Furan may be a carcinogen since it has been shown to cause cancer of the liver and white blood cells in animals. May cause skin allergy. May damage the liver and kidneys.

Points of Attack: Skin, liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator.[52] Keep in a tightly closed container under an inert atmosphere and protect from light for long-term storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid breathing vapors. Keep upwind. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. The exposure concentration limit of 10 ppm together with the low boiling point of furan requires that adequate ventilation be provided in areas handling this chemical. Establish forced ventilation to keep levels below explosive limit. Contact with liquid must be avoided since this chemical can be absorbed through the skin. Keep furan out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Thorough washing with soap and water followed by prolonged rinsing should be done immediately after accidental contact. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Water may be ineffective. *Small fires:* use dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if this can be accomplished without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fires in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for ½ mile in all directions if a tank car or truck is involved. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 3, 93−95

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Furan*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Furan*. Trenton, NJ

Furfural F:0510

Molecular Formula: $C_5H_4O_2$

Synonyms: Artificial Ant oil; Fural; 2-Furaldehyde; Furale; 2-Furanaldehyde; 2-Furancarbonal; 2-Furancarboxaldehyde; Furfuraldehyde; α-Furole; Furole; 2-Furyl-methanal; NCI-C56177; Oil of ants, artificial; Pyromucic aldehyde

CAS Registry Number: 98-01-1

RTECS® Number: LT7000000

UN/NA & ERG Number: UN1199/132

EC Number: 202-627-7 [*Annex I Index No.*: 605-010-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, 1995; US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test NTP: Carcinogenesis Studies (gavage); some evidence: rat; NCI: Carcinogenesis Studies (gavage); equivocal evidence: rat; clear evidence: mouse.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U125.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21/22; R23; R36/37; R40; R48/20; Safety phrases: S1/2; S36/37; S S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Furfural is a colorless to yellow aromatic heterocyclic aldehyde with an almond-like odor. Turns amber on exposure to light and air. Molecular weight = 96.09; Boiling point = 161.7°C; Freezing/Melting point = −36.7; Flash point = 60°C; Autoignition temperature = 316°C. Explosive limits: LEL = 2.1%; UEL = 19.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water; solubility = 8%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Furfural is used for lube oil refining and butadiene extraction; as a solvent for wood resin, nitrated cotton, cellulose acetate, and gums; in the production of phenolic plastics, thermosetting resins, refined petroleum oils, dyes, and varnishes; in the manufacture of pyromucic acid, vulcanized rubber, insecticides, fungicides, herbicides, germicides, furan derivatives, polymers, and other organic chemicals.

Incompatibilities: Forms explosive mixture with air. Acids and bases can cause polymerization, causing fire or explosion hazard. Reacts violently with oxidants. Incompatible with strong acids; caustics, ammonia, aliphatic amines; alkanolamines, alromatic amines; oxidizers. Attacks many plastics.

Permissible Exposure Limits in Air

OSHA PEL: 5 ppm/20 mg/m^3 TWA [skin].

NIOSH REL: None, see Appendix D.

ACGIH TLV®[1]: 2 ppm/7.9 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans; BEI: 200 mg/g creatinine, end-of-shift; Total fuoric acid in urine.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **2** ppm

PAC-2: **10** ppm

PAC-3: **100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 2 ppm (8 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (20 mg/m^3), 1999; Belgium: TWA 2 ppm (7.9 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (7.9 mg/m^3), [skin], 1999; Finland: TWA 2 ppm (8 mg/m^3), [skin], 1999; France: VLE 2 ppm (8 mg/m^3), 1999; Japan: 2.5 ppm (9.8 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 8 mg/m^3, 2003; Norway: TWA 2 ppm (8 mg/m^3), 1999; the Philippines: TWA 5 ppm (20 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 40 mg/m^3, 1999; Russia: TWA 2.5 ppm; STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (8 mg/m^3), KTV 5 ppm (20 mg/m^3), [skin], 1999; Switzerland: MAK-W 2 ppm (8 mg/m^3), [skin], 1999; Turkey: TWA 5 ppm (20 mg/m^3), [skin], 1993; United Kingdom: TWA 2 ppm (8 mg/m^3); STEL 5 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic: MAC 2.5 ppm. Russia[35, 43] set a MAC of 0.05 mg/m^3 in ambient air of residential areas both on a momentary and on a daily average basis. Several states have set guidelines or standards for furfural in ambient air[60] ranging from 26.7 μg/m^3 (New York) to 80.0 μg/m^3 (Florida) to 160.0 μg/m^3 (Connecticut) to 190 μ/m^3 (Nevada) to 200.0 μg/m^3 (South Carolina) to 80.0−400.0 μg/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #2529 or OSHA Analytical Method 72.

Permissible Concentration in Water: Russia[35,43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause skin irritation, causing rash and a burning sensation. Liquid and concentrated vapor are irritating to the eyes, skin, upper respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Workers chronically exposed to the vapor have had complaints of headache, fatigue, itching of the throat, lacrimation, loss of the sense of taste, numbness of the tongue, and tremor. Occupational overexposure is relatively rare due to the liquid's low vapor pressure, and symptoms usually disappear rapidly after removal from exposure.

Long Term Exposure: Eczematous dermatitis as well as skin sensitization, resulting in allergic contact dermatitis and photosensitivity, may develop following repeated exposure. The substance may have effects on the liver. Furan causes mutations. Repeated exposure may cause loss of taste, numbness of the tongue, and may cause headaches, tiredness, tremors, itchy throat, watery eyes. Long-term exposure may cause skin to sunburn more easily.

Points of Attack: Eyes, respiratory system, skin.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift. For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h:** butyl rubber (gloves, suits, boots), 4H™ and Silver Shield™ gloves; Barricade™ coated suits; CPF3™ suits, Trellchem HPS™ suits; Trychem 1000™ suits; **4 h:** PVA, Saranex™ coated suits. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *50 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or

SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Furfural must be stored to avoid contact with oxidizing materials (such as perchlorates, peroxides, chlorates, nitrates, and permanganates) and strong acids because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where furfural is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep furfural out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 41−42 (1980) and 7, No. 3, 96−102 (1987)

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Furfural*. Trenton, NJ

Furfuryl alcohol F:0520

Molecular Formula: $C_5H_6O_2$

Common Formula: $C_4H_3OCH_2OH$

Synonyms: Alcohol furfurilico (Spanish); Alcool furfurylique (French); 2-Furancarbinol; 2-Furanmethanol; Furfural alcohol; Furfuralcohol; Furfurylalkohol (German); Furylalcohol; 2-Furylcarbinol; 2-Hydroxymethylfuran; Microposit remover 1112A; NCI-C56224

CAS Registry Number: 98-00-0

RTECS® Number: LU9100000

UN/NA & ERG Number: UN2874/153

EC Number: 202-626-1[*Annex I Index No.:* 603-018-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies (inhalation): some evidence: mouse, rat; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21/22; R23; R36/37; R40; R48/20; Safety phrases: S1/2; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Furfural alcohol is a colorless to amber liquid that darkens on exposure to light. It has a faint, burning odor. Molecular weight = 98.11; Specific gravity

(H_2O:1) = 1.13; Boiling point: 171°C; Melting point: −15°C; Vapor pressure = 6 mmHg at 25°C; Flash point = 65°C (cc); 75°C (oc); Autoignition temperature = 491°C. Explosive limits: LEL = 1.8%; UEL = 16.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Primary Irritant. Used as a starting monomer in the production of furan resins and used to produce tetrahydrofurfural alcohol (THFA).

Incompatibilities: Violent reaction with strong oxidizers. Contact with acids can cause polymerization. Strong reaction with oxidizers. Incompatible with alkaline earth and alkali metals; strong caustics; aliphatic amines; isocyanates, acetaldehyde, benzoyl peroxide; chromic acid, chromium trioxide; cyanoacetic acid; dialkylzincs, dichlorine oxide; ethylene oxide; hydrogen peroxide; isopropyl chlorocarbonate; lithium tetrahydroaluminate; nitric acid; nitrogen dioxide; pentafluoroguanidine, phosphorus pentasulfide; tangerine oil; triethylaluminum, triisobutylaluminum. Attacks some plastics, coatings, and rubber.

Permissible Exposure Limits in Air

OSHA PEL: 50 ppm/200 mg/m^3 TWA [skin].

NIOSH REL: 10 ppm/40 mg/m^3 TWA; 15 ppm/60 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 10 ppm/40 mg/m^3 TWA; 15 ppm/60 mg/m^3 STEL [skin].

NIOSH IDLH: 75 ppm.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 15 ppm

PAC-2: 15 ppm

PAC-3: 75 ppm

DFG MAK: 10 ppm/41 mg/m^3 TWA; Peak Limitation Category I(1) [skin].

Australia: TWA 10 ppm (40 mg/m^3); STEL 15 ppm, [skin], 1993; Austria: MAK 5 ppm (20 mg/m^3), 1999; Belgium: TWA 10 ppm (40 mg/m^3); STEL 15 ppm, [skin], 1993; Denmark: TWA 5 ppm (20 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (20 mg/m^3); STEL 10 ppm (40 mg/m^3), [skin], 1999; France: VME 10 ppm (40 mg/m^3), [skin], 1999; Hungary: STEL 8 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 20 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (20 mg/m^3), 1999; the Philippines: TWA 50 ppm (200 mg/m^3), 1993; Russia: TWA 5 ppm; STEL 0.5 mg/m^3, [skin], 1993; Sweden: NGV 5 ppm (20 mg/m^3), KTV 10 ppm (40 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (40 mg/m^3), [skin], 1999; Turkey: TWA 50 ppm (200 mg/m^3), 1993; United Kingdom: TWA 5 ppm (20 mg/m^3); STEL 15 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm [skin].

Determination in Air: Use NIOSH Analytical Method #2505.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.28$.

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Causes tearing of the eyes, dizziness, nausea, diarrhea, diuresis, vomiting, dermatitis. High exposures may cause respiratory and body temperature depression, with a lowering of consciousness.

Long Term Exposure: Removes the skin's natural oils, causing redness and itching. May affect the central nervous system.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: NIOSH lists the following tests: expired air; pulmonary function tests. Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. **8 h:** 4H™ and Silver Shield™ gloves. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *75 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Metal containers involving the transfer of 5 gallons or more of ethyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl acetate. Store in containers that are properly labeled with health hazard information and safe handling procedures. Wherever ethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Furfuryl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and any acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where furfuryl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever furfuryl alcohol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a more flammable solvent.

References

National Institute for Occupational Safety and Health. (1977). *Information Profiles on Potential Occupational Hazards: Furfuryl Alcohol*, Report PB-276,678. Rockville, MD. pp. 12−15

National Institute for Occupational Safety and Health. (1979). *Criteria for a Recommended Standard: Occupational Exposure to Furfuryl Alcohol*, NIOSH Document No. 79-133

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Furfuryl Alcohol*. Trenton, NJ

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 6, 56−60

G

Gallium G:0050

Molecular Formula: Ga
Synonyms: Elemental gallium
CAS Registry Number: 7440-55-3
RTECS® Number: LW8600000
UN/NA & ERG Number: UN2803
EC Number: 231-163-8

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Gallium is a lustrous, silvery liquid, metal or gray solid. Molecular weight = 69.72; Boiling point = 2403°C; Freezing/Melting point = 30°C. Hazard Identification (based on NFPA-704 M Rating System): (metal) Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in preparing semiconductor compounds such as gallium arsenide. Used in light-emitting diodes, batteries, microwave equipment.

Incompatibilities: Violent reaction with acids, halogens.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 10 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 250 mg/m^3

Routes of Entry: Inhalation, ingestion, skin, and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Gallium can affect you when breathed in. Gallium is a corrosive chemical and exposure can irritate or burn the eyes, nose, and throat. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Repeated or high exposures can cause metallic taste; nausea, vomiting, skin rash and may damage the kidneys.

Long Term Exposure: May cause kidney damage. Some gallium compounds affect the nervous system. Highly irritating substances, such as gallium, may affect the lungs.

Points of Attack: Kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids. *Skin Contact:* Remove contaminated clothing. Wash contaminated skin with water. *Breathing:* Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If swallowed, do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to solid gallium, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for exposure to liquid gallium or high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Gallium must be stored to avoid contact with acids and halogens, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. If material or contaminated runoff enters waterways, notify downstream users of potentially

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00007-2

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Gallium.* Trenton, NJ

Gallium trichloride G:0075

Molecular Formula: Cl_3Ga

Common Formula: $GaCl_3$

Synonyms: Gallium chloride; Gallium(3 +) chloride; Gallium(III) chloride; Tricloruro de galio (Spanish)

CAS Registry Number: 13450-90-3

RTECS® Number: LW9100000

UN/NA & ERG Number: UN1759 (corrosive solids, n.o.s.)/154

EC Number: 236-610-0

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Gallium trichloride is a colorless solid which forms needle-like crystals. Acidic odor. Molecular weight = 176.03; Boiling point = 201°C; Freezing/Melting point = 77.9°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Moisture sensitive. Extremely soluble in water.

Incompatibilities: Keep away from strong oxidizers, active metals, water.

Potential Exposure: Compound Description: Mutagen. Used as a raw material in the production of metallic gallium; and in the processing of monocrystal, semiconductor compounds.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 6 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 32 mg/m^3

PAC-3: 100 mg/m^3

Routes of Entry: Inhalation, skin, eyes.

Harmful Effects and Symptoms

Short Term Exposure: May act on skin or mucous membranes. May cause rash and neuritis. Can cause respiratory center paralysis and death in animals.

Points of Attack: Skin.

Medical Surveillance: In view of the toxicity of gallium and its compounds, as shown by experiments, all persons involved in work with these substances should undergo periodic medical examinations, during which special attention should be paid to the condition of the liver, respiratory organs, and skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Gallium Trichloride.* Washington, DC: Chemical Emergency Preparedness Program

Gasoline G:0100

Molecular Formula: C_5H_{12} to C_9H_{20}

Synonyms: Benzine; Essance (French); Gasolina (Spanish); Motor fuel; Motor spirits; Natural gasoline; Petrol

CAS Registry Number: 8006-61-9; 86290-81-5 [A complex combination of hydrocarbons consisting primarily of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having carbon numbers predominantly greater than C3 and boiling in the range of 30−260°C/86−500°F].

RTECS® Number: LX3300000

UN/NA & ERG Number: UN1203/128

EC Number: 232-349-1 [*Annex I Index No.:* 649-261-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1989; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (Several States).[61]

California Proposition 65 Chemical: Cancer [Unleaded gasoline (wholly vaporized)] 1/1/88; [Gasoline engine exhaust (condensates/extracts)] 10/1/90.

European/International Regulations (*8006-61-9*): Hazard Symbol: F, Xi; Risk phrases: R11; R36; R657; Safety phrases: S2; S7; S16; S24/25; S26; (*86290-81-5*): European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R46; R65; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (CAS: 86290-81-5).

Description: Gasoline is a highly flammable, mobile liquid with a characteristic odor. A complex mixture of volatile hydrocarbons (paraffins, cycloparaffins, and aromatics). Physical property values may vary depending on grade. The odor threshold is 0.25 ppm.[41] Specific gravity = 0.72−0.76 at 16°C; Boiling point = 38°C; Flash point = −45°C to −38 (depending on octane). Explosive limits: LEL = 1.4%; UE = 7.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Human Data; Primary Irritant. Gasoline is used as a fuel, diluent, and solvent throughout industry.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with nitric acid. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.5 mg/m^3 (approx.) at 25°C & 1 atm.

Presently, the composition of gasoline is so varied that a single standard for all types of gasoline is not applicable.[3] It is recommended, however, that atmospheric concentrations should be limited by the aromatic hydrocarbon content.

OSHA PEL: None.

NIOSH REL: Potential occupational carcinogen; See *NIOSH Pocket Guide*, Appendix A; [15 ppm LOQ (*The analytical limit of quantitation)], DHHS #92-100, 1992.

ACGIH TLV®[1]: 300 ppm/890 mg/m^3 TWA; 500 ppm/1480 mg/m^3 STEL; confirmed animal carcinogen with unknown relevance to humans, See *NIOSH Pocket Guide*, Appendix A.

Protective Action Criteria (PAC)*

TEEL-0: 200 ppm

PAC-1: **200** ppm

PAC-2: **1000** ppm
PAC-3: **4000** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Japan; 100 ppm (300 mg/m^3), 1999; Sweden: NGV 200 ppm (800 mg/m^3), KTV 300 ppm (1200 mg/m^3), 1993; Switzerland: MAK week 500 ppm (2000 mg/m^3), 1999; Turkey: TWA 500 ppm (2000 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 500 ppm.

Several states have set guidelines or standards for gasoline in ambient air[60] ranging from 15.0 mg/m^3 (Virginia) to 18.0 mg/m^3 (Connecticut) to 21.429 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #PV2820.

Permissible Concentration in Water: States which have set guidelines for gasoline in drinking water include Rhode Island (zero concentration) and Maine (100 μg/L).

Routes of Entry: Inhalation, percutaneous absorption.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation. Inhalation can cause irritation of the respiratory tract. High levels can cause headache, nausea, dizziness, irregular heartbeat, loss of coordination, seizures, coma, and possible death. *Inhalation:* Nose and throat irritation have been reported after exposure to 900 ppm for 1 h. Drowsiness, dizziness, nausea, and numbness may occur at 1000 ppm after 15 min exposure. In animal studies, death occurred after 30,000 ppm for 5 min. *Skin:* May cause itching and burning of the skin and after a longer exposure, redness and blistering. *Eyes:* Moderate irritation of the eye has been reported after 1 h exposure to 500 ppm. Mild irritation has been reported after an 8 h exposure to 140 ppm. *Ingestion:* Gasoline causes a burning sensation in the mouth, throat, and stomach. Vomiting, diarrhea, drowsiness, and intoxication may follow. As little as 3−4 oz may be fatal. Inhalation of liquid gasoline into the lungs following ingestion or vomiting may result in pulmonary edema (an accumulation of fluid in the lungs and a medical emergency that can be delayed for several hours), rapid breathing or death.

Long Term Exposure: There is evidence that gasoline can cause kidney cancer in animals. Repeated exposure can cause permanent eye damage. Prolonged contact can cause drying of the skin with cracking and rash. Repeated high exposure may damage the lungs; and/or cause brain damage. May cause kidney damage. Gasolines often contain hexane, benzene, and lead. Hexane, a component of gasoline, can produce disturbed sleep; resulting in tremors, numbness of hands and feet, and loss of muscle control. Benzene has been linked to blood disorders in humans, including leukemia. Lead additives can produce nausea, cramps, loss of appetite, sleep problems, headaches, and agitation. See also entries for *tetraethyl lead, benzene, hexane, and ethylene dibromide.*

Points of Attack: Kidneys, skin, eyes, nervous system, brain. Cancer site in animals: liver, kidney.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: urinary lead level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If swallowed, use gastric lavage (stomach wash) followed by saline catharsis. Get medical attention. Medical observation is recommended for 24−48 h after ingestion, as pulmonary edema may be delayed.

Personal Protective Methods: Barrier creams and impervious gloves. Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h:** nitrile rubber gloves, suits, boots; Viton™ gloves, suits; Barricade™ coated suits; **4 h:** polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash, protective clothing, masks in heavy exposure to vapors.

Respirator Selection: Where there is potential for exposure over 300 ppm, use a NIOSH/MSHA- or European Standard EN149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained

on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Sources of ignition, such as smoking and open flames, are prohibited where gasoline is handled, used, or stored. Metal containers involving the transfer of 1 gallon or more of gasoline should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of gasoline. Wherever gasoline is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Alternatively, gasoline vapors may be recovered from fuel transfer operations by various techniques.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Gasoline*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 75−76

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Gasoline*. Trenton, NJ

Germanium G:0110

Molecular Formula: Ge

Synonyms: Elemental germanium; Germanium element

CAS Registry Number: 7440-56-4

RTECS® Number: LY5200000 (powder)

UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170; UN1759 (corrosive solid, n.o.s.)/154

EC Number: 231-164-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Germanium is a grayish-white, lustrous, brittle metalloid. The powder is grayish black and odorless. It is never found free and occurs most commonly in argyrodite and germanite. It is generally recovered as a by-product in zinc production, coal processing, or other sources. Molecular weight = 72.59; Boiling point = 2700°C; Melting/Freezing point = 937°C; Specific gravity/density = 5.350 g/cm^3. Insoluble in water.

Potential Exposure: Because of its semiconductor properties, germanium is widely used in the electronic industry in rectifiers, diodes, and transistors. It is alloyed with aluminum, aluminum−magnesium, antimony, bronze, and tin to increase strength, hardness, or corrosion resistance. In the process of alloying germanium and arsenic, arsine may be released; stibine is released from the alloying of germanium and antimony. Germanium is also used in the manufacture of optical glass for infrared applications; red-fluorescing phosphors; and cathodes for electronic valves; and in electroplating; in the hydrogenation of coal; and as a catalyst, particularly at low temperatures. Certain compounds are used medically. Industrial exposures to the dust and fumes of the metal or oxide generally occur during separation and purification of germanium, welding, multiple-zone melting operations; or cutting and grinding of crystals. Germanium tetrahydride (germanium hydride, germane, monogermane) and other hydrides are produced by the action of a reducing acid on a germanium alloy.

Incompatibilities: A strong reducing agent and flammable solid. Finely divided metal is incompatible with oxidizing and nonoxidizing acids, ammonia, bromine, oxidizers, aqua regia, sulfuric acid, carbonates, halogens, nitrates. Explosive reaction or ignition with potassium chlorate, potassium nitrate, chlorine, bromine, oxygen, potassium hydroxide, in the presence of heat. Violent reaction with nitric acid.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.0125 mg/m^3
PAC-1: 0.035 mg/m^3
PAC-2: 0.25 mg/m^3
PAC-3: 500 mg/m^3
Russia[43] set a MAC of 2 mg/m^3 in work-place air.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 8 μg/L based on health effects.

Determination in Water: Germanium may be determined by atomic absorption spectroscopy, emission spectrography, and spectrophotometry with phenylfluorone.

Routes of Entry: Inhalation of gas, vapor, fume, or dust.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of germanium exposure[24] include low temperature, languor, diarrhea, cyanosis, extreme depression of heart and breath, edema, lung hemorrhage, hemorrhage from the small intestinal wall, peritoneal extravasation. The dust of germanium dioxide is irritating to the eyes. Germanium tetrachloride causes irritation of the skin. Germanium tetrachloride is an upper respiratory tract irritant and may cause bronchitis and pneumonitis.

Long Term Exposure: Prolonged exposure to high-level concentrations may result in damage to the liver, kidney, and other organs.

Medical Surveillance: Consider respiratory, liver, and kidney disease in any placement or periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatibles listed above.

Shipping: Metal powder, flammable, n.o.s. require a label of "SPONTANEOUSLY COMBUSTIBLE." They fall in Hazard Class 4.2 and Packing Group III. Corrosive metals require a shipping label of "CORROSIVE."

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and return to suppliers for reprocessing is preferable.

Reference

US Environmental Protection Agency. (May 1977). *Toxicology of Metal, Vol. II: Germanium*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 222−223

Germanium tetrahydride (Germane) G:0120

Molecular Formula: GeH_4

Synonyms: Germane; Germanium hydride; Germanomethane; Monogerman

CAS Registry Number: 7782-65-2

RTECS® Number: LY4900000

UN/NA & ERG Number: UN2192 (toxic, inhalation hazard, Zone B)/119

EC Number: 231-961-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥20.73% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Germane is a colorless, flammable gas. Molecular weight = 76.62; Specific gravity (H_2O:1) = 1.52; Boiling point = − 88.4°C; Decomposes at 350°C. Freezing/Melting point = − 166.1°C; Relative vapor density (air = 1) = 2.65; Vapor pressure = >1 atm at 25°C; Autoig-nition temperature = <85°C. Flammable Limits in air: pyrophoric. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: This material is used as a doping agent in solid state electronic component manufacture.

Incompatibilities: Pyrophoric; may ignite spontaneously in air. Reacts explosively with bromine. Attacks hydrocarbon and fluorocarbon lubricants.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.13 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.2 ppm/0.6 mg/m^3 TWA.

ACGIH TLV®[1]: 0.2 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.17 ppm

PAC-1: 0.17 ppm

PAC-2: **0.17** ppm

PAC-3: **0.50** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.2 ppm (0.6 mg/m^3), 1993; Belgium: TWA 0.2 ppm (0.63 mg/m^3), 1993; Denmark: TWA 0.2 ppm (0.6 mg/m^3), 1999; Finland: STEL 0.2 ppm (0.6 mg/m^3), 1999; France: VME 0.2 ppm (0.6 mg/m^3), 1999; the Netherlands: MAC-TGG 0.6 mg/m^3, 2003; Norway: TWA 0.2 ppm (0.6 mg/m^3), 1999; Russia: STEL 5 mg/m^3, 1993; United Kingdom: TWA 0.2 ppm (0.64 mg/m^3); STEL 0.6 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 ppm. Several states have set guidelines or standards for germane in ambient air[60] ranging from 6.0 μg/m^3 (North Dakota) to 10.0 μ/m^3 (Virginia) to 12.0 μg/m^3 *(*Connecticut) to 14.0 μ/m^3 (Nevada).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause headache, giddiness, fainting, nausea, vomiting. Data on toxicity are limited but ACGIH reports that it is between ten hydride (stannone) and arcine in toxicity. Germanium tetrahydride is a toxic hemolytic gas capable of producing kidney damage. This effect is similar to that of arsine and stibine (antimony hydride). One-hour exposure tests on animals yielded the following results: animal rabbit, concentration 100 ppm, effect survived; animal mouse, concentration 150 ppm, effect fatal; animal mouse, concentration 185 ppm, effect fatal; animal guinea pig, concentration 150 ppm, effect sickened; animal guinea pig, concentration 185 ppm, effect fatal. The TWA value was set on the rather arbitrary basis that germane can be considered half as toxic as stibine.[53]

Long Term Exposure: May cause kidney injury. Hemolytic effects.

Points of Attack: Central nervous system, kidneys, blood.

Medical Surveillance: Workers exposed to germane should undergo periodic physical examinations.[30] Kidney function tests. Complete blood count (CBC). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool (below 50°C), well-ventilated area away from bromine. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class (Poison A) 2.3.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.8/2.8

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Glucose G:0123

Molecular Formula: $C_6H_{12}O_6$

Synonyms: Corn Sugar; Dextropur; Dextrose, anhydrous; Dextrosol; Glucolin; D-Glucose, anhydrous; D(+)-Glucose; Grape Sugar

CAS Registry Number: 50-99-7

RTECS®Number: LZ6600000

UN/NA & ERG Number: Not regulated.

EC Number: 200-075-1

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory.

Canada: listed on DSL List; no WHMIS listing.

European/International Regulations: Hazard Symbol: None; Risk phrases: None; Safety phrases: S24/25 (see Appendix 4).

WGK (German Aquatic Class): No value assigned.

Description: A white crystalline solid or granular powder. Odorless. Molecular weight = 180.16; 180.08; Specific Gravity (water = 1) = 1.56; 1.2 at 20°C (estimate)[USCG]; Boiling Point: >100°C at 760.0 mmHg [USCG]; Freezing/Melting Point: 146°C; Refractive index = 1.51 at 142°C; Autoignition temperature = 500°C; Hazard Identification (based on NFPA-704 M Rating System): Health 0; Flammability 1; Reactivity 0. Freely soluble in water.

Potential Exposure: NIOSH compound descriptor: Tumorigen; Mutagen; Reproductive Effector; Human Data. Most dietary carbohydrates contain glucose. Used as a fluid and nutrient replenisher. A precursor to Vitamin C to make other chemicals.

Incompatibilities: Dust may form explosive mixture with air. Dextrose is a weak reducing material; keep away from strong oxidizers, strong acids, halogenated agents, nitrates, and permanganates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.4 mg/m^3
PAC-1: 1.25 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 500 mg/m^3

Determination in Air: No method available from NIOSH or OSHA.

Determination in Water: Ecotoxicity: Log $K_{ow} = -3.26$.

Routes of Entry: Eyes, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Dust may cause skin, eye, or respiratory tract irritation. With a low pH (about 5.8−6.0), may cause eye and skin irritation; respiratory and digestive tract irritation. LD_{50} = (oral, rat) 25,800 mg/kg, low toxicity.

Long Term Exposure: No chronic symptoms found.

First Aid: *Ingestion*: Get medical aid. Do NOT induce vomiting. If conscious and alert, rinse mouth and drink 2−4 cupfuls of milk or water. Get medical aid if irritation or other symptoms occur. *Inhalation:* Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear. *Skin*: Get medical aid if irritation develops or persists. Wash clothing before reuse. Flush skin with plenty of soap and water. *Eyes*: Gently lift eyelids and flush continuously with water. If irritation develops, get medical aid.

Personal Protective Methods: *Eyes*: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. *Skin*: Protective garments not normally required. *Clothing:* Protective garments not normally required.

Respirator Selection: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Storage: Color Code—Green: General storage may be used. Store in a cool, dry, well-ventilated area away from strong oxidizers, strong acids.

Shipping: Not regulated.

Spill Handling: Provide adequate ventilation. Avoid generating dust. Vacuum or sweep up material and place into a suitable disposal container. Clean up spills immediately, using the appropriate protective equipment.

Fire Extinguishing: Thermal decomposition products include carbon dioxide, carbon monoxide, and irritating and toxic fumes and/or gases. For any fire, wear a self-contained breathing apparatus (SCBA) in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Dusts at sufficient concentrations can form explosive mixtures with air. On fire use water spray, dry chemical, carbon dioxide, or appropriate foam.

α(D+) Glucose G:0123

Molecular Formula: $C_6H_{12}O_6$

Synonyms: Dextrose; alpha-Dextrose; Dextrosum; α-D-Glucopyranose; Glucose; Glucose (α-anomer); Glucose, alpha-D-; α-D(+)-Glucose, anhydrous; Glucosum

CAS Registry Number: 492-62-6 (α-anomer); 492-61-5 (β-anomer)

RTECS®Number: LZ6600000

UN/NA & ERG Number: Not regulated.

EC Number: 207-757-8

Regulatory Authority and Advisory Bodies

Canada: listed on DSL List; no WHMIS listing.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Class): 3—Severe hazard to waters.

Description: (CAS: 492-62-6) A white crystalline solid or granular powder. Odorless. Molecular weight = 180.1572; Density = 1.54 g/cm^3; Freezing/Melting Point: 153−156°C; Hazard Identification (based on NFPA-704 M Rating System): Health 0; Flammability 0; Reactivity 0. Soluble in water; solubility 0.13 g/mL; 91 g/100 mL at 25°C. Little information can be found for the beta-anomer but its description is probably similar.

Potential Exposure: Reagent; used as a research and development chemical; for making antibiotics and other cell culture.

Incompatibilities: Dust may form explosive mixture with air. α-Dextrose is a weak reducing material; keep away from strong oxidizers, strong acids, halogenated agents, nitrates, permanganates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.4 mg/m^3
PAC-1: 1.25 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 500 mg/m^3

Determination in Air: No method available from NIOSH or OSHA.

Routes of Entry: Eyes, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Dust may cause skin, eye, or respiratory tract irritation. May cause eye and skin irritation; respiratory and digestive tract irritation. LD_{50} = (oral, rat) Oral, rat >90 mL/kg.

Long Term Exposure: No chronic symptoms found.

First Aid: *Ingestion*: Get medical aid. Do NOT induce vomiting. If conscious and alert, rinse mouth and drink 2–4 cupfuls of milk or water. Get medical aid if irritation or other symptoms occur. *Inhalation:* Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear. *Skin*: Get medical aid if irritation develops or persists. Wash clothing before reuse. Flush skin with plenty of soap and water. *Eyes*: Gently lift eyelids and flush continuously with water. If irritation develops, get medical aid.

Personal Protective Methods: *Eyes*: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. *Skin*: Protective garments not normally required. *Clothing:* Protective garments not normally required.

Respirator Selection: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Storage: Color Code—Green: General storage may be used. Store in a cool, dry, well-ventilated area away from strong oxidizers, strong acids.

Shipping: Not regulated.

Spill Handling: Provide adequate ventilation. Avoid generating dust. Vacuum or sweep up material and place into a suitable disposal container. Clean up spills immediately, using the appropriate protective equipment.

Fire Extinguishing: Thermal decomposition products include carbon dioxide, carbon monoxide, and irritating and toxic fumes and/or gases. For any fire, wear a self-contained breathing apparatus (SCBA) in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Dusts at sufficient concentrations can form explosive mixtures with air. On fire use water spray, dry chemical, carbon dioxide, or appropriate foam.

Disposal Method Suggested: Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Glucose oxidase G:0130

Synonyms: Deoxin-1; E.C. 1.1.3.4; Glucose aerodehydrogenase; β-D-Glucose oxidase; Microcide; Notatin; Orylophyline; Oxidase glucose; Penatin

CAS Registry Number: 9001-37-0

RTECS® Number: RQ8452000

EC Number: 232-601-0

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Glucose Oxidase takes the form of amorphous powder or crystals. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Glucose Oxidase is used as a food preservative, as a stabilizer for vitamins and in laboratories.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Glucose oxidase can affect you when breathed in.

Long Term Exposure: Exposure can cause an asthma-like lung allergy. Once allergy develops, even very small future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and chest tightness. Allergy symptoms can also resemble hay fever, with itching eyes, sneezing, and watery or stuffy nose.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Glucose oxidase, use a NIOSH/MSHA- or European Standard EN149-approved respirator with a high-efficiency particulate filter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Glucose oxidase should be stored in a freezer.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agent suitable for surrounding fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1986). *Hazardous Substances Fact Sheet: Glucose Oxidase*. Trenton, NJ

Glutaraldehyde G:0140

Molecular Formula: $C_5H_8O_2$

Common Formula: $HCO(CH_2)_3CHO$

Synonyms: Cidex; Cudex; 1,3-Diformal propane; Glutamic dialdehyde; Glutaral; Glutard dialdehyde; Glutaric acid dialdehyde; Glutaric dialdehyde; NCI-C55425; 1,5-Pentanedial; Pentanedial; 1,5-Pentanedione; Potentiated acid glutaraldehyde; Sonacide

CAS Registry Number: 111-30-8

RTECS® Number: MA2450000

UN/NA & ERG Number: UN2810/Guide 153

EC Number: 203-856-5 [*Annex I Index No.:* 605-022-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

US EPA Gene-Tox Program, Negative: CHO gene mutation.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/25; R34; R42/43; R50; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Glutaraldehyde is a colorless liquid with a pungent odor, which readily changes to a glossy polymer. The odor threshold is 0.04 ppm (NY) and 0.2 ppm (NJ). Molecular weight = 100.13; Specific gravity (H_2O:1) = 1.10; Boiling point = 100°C; also reported at 187−189°C (decomposes); Freezing/Melting point = − 13.8°C; Vapor pressure = 17 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Glutaraldehyde is used in leather tanning; in embalming fluids; as a germicide; as a cross-linking agent for protein and polyhydroxy materials; as a fixative for tissues; as an intermediate. Buffered solutions are used as antimicrobial agents in hospitals.

Incompatibilities: Water contact forms a polymer solution. A strong reducing agent. Incompatible with strong acids, caustics, ammonia, amines, strong oxidizers. *Note:* Alkaline solutions of glutaraldehyde (i.e., activated glutaraldehyde) react with alcohol, ketones, amines, hydrazines, and proteins.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.09 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.2 ppm/0.8 mg/m^3 Ceiling Concentration.

Note: NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112]; See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 ppm/0.2 mg/m^3 Ceiling Concentration, sensitizer, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 0.05 ppm

PAC-1: 0.2 ppm

PAC-2: **1** ppm

PAC-3: **5** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.05 ppm/0.21 mg/m^3 TWA; Peak Limitation Category I(2) a momentary value of 0.2 mL/m^3/0.83 mg/m^3

should not be exceeded; danger of skin and airway sensitization; Carcinogen Category 4; Pregnancy Risk Group C. Australia: TWA 0.2 ppm (0.7 mg/m^3), 1993; Austria: MAK 0.2 ppm (0.8 mg/m^3), 1999; Belgium: TWA 0.2 mg/m^3; STEL 0.82 mg/m^3, 1993; Denmark: TWA 0.2 ppm (0.8 mg/m^3), 1999; Finland: ceiling 0.1 ppm, 1999; France: VLE 0.2 ppm (0.8 mg/m^3), 1999; the Netherlands: MAC 0.25 mg/m^3, 2003; Norway: TWA 0.2 ppm (0.8 mg/m^3), 1999; Russia: STEL 5 mg/m^3, 1993; Sweden: STEL 0.2 ppm (0.8 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.2 ppm (0.8 mg/m^3), KZG-W 0.4 ppm (1.6 mg/m^3), 1999; United Kingdom: TWA 0.05 ppm (0.2 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.05 ppm (sensitizer). Several states have set guidelines or standards for glutaraldehyde in ambient air[60] ranging from 6.0 $\mu g/m^3$ (Virginia) to 7.0 $\mu g/m^3$ (North Dakota) to 14.0 $\mu g/m^3$ (Connecticut) to 17.0 $\mu g/m^3$ (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2532 or OSHA Analytical Method 64.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.22$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* 0.3 ppm can cause nose and throat irritation. 0.4 ppm has caused headaches. 0.5 ppm has been described as intolerably irritating. *Skin:* Can cause irritation. Contact with a 5% solution can sensitize the skin and cause an allergic response to subsequent contact of much lower concentrations. *Eyes:* Vapors of a 2% solution (0.4 ppm) have produced irritation. *Ingestion:* Can cause irritation of the mouth and stomach. The LD_{50} oral rat is 134 mg/kg (moderately toxic).

Long Term Exposure: Repeated or prolonged contact with skin may cause chemical sensitization, skin allergy, and asthma. Exposure may cause liver and nervous system damage. Glutaraldehyde may cause mutations, handle with extreme caution. Testing has not been completed to determine the carcinogenicity of glutaraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system, liver, nervous system.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h:** butyl rubber gloves, suits, boots; Viton™ gloves, suits; **4 h:** natural rubber gloves; Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.2 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator with an organic vapor cartridge/canister and a dust/mist/fume prefilter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, caustics, ammonia, amines, oxidizers.

Shipping: Glutaraldehyde fits the shipping name of Toxic, liquids, organic, n.o.s. It requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls into Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Glutaraldehyde itself does not burn. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Glutaraldehyde*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Glutaraldehyde*. Trenton, NJ

Glycerin (mist) G:0150

Molecular Formula: $C_3H_8O_3$

Common Formula: $HOCH_2CHOHCH_2OH$

Synonyms: 90 Technical glycerin; Glycerin, anhydrous; Glycerin, synthetic; Glyceritol; Glycerol; Glycyl alcohol; Grocolene; Moon; 1,2,3-Propanetriol; Synthetic glycerin; 1,2,3-Trihydroxypropane; Trihydroxypropane

CAS Registry Number: 56-81-5

RTECS® Number: MA8050000

EC Number: 200-289-5

Regulatory Authority and Advisory Bodies

FDA—over-the-counter and proprietary drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Glycerol is a viscous colorless or pale yellow, odorless, syrupy liquid. Molecular weight = 92.11; Specific gravity (H_2O:1) = 1.26; Boiling point = (decomposes) 290°C; Freezing/Melting point = 17.8°C; Vapor pressure = 0.003 mmHg at 50°C; Flash point = 160°C; also listed at 177°C (oc). Autoignition temperature = 370°C. Explosive limits: LEL = 0.9%; UEL = Unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Glycerol is used as a humectant in tobacco; it is used in cosmetics, antifreezes, and inks. It is used as a fiber lubricant. It is used as a raw material for alkyd resins and in explosives manufacture.

Incompatibilities: Able to polymerize above 300°F/150°C. Incompatible with acetic anhydrides (especially in the presence of a catalyst), strong acids, caustics, aliphatic amines, isocyanates. Strong oxidizers (e.g., chromium trioxide, potassium chlorate, potassium permanganate) can cause fire and explosion hazard. Hygroscopic (i.e., absorbs moisture from the air). Decomposes when heated, producing corrosive gas of acrolein.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (total dust); 5 mg/m^3, respirable fraction, TWA.

NIOSH REL: None, see Appendix D.

ACGIH TLV®[1]: 10 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 50 mg/m^3, inhalable fraction of the aerosol; Peak Limitation Category I(2); Pregnancy Risk Group C.

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Finland: TWA 20 mg/m^3, 1999; France: VME

10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; United Kingdom: TWA 10 mg/m^3, mist, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3. Several states have set guidelines or standards for glycerol in ambient air[60] ranging from 3.0 μg/m^3 (Virginia) to 200.0 μ/m^3 (Florida and New York) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #0500 for total nuisance dust and #0600 for respirable nuisance dust.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = -1.8$.

Harmful Effects and Symptoms

Short Term Exposure: Glycerin can be irritating to the eyes, skin, and respiratory tract. When swallowed, it can cause insomnia, nausea, vomiting, diarrhea, fever, hemoglobinuria, convulsions, and paralysis. Toxic in high concentrations; it is somewhat dehydrating and irritating to exposed tissues. Symptoms include headache, dizziness, insomnia, nausea, vomiting, diarrhea, fever, elevated blood sugar, and diabetic coma; very large doses may cause irritation and dehydration of tissues, hemolysis, renal failure, hemoglobinuria, convulsions, and paralysis.

Long Term Exposure: May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system, kidneys.

Medical Surveillance: Kidney function tests.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20–30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: Prevent skin contact. **8 h:** natural rubber gloves, Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; **4 h:** 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous and corrosive gases, including acrolein, are produced in fire. Use dry chemical, carbon dioxide, water fog, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank

discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mixture with a more flammable solvent followed by incineration.

Reference

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 61−63 (1981) and 3, No. 4, 58−60 (1983)

Glycidol G:0160

Molecular Formula: $C_3H_6O_2$

Common Formula: $HOCH_2CH(O)CH_2$

Synonyms: Epihydrin alcohol; 2,3-Epoxy-1-propanol; 2,3-Epoxypropanol; Glycide; Glycidyl alcohol; 3-Hydroxy-1,2-epoxypropane; 3-Hydroxypropylene oxide; Methanol, oxiranyl-; NCI-C55549; Oxiranemethanol

CAS Registry Number: 556-52-5

RTECS® Number: UB4375000

UN/NA & ERG Number: UN2810/Guide 153

EC Number: 209-128-3 [*Annex I Index No.:* 603-063-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 2000; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R455; R60; R21/22; R23; R36/37/38; R68; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Glycidol is a colorless liquid. Molecular weight = 74.09; Specific gravity (H_2O:1) = 1.1; Boiling point = (decomposes) 166°C; Freezing/Melting point = −45°C; Vapor pressure = 0.9 mmHg at 20°C; Flash point = 72°C (cc); Autoignition temperature = 415°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Glycidol is used as an intermediate in the synthesis of glycerol, glycidyl ethers, esters, and amines.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers, nitrates. Decomposes on contact (especially in the presence of heat) with strong acids, strong bases, water, metal salts (e.g., aluminum chloride, ferric chloride, tin chloride), or metals (copper, zinc), causing fire and explosion hazard. Contact with barium, lithium, sodium, magnesium, titanium may cause polymerization. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.03 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/150 mg/m^3 TWA.

NIOSH REL: 25 ppm/75 mg/m^3 TWA.

ACGIH TLV®[1]: 2 ppm/6.1 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 150 ppm.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 4 ppm

PAC-2: 30 ppm

PAC-3: 150 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 25 ppm (75 mg/m^3), 1993; Austria: MAK 50 ppm (150 mg/m^3), 1999; Belgium: TWA 25 ppm (76 mg/m^3), 1993; Denmark: TWA 0.2 ppm (1 mg/m^3), 1999; Finland: TWA 50 ppm (150 mg/m^3); STEL 75 ppm (225 mg/m^3) [skin] 1999; France: VME 25 ppm (75 mg/m^3), 1999; Norway: TWA 25 ppm (75 mg/m^3), 1999; the Philippines: TWA 50 ppm (150 mg/m^3), 1993; Russia: STEL 5 mg/m^3, 1993; Sweden: NGV 25 ppm (75 mg/m^3), KTV 50 ppm (150 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (75 mg/m^3), KZG-W 50 ppm (150 mg/m^3), 1999; Turkey: TWA 50 ppm (150 mg/m^3), 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for glycidol in ambient air[6] ranging from 750−3000 μg/m^3 (North Dakota) to 1300 μg/m^3 (Virginia) to 1500 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #1608[18] or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Glycidol affects you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Vapor exposure can damage vision. Exposure can irritate the eyes, nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High levels can cause you to feel dizzy, lightheaded, confused, excited, to pass out, and even die. May affect the central nervous system.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. It can irritate the lungs; bronchitis may develop. May cause personality changes; depression, anxiety, or irritability. Possibly carcinogenic to humans. Because this is a mutagen, handle it as a possible carcinogen, with extreme caution. May cause sterility in males. Based on animal tests, this substance may have toxic effects on human reproduction.

Points of Attack: Eyes, skin, respiratory system, central nervous system. Cancer site in animals: stomach, brain, and breast.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Examination of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 150 ppm:* Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Glycidol must be stored to avoid contact with strong oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Store in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Glycidol fits the shipping name of Toxic, liquids, organic, n.o.s. It requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls into Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Acrid smoke and Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Concentrated waste containing no peroxides:* discharge liquid at a controlled rate near a pilot flame. *Concentrated waste containing peroxides:* perforation of a container of the waste from a safe distance followed by open burning.

Reference

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: 2,3-Epoxy-1-Propanol*. Trenton, NJ

Glycidylaldehyde G:0170

Molecular Formula: $C_3H_4O_2$

Common Formula: $CH_2-(O)-CH-CHO$

Synonyms: Epihydrinaldehyde; Epihydrine aldehyde; 2,3-Epoxy-1-propanal; 2,3-Epoxypropanal; 2,3-Epoxypropionaldehyde; Glycidal; Glycidaldehyde; Oxiranecarboxaldehyde

CAS Registry Number: 765-34-4

RTECS® Number: MB3150000

UN/NA & ERG Number: UN2622/131P

EC Number: 212-143-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: Carcinogenicity: Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U126.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Glycidylaldehyde is a colorless liquid with a pungent, aldehyde-like odor. Molecular weight = 72.07; Boiling point = 112−113°C; Freezing/Melting point = −62°C; Flash point = 31°C. Hazard Identification [NJDHSS]: Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: This material has been used in the finishing of wool and the tanning of leather and surgical sutures in the United Kingdom. It has been tested as a disinfectant.

Incompatibilities: Glycidaldehyde may undergo violent polymerization when subjected to heat, strong sunlight, or contamination. Contact with oxidizers may cause a fire and explosion hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.025 ppm

PAC-1: 0.075 ppm

PAC-2: 0.5 ppm

PAC-3: 40 ppm

Several states have set guidelines or standards for glycidylaldehyde in ambient air[60] ranging from zero (Nevada) to 0.03 μg/m^3 (New York) to 75.0 μg/m^3 (South Carolina).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May be fatal if inhaled, ingested, or absorbed through the skin. Contact can cause severe skin and eye irritation and burns with possible permanent eye damage. Skin burns can be slow healing, followed by pigmentation. Inhalation can cause respiratory tract irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May be a carcinogen in humans. May cause skin sensitization and allergy. May cause liver and kidney damage. May affect the nervous system. Can cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, liver, kidneys, nervous system, lungs, mucous membranes.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. *Gloves:* Butyl, PVC, and Silver Shield®/4H®, (4-h breakthrough for aldehydes); *Coveralls:* DuPont Tychem® BR, LV, Responder®, and TK; Kappler® Zytron® 500; and Saint-Gobain ONE Suit® TEC (>8-h breakthrough for aliphatic aldehydes). Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, nitrates, heat, and flames. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use water spray to reduce vapors. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, water spray, fog, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 3, 103−105

New Jersey Department of Health and Senior Services. (July 2008). *Hazardous Substances Fact Sheet: Glycidaldehyde*. Trenton, NJ

Glyphosate G:0180

Molecular Formula: $C_3H_8NO_5P$

Common Formula: $HOCOCH_2NHCH_2PO(OH)_2$

Synonyms: Glycine, *N*-(phosphonomethyl)-; MON0573; MON 2139*;* *N*-(Phosphonomethyl)-glycine; Phosphonomethyliminoacetic acid; Rodeo®; Roundup®

CAS Registry Number: 1071-83-6

RTECS® Number: MC1075000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-997-4 [*Annex I Index No.*: 607-315-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

NTP: Toxicity studies, Report #TOX-16, October 2000.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R41; R51/53; Safety phrases: S2; S26; S39; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Glyphosate, an organophosphate, is a colorless crystalline powder. Often used as a liquid in a carrier solvent which may change physical and toxicological properties. Molecular weight = 169.09; Freezing/Melting point = (decomposes) 230°C. Soluble in water; solubility = 1.2% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this nonselective, nonresidual preemergence herbicide. Has wide residential use in the United States for the control of weeds.

Incompatibilities: Solutions are corrosive to iron, unlined steel, and galvanized steel, forming a highly combustible or explosive gas mixture. *Do not* store glyphosate in containers made from these materials.

Permissible Exposure Limits in Air: No OELs have been established in the United States for this chemical. Russia has set a ceiling value of 1.5 mg/m^3 in work-place air.[35,43]

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: The US EPA has developed data on Glyphosate including a no-observed-adverse-effects-level (NOAEL) of 10 mg/kg/day. This corresponds to a drinking water equivalent level of 3.5 mg/L from which a lifetime health advisory of 0.7 mg/L was derived. California[61] has set a guideline of 0.5 mg/L for drinking water.

Determination in Water: Analysis of glyphosate is by a high-performance liquid chromatographic (HPLC) method. Human Tox = 700.00000 pbb (VERY LOW). Octanol–water coefficient: Log $K_{ow} = -0.9$.

Routes of Entry: Inhalation, ingestion, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure to high levels can cause nausea, vomiting, diarrhea, decreased blood pressure, and convulsions. High exposures can cause arrhythmia and possible death. The acute LD_{50} oral for rats is 5600 mg/kg (insignificantly toxic). Human Tox = 700.00000 ppb (Very Low).

Long Term Exposure: May cause liver and kidney damage. It does not seem to exhibit reproductive effects, mutagenicity, or carcinogenicity in animal studies.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase, liver, kidney, heart.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver and kidney function tests. Special 24-h EKG (Holter monitor) for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers

Shipping: This is an Organic phosphorus compound, solid, toxic requiring a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Solid glyphosate may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Glyphosate*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Glyphosate*. Trenton, NJ

Grain dust (oat, wheat, and barley) G:0190

Synonyms: None.

RTECS® Number: MD7900000

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Description: Oats, barley, or wheat dust containing microbial flora and fauna. Grain dust consists of 60−75% organic materials (cereal grains) and 25−40% inorganic materials (soil); and includes fertilizers, pesticides, and microorganism.

Potential Exposure: Grain elevator workers, grain harvesters.

Permissible Exposure Limits in Air

OSHA PEL: 10 mg/m^3 TWA.

NIOSH REL: 4 mg/m^3 TWA.

ACGIH TLV®[1]: 4 mg/m^3 for particulate matter containing no asbestos and $<1\%$ crystalline silica.

No TEEL available.

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, upper respiratory system. Can cause coughing, wheezing.

Long Term Exposure: Impaired lung function, chronic bronchitis; both immediate and delayed asthmatic reactions; grain fever upon exposure to dust concentrations in excess of 15 mg/m^3.[53]

Points of Attack: Respiratory system.

Medical Surveillance: Lung function tests.

First Aid: If this material gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Dust respirator required.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may be a combustible solid depending on specific components of the grain dust including fertilizers, pesticides, and microorganisms. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases may be produced in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Graphite G:0200

Molecular Formula: C

Synonyms: Black lead; Mineral carbon; Plumbago; Silver graphite; Stove black

synthetic: Acheson graphite; Artificial graphite

CAS Registry Number: 7782-42-5 (graphite, natural); 7440-44-0 (carbon, graphite, synthetic); 16291-96-6 (synthetic graphite)

RTECS® Number: MD9659600 (carbon, graphite, natural); FF5250100 (carbon, graphite, synthetic)

UN/NA & ERG Number: Not regulated

EC Number: 231-955-3 (graphite, natural); 231-153-3 (carbon); 240-383-3 (charcoal or synthetic graphite)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Graphite is crystallized carbon and usually appears as soft, black scales. There are two types of graphite, natural and artificial (activated). Natural and synthetic graphite may be mixed with each other or contain other additives. Molecular weight = 12.01; Specific gravity = 2.0−2.25 (natural); 1.5−1.8 (synthetic); Sublimation point = 3652°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Natural graphite is used in foundry facings, steel making lubricants, refractories, crucibles, pencil "lead," paints, pigments, and stove polish. Artificial graphite may be substituted for these uses with the exception of clay crucibles; other types of crucibles may be produced from artificial graphite. Additionally, it may be used as a high temperature lubricant or for electrodes. It is utilized in the electrical industry in electrodes, brushes, contacts, and electronic tube rectifier elements; as a constituent in lubricating oils and greases; to treat friction elements, such as brake linings; to prevent molds from sticking together; and in moderators in nuclear reactors. In addition, concerns have been expressed about synthetic graphite in fibrous form. Those exposed are involved in the production of graphite fibers from pitch or acrylonitrile fibers and the manufacture and use of composites of plastics, metals, or ceramics reinforced with graphite fibers.

Incompatibilities: Graphite is a strong reducing agent and reacts violently with oxidizers, such as fluorine, chlorine trifluoride, potassium peroxide. Forms an explosive mixture with air. May be spontaneously combustible in air.

Permissible Exposure Limits in Air

Graphite, natural

OSHA PEL: 15 mppcf, respirable fraction (based on impinger samples counted by light field techniques) TWA.

NIOSH REL: 2.5 mg/m^3, respirable dust TWA.

ACGIH TLV®[1]: (all forms except graphic fibers) 2 mg/m^3, respirable fraction TWA.

Graphite, synthetic

OSHA PEL: 15 ppm total dust/5 mg/m^3, respirable fraction TWA.

ACGIH TLV®[1]: (all forms except graphic fibers) 2 mg/m^3, respirable fraction TWA.

NIOSH IDLH: 1250 mg/m^3.

Protective Action Criteria (PAC)

Natural and synthetic

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1.5 mg/m^3, respirable fraction; 4 mg/m^3, inhalable fraction; Pregnancy Risk Group C.

Australia: TWA 10 mg/m^3, 1993; Australia: TWA 2.5 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Belgium: TWA 2.5 mg/m^3, 1993; Finland: TWA 5 mg/m^3, 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Sweden: NGV 5 mg/m^3 (*dust*), 1999; Switzerland: MAK-W 2.5 mg/m^3, 1999; United Kingdom: LTEL 5 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®[1]: TWA 2 mg/m^3, respirable fraction.

Determination in Air: Use NIOSH Analytical Methods #0500 or #0600.

Routes of Entry: Inhalation of dust, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Causes upper respiratory irritation.

Long Term Exposure: Lungs may be affected by repeated or prolonged exposure to dusts, resulting in graphite pneumoconiosis. Exposure to natural graphite may produce a progressive and disabling pneumoconiosis similar to anthracosilicosis. Symptoms include headache, coughing, depression, decreased appetite, dyspnea, and the production of black sputum. Some individuals may be asymptomatic for many years then suddenly become disabled. It has not yet been determined whether the free crystalline silica in graphite is solely responsible for development of the disease. There is evidence that artificial graphite may be capable of producing pneumoconiosis.

Points of Attack: Respiratory system, lungs, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash

Respirator Selection: NIOSH: (natural) *Up to 12.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. *62.5 mg/m^3*: PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *1250* mg/m^3: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Carbon (graphite) fibers are difficult to dispose of by incineration. Waste fibers should be packaged and disposed of in a landfill authorized for the disposal of special wastes of this nature, or as otherwise may be required by law. Do not incinerate.

Gum Arabic G:0210

Molecular Formula: None listed.
Synonyms: Acacia; Acacia dealbata gum; Acacia gum; Acacia Senegal; Acacia syrup; Arabic gum; Australian gum; Gum acacia; Gum ovaline; Gum Senegal; Indian gum; NCI-C50748; Senegal gum; Starsol No. 1; Wattle gum
CAS Registry Number: 9000-01-5
RTECS® Number: CE5945000
UN/NA & ERG Number: Not regulated.
EC Number: 232-519-5
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): No value assigned.
Description: Gum arabic is a white or yellowish solid. It has a molecular weight of about 240,000 but no clearly defined structure.[52] It is an exudate from acacia trees. A combustible solid when present as a dust. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0.
Potential Exposure: Compound Description: Mutagen. Primary Irritant, Natural Product; Food Additive; Reproductive Effector. Gum arabic is used in granular or powder form in foods, pharmaceuticals, cosmetics, adhesives, inks, and textile printing.
Incompatibilities: Oxidizers. Aqueous solution is acidic; keep away from bases. It jells or precipitates out of solution on contact with solutions of alcohol, basic lead acetate, borax, ferric salts, gelatin, ammoniated tincture of guaiac, or sodium silicate.[NTP]
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 200 mg/m^3
PAC-1: 500 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
Determination in Air: No method available.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Unknown at this time.
Long Term Exposure: Exposure can cause an asthma-like lung allergy to develop. Once allergy develops, even very small future exposures can cause attacks with wheezing, coughing, chest tightness, and shortness of breath. Gum arabic can also cause allergy-like symptoms of chronic runny nose and skin allergy with rash.
Points of Attack: Lungs, skin.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Engineering controls should be established to eliminate hazardous exposures to gum arabic. If, however, you experience irritation, discomfort, or sensitization, or *where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved high-efficiency particulate filter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Dust is combustible. Sources of ignition, such as smoking and open flames, are prohibited where gum arabic is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 1986). *Hazardous Substances Fact Sheet: Gum Arabic*. Trenton, NJ

H

Hafnium and compounds H:0100

Molecular Formula: Hf
Synonyms: Celtium; Elemental hafnium; Hafnium metal
CAS Registry Number: 7440-58-6 (metal); 12055-23-1 (oxide)
RTECS® Number: MG4600000
UN/NA & ERG Number: UN1326 (hafnium powder, wet with not <25% water)/170; UN2545(hafnium powder, dry/135
EC Number: 231-166-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Hafnium is a refractory metal which occurs in nature in zirconium minerals. Molecular weight = 178.49; Specific gravity (H_2O:1) = 13.31; Boiling point = 4602°C; Freezing/Melting point = 2227°C; Vapor pressure = 1×10^{-4} mmHg at 20°C. Insoluble in water.

Potential Exposure: Hafnium metal has been used as a control rod material in nuclear reactors. Thus, those engaged in fabrication and machining of such rods may be exposed.

Incompatibilities: Moisture may cause self-ignition or explosions. The powder is highly flammable, a strong reducing agent, and water and air reactive. The powder or dust may spontaneously ignite on contact with air; and at higher temperatures with nitrogen, phosphorous, oxygen, halogens, and sulfur; contact with hot nitric acid; heat, shock, friction, strong oxidizers; or ignition sources may cause explosions.

Permissible Exposure Limits in Air

Note: Also applies to other hafnium compounds (as Hf).
OSHA PEL: 0.5 mg[Hf]/m^3 TWA.
NIOSH REL: 0.5 mg[Hf]/m^3 TWA.
ACGIH TLV®[1]: 0.5 mg[Hf]/m^3 TWA.
NIOSH IDLH: 50 mg [Hf]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 50 mg/m^3
Oxide
TEEL-0: 0.59 mg/m^3
PAC-1: 1.77 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 59 mg/m^3

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1999; France: VME 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.5 mg/m^3, 1999; Switzerland: MAK-W 0.5 mg/m^3, 1999; United Kingdom: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg[Hf]/m^3. Several states have set guidelines or standards for hafnium in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II(5), Method #S-194 or OSHA Analytical Method ID-121.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of eyes, skin, and mucous membranes.

Long Term Exposure: Lungs may be affected by repeated or prolonged exposure. May cause liver damage.

Points of Attack: Eyes, skin, lungs, liver, and mucous membranes.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00008-4

filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m*^{3}*:* Sa:Cf (APF = 25) (any powered, air-purifying respirator with a dust and mist filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m*^{3}*:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100) or SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie* (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 50 mg/m*^{3}*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SaF: Pd,Pp (APF = 2000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe (*dry powder is a strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Dry hafnium powder requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.2 and Packing Group II. Hafnium powder, wetted with not <25% water (a visible excess of water must be present) (a) mechanically produced, particle size <53 μm; (b) chemically produced, particle size <840 μm requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery.

Halothane H:0110

Molecular Formula: $C_2HClBrF_3$

Common Formula: $CF_3CHBrCl$

Synonyms: Anestan; 2-Bromo-2-chloro-1,1,1-trifluoro-; 2-Bromo-2-chloro-1,1,1-trifluoroethane; Chalothane; Ethane, 2-bromo-2-chloro-1,1,1-thrifluoro-; Fluotane; Fluothane; Halotan; Halsan; Narcotane; 1,1,1-Trifluoro-2-bromo-2-chloroethane; 1,1,1-Trifluoro-2-chloro-2-bromoethane; 2,2,2-Trifluoro-1-chloro-1-bromoethane

CAS Registry Number: 151-67-7

RTECS® Number: KH6475000

EC Number: 205-796-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Halothane is a highly volatile, nonflammable, colorless liquid. Sweet odor. Odor threshold = 33 ppm. Molecular weight = 197.39; Specific gravity (H_2O:1) = 1.87; Boiling point = 50°C; Freezing/Melting point = − 118°C; Relative vapor density (air = 1) = 2.9; Vapor pressure = 244 mmHg@20°C.

Incompatibilities: May attack rubber and some plastics; sensitive to light. Light causes decomposition. May be stabilized with 0.01% thymol.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2 ppm/16.2 mg/m^3 [60-min exposure to wasted anesthetic gas] Ceiling Concentration.

ACGIH TLV®[1]: 50 ppm/404 mg/m^3 TWA; not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: 5 ppm/41 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group B.

Determination in Air: Use OSHA Analytical Method #29.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.30$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate the respiratory tract causing coughing and wheezing. May affect the cardiovascular system with low blood pressure and abnormal heartbeat; and may affect central nervous system. High levels of exposure may cause dizziness, lightheadedness, nausea, vomiting, and very high levels can cause unconsciousness. Medical observation is indicated. *Inhalation:* Exposure to 4000 ppm can cause amnesia and impairment of manual dexterity. Exposure to 10,000 ppm can cause anesthesia. Liver impairment has occurred from use as an anesthetic. *Skin:* Repeated or prolonged application can destroy the skin. Halothane gives rise to only a very low incidence of postoperative nausea and is generally safe, which accounts for its widespread use.

Long Term Exposure: May affect the liver and kidneys. Reported to have caused irregular menstrual period, headache, fatigue, and unconsciousness. Halothane has also been shown to cause birth defects in rats. May cause reproductive toxicity in humans. Experiments in laboratory animals have shown that continuous exposures of 15−50 ppm may cause liver damage.

Points of Attack: Liver, kidneys, skin, respiratory system, cardiovascular system, central nervous system, reproductive system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. EKG. If symptoms develop or overexposure has occurred, repeat these tests. More than light alcohol consumption may exacerbate liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Prevent skin contact. **8 h:** polyvinyl alcohol gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area, away from direct sunlight, oxidizers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable liquid. Poisonous gases, including hydrogen chloride, hydrogen fluoride, and hydrogen bromide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 63

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Halothane*. Trenton, NJ

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Halothane*. Albany, NY: Bureau of Toxic Substance Assessment

Helium H:0120

Molecular Formula: He
Synonyms: Helium, elemental
CAS Registry Number: 7440-59-7
RTECS® Number: MH6520000
UN/NA & ERG Number: UN1046 (Helium, compressed)/121; UN1963 [Helium, refrigerated liquid (cryogenic liquid)]/120
EC Number: 231-168-5

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Helium is a colorless, odorless, and tasteless gas. It is nonflammable. Molecular weight = 4.0; Boiling point = −269°C; Freezing/Melting point = − 272°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: It is used in weather balloons and in welding gases. Liquid helium is used as a closed system cooling agent.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: simple asphyxiant.
Protective Action Criteria (PAC)
TEEL-0: 65,000 ppm
PAC-1: 65,000 ppm
PAC-2: 230,000 ppm
PAC-3: 400,000 ppm

No occupational exposure limits have been established for this substance. Large amounts of helium will, however, decrease the amount of available oxygen. Oxygen content should never be below 19%.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Helium can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out and even die due to suffocation from lack of oxygen. Contact with liquid helium can cause frostbite.

Long Term Exposure: Unknown at this time.

First Aid: If frostbite has occurred, seek medical attention immediately; *do not* rub the affected areas or flush them with water. In order to prevent further tissue damage, *do not* attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention promptly. *Breathing:* Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: *Clothing:* Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn.

Respirator Selection: Exposure to helium gas is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in the positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Liquid helium should be stored and transferred under positive pressure to prevent infiltration of air and other gasses. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Helium, compressed, requires a shipping label of “NONFLAMMABLE GAS.” It falls in Hazard Class 2.2. Helium, *refrigerated liquid* (cryogenic liquid), requires a shipping label of “NONFLAMMABLE GAS.” It falls in Hazard Class 2.2.

Spill Handling: If liquid helium is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stop the leak or move container to a safe area and allow the liquid to evaporate. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Fire Extinguishing: Helium gas may burn but does not readily ignite. Stop flow of gas. Use extinguisher suitable for surrounding fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure

position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Helium*. Trenton, NJ

Hematite (underground mining)

H:0130

Molecular Formula: Fe_2O_3

Synonyms: Bloodstone; Haematite; Hematite, red; Iron ore; Iron oxide; Red iron ore

CAS Registry Number: 1317-60-8; 1309-37-1 (ferric oxide, Fe_2O_3)

RTECS® Number: MH7600000

EC Number: 215-168-2 (diiron trioxide; protohematite; CAS 1309-37-1)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal No Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; (*underground mining with exposure to radon*) Human Sufficient Evidence (underground mining with exposure to radon), *carcinogenic to humans*, Group 1, 1998.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent. (CAS: 1309-37-1).

Description: Hematite is a noncombustible, black to black-red or brick-red mineral (iron ore) composed mainly of ferric oxide, Fe_2O_3. See also *Iron oxide*.

Potential Exposure: Compound Description: Tumorigen (as Fe_2O_3). Hematite, as an iron ore composed mainly of ferric oxide, is a major source of iron and is used as a pigment for rubber, paints, paper, linoleum, ceramics, dental restoratives, and as a polishing agent for glass and precious metals. It is also used in electrical resistors, semiconductors, magnets, and as a catalyst. Human exposure to hematite from underground hematite mining is principally through inhalation and/or ingestion of dusts. No estimates are available concerning the number of underground miners exposed.

Incompatibilities: Contact with hydrogen peroxide, ethylene oxide, calcium hypochlorite will cause explosion. Violent reaction with powdered aluminum, hydrazine, hydrogen trisulfide.

Permissible Exposure Limits in Air

OSHA PEL: 10 mg[Fe]/m^3 TWA (dust and fume).

ACGIH TLV®[1]: 5 mg[Fe]/m^3 (vapor, dust) TWA; not classifiable as a human carcinogen (2005).

DFG MAK: 1.5 mg[Fe]/m^3 respirable fraction.

Protective Action Criteria (PAC)

Ferric oxide (1309-37-1)

TEEL-0: 10 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

NIOSH IDLH: 2500 mg[Fe]/m^3.

Arab Republic of Egypt: TWA 3 ppm (5 mg/m^3) (fume), 1993; Australia: TWA 5 mg/m^3 (fume), 1993; Austria: MAK 6 mg/m^3 (*dust*), 1999; Denmark: TWA 3.5 mg[Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 mg/m^3 (fume), 1999: MAC-TGG 5 mg[Fe]/m^3, 2003; MAC-TGG 10 mg/m^3, 2003; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 10 mg/m^3 (fume), 1993; Poland: MAC (TWA) (fume) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Sweden: NGV 3.5 mg/m^3 (fume), 1999; Switzerland: MAK-W 6 mg/m^3) (fume), 1999; Thailand: TWA 10 mg/m^3 (fume), 1993; Turkey: TWA 10 mg/m^3 (fume), 1993; United Kingdom: TWA 5 mg[Fe]/m^3; STEL 10 mg[Fe]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 4 mg/m^3 in workplace air.

Determination in Air: As iron oxide, use NIOSH Analytical Methods #7300, #7301,#7303, #9102; OSHA Analytical Methods ID-121, ID-125G.

Routes of Entry: Dust inhalation.

Harmful Effects and Symptoms

Long Term Exposure: There is sufficient evidence for the carcinogenicity in humans of underground hematite mining (with exposure to radon). Underground hematite miners have a high incidence of lung cancer, whereas surface hematite miners do not. It is not known whether this excess risk may be due to hematite; to radon (a known lung carcinogen); to inhalation of ferric oxide or silica; or to a combination of these or other factors. Some studies of metal workers exposed to ferric oxide dusts have shown an increased incidence of lung cancer, while other studies have not. The influence of factors in the workplace, other than ferric oxide, cannot be eliminated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol

($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 mg/m³*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. *125 mg/m³*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m³*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *2500 mg/m³*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from other storage containers to process containers A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding fires. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Heptachlor H:0140

Molecular Formula: $C_{10}H_5Cl_7$

Synonyms: Aahepta; Agroceres; Arbinex 30TN; 3-Chlorochlordene; Drinox; E 3314; ENT15,152; GPKH; Hepta; Heptachlorane; Heptachlore; Heptachlore (French); 3,4,5,6,7,8,8a-Heptachlorodicyclopentadiene; 3,4,5,6,7,8,8-Heptachlorodicyclopentadiene; 1,4,5,6,7,10,10-Heptachloro-4,7,8,9-tetrahydro-4,7-endomethyleneindene; 1(3a),4,5,6,7,8,8-Heptachloro-3a(1),4,7,7a-tetrahydro-4,7-methanoindene; 1,4,5 ,6,7,8,8a-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanol-1H-indene; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7,7a-tetrahydro-4,7-methelene indene; 1,4,5,6,7,8,8-Heptachlor-3a,4,7,7,7a-tetrahydro-4,7-endo-methano inden (German); Heptacloro (Spanish); Heptagran; Heptamul; Heptox; Indene; 4,7-Methanoindene, 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-; NCI-C00180; Rhodiachlor; Velsicol 104

Epoxide: ENT 25,584; Epoxyheptachlor; HCE; 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan; 2,3,5,6,7,7-Heptachloro-1a,1b,5,5a,6,6a-hexahydro-2,5-methano-2H-indeno (1,2-b)oxirene; Heptaclorepoxido (Spanish); 4,7-Methanoindan, 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a, 4,7,7a-tetrahydro; Velsicol 53-CS-17

CAS Registry Number: 76-44-8; *(alt.)* 23720-59-4; *(alt.)* 37229-06-4

RTECS® Number: PC0700000

UN/NA & ERG Number: UN2761/151

EC Number: 200-962-3 [*Annex I Index No.:* 602-046-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B 1991; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

Persistent Organic Pollutants (UN).

US EPA Gene-Tox Program, Positive/limited: Carcinogenicity—mouse/rat; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (many countries) (UN).[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): P059; D031.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.008 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0012; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8270 (10).

Safe Drinking Water Act: MCL, 0.0004 mg/L; MCLG, zero.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

California Proposition 65 Chemical: Cancer 7/1/88.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R33; R40; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pure heptachlor is a white powder; technical-grade is a tan powder and has a lower level of purity. The technical-grade is the form used most often as a pesticide. Its odor is somewhat like camphor. Heptachlor is both a breakdown product and a component of the pesticide chlordane (approximately 10% by weight). It is a noncombustible solid, but may be dissolved in flammable liquids which may change the physical properties shown here. Molecular weight = 373.30; Boiling point = (decomposes) 145°C; Freezing/Melting point = 95°C (pure); 46–74°C (technical product); Vapor pressure = 0.0004 mmHg[EPA]; 0.0003 mmHg at 25°C[NIOSH]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.0006%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those involved in the manufacture, formulation, and application of this insecticide for control of cotton boll weevil. Registration of heptachlor-containing pesticides has been canceled by the US EPA with the exception of its use for termite control outside of dwellings by in-ground (subsurface) insertion. Infants have been exposed to heptachlor and heptachlor epoxide through mothers' milk, cows' milk, and commercially prepared baby foods. It appears that infants raised on mothers' milk run a greater risk of ingesting heptachlor epoxide than if they were fed cows' milk and/or commercially prepared baby food. Persons living and working in or near heptachlor-treated areas have a particularly high inhalation exposure potential. Heptachlor has been found in at least 206 of the 1662 current or former EPA National Priorities List (NPL) sites. Heptachlor epoxide has been found in at least 195 NPL sites.

Incompatibilities: Reacts with strong oxidizers. Attacks metal. Forms hydrogen chloride gas with iron and rust above 74°C.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA[skin].

NIOSH REL: 0.5 mg/m^3 TWA[skin]; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.05 mg/m^3 TWA[skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: potential occupational carcinogen, 35 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 35 mg/m^3

DFG MAK: 0.5 mg/m^3, inhalable fraction [skin]; Peak Limitation Category II(2); Pregnancy Risk Category D; Carcinogen Category 4.

Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: MAK 0.5 mg/m^3, [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, [skin], 2003; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999; Turkey:

TWA 1 mg/m^3, [skin], 1993; United Kingdom: LTEL 0.5 mg/m^3; STEL 2 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia has set[35, 43] a much lower limit of 0.01 mg/m^3 in work-place air and values in ambient air of residential areas of 0.001 mg/m^3 on a once daily basis and 0.0002 mg/m^3 on a daily average basis. Several states have set guidelines of standards for heptachlor in ambient air[60] ranging from 0.0068 μg/m^3 (Massachusetts) to 0.18 μg/m^3 (Pennsylvania) to 1.19 μg/m^3 (Kansas) to 1.7 μg/m^3 (New York) to 2.5 μg/m^3 (Connecticut and South Carolina) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 12.0 μg/m^3 (Nevada).

Determination in Air: Heptachlor or heptachlor epoxide can be detected by smell at around 0.3 mg in a cubic meter of air (0.3 mg/m^3). Use NIOSH II(5), Method #S-287; OSHA Analytical Method 76448.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0038 μg/L as a 24-h average, never to exceed 0.52 μg/L. *To protect saltwater aquatic life:* 0.0036 μg/L as a 24-h average, never to exceed 0.053 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is imposed by a concentration of 2.78 ng/L (0.00278 μg/L).[6] The US EPA has set health advisories[47] for heptachlor and heptachlor epoxide. The lifetime health advisory is 17.5 μg/L for heptachlor and 0.4 μg/L for heptachlor epoxide. Mexico[35] has set limits of 0.018 mg/L (18 μg/L) for both heptachlor and heptachlor epoxide in drinking water; 0.2 μg/L for heptachlor in coastal waters and 2.0 μg/L for heptachlor in estuaries. Russia has set a limit of 50 μg/L of heptachlor in water bodies used for domestic purposes.[35,43] WHO[35] has set a limit of 0.1 μg/L in drinking water for heptachlor. Several states have set guidelines and standards for heptachlor and heptachlor epoxide in drinking water.[61] Illinois has set a standard of 0.1 μg/L for both heptachlor and heptachlor epoxide. Guidelines have been set for heptachlor ranging from 0.02 μg/L (California) to 0.1 μg/L (Minnesota) to 0.104 μg/L (Kansas) to 0.23 μg/L (Maine) to 0.50 μg/L (Arizona). Guidelines have been set for heptachlor epoxide in drinking water[61] ranging from 0.006 μg/L (Kansas and Minnesota) to 0.10 μg/L (California). The EPA has recently[62] proposed drinking water maximum contaminant levels for heptachlor at 0.4 μg/L and heptachlor epoxide at 0.2 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{\text{ow}} = 5.35$. Fish Tox = 0.05276000 ppb MATC (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Heptachlor can cause a feeling of anxiety, headache, dizziness, weakness, a sensation of "pins and needles" on the skin, and muscle twitching. Heptachlor has been demonstrated to be highly toxic to aquatic life; to persist for prolonged periods in the environment; to bioconcentrate in organisms at various trophic levels; and to exhibit carcinogenic activity in mice. Exposure symptoms in animals include tremors, convulsions, and liver damage. The principal metabolite of heptachlor, heptachlor epoxide is more acutely toxic than heptachlor. Human Tox = 0.40000 ppb MCL (EXTRA HIGH).

Long Term Exposure: High or repeated exposure may cause brain damage with personality changes, decreased memory, difficult coordination and concentration. Higher levels can cause tremor, seizures, unconsciousness, and death. This substance is possibly carcinogenic to humans. There is limited evidence that heptachlor may damage the developing fetus. May cause liver and kidney damage.

Points of Attack: Central nervous system, liver. Cancer site in animals: liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Evaluation for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Heptachlor (organochloride pesticides, solid, toxic, n.o.s.) requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including chlorine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s minimum for primary combustion; 1760°C, 1.0 s for secondary combustion) with adequate scrubbing and ash disposal facilities. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (1980). *Heptachlor: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Heptachlor, Health and Environmental Effects Profile No. 108*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Heptachlor Epoxide, Health and Environmental Effects Profile No. 109*. Washington, DC: Office of Solid Waste

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US Public Health Service. (October 1987). *Toxicological Profile for Heptachlor/Heptachlor Epoxide*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (March 1998). *Hazardous Substances Fact Sheet: Heptachlor*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Heptachlor epoxide H:0150

Molecular Formula: $C_{10}H_5Cl_7O$

Synonyms: ENT 25,584; Epoxyheptachlor; HCE; 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan; 2,3,5,6,7,7-Heptachloro-1a,1b,5,5a,6,6a-hexahydro-2,5-methano-2H-indeno (1,2-b) oxirene; Heptaclorepoxido (Spanish); 4,7-Methanoindan, 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a, 4,7,7a-tetrahydro; Velsicol 53-CS-17

CAS Registry Number: 1024-57-3

RTECS® Number: PB9450000

UN/NA & ERG Number: UN2761/151

EC Number: 213-831-0 [*Annex I Index No.:* 602-063-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B 1991;EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (many countries) (UN).[13]

Carcinogenicity: (Animal Positive) IARC: NCI.[9]

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane.

US EPA Hazardous Waste Number (RCRA No.): D031.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.008 mg/L.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.016; Nonwastewater (mg/kg), 0.066.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (1); 8270 (10).
Safe Drinking Water Act: MCL, 0.0002 mg/L; MCLG, zero.
Reportable Quantity (RQ): 1 lb (0.454 kg).
California Proposition 65 Chemical: Cancer 7/1/88.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R33; R40; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Like pure heptachlor, heptachlor epoxide is a white powder that does not explode easily. Heptachlor epoxide is an oxidation product of heptachlor formed by plants and animals, including humans, after exposure to heptachlor. About 20% of heptachlor is changed within hours into heptachlor epoxide in the environment and in the body. It is also present as a contaminant in heptachlor. It was not manufactured and was not used as an insecticide like heptachlor. Molecular weight = 389.30; Freezing/Melting point = 160−162°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide. Infants have been exposed to heptachlor and heptachlor epoxide through mothers' milk, cows' milk, and commercially prepared baby foods. It appears that infants raised on mothers' milk run a greater risk of ingesting heptachlor epoxide than if they were fed cows' milk and/or commercially prepared baby food. Persons living and working in or near heptachlor treated areas have a particularly high inhalation exposure potential. Heptachlor epoxide has been found in at least 195 EPA National Priorities List.

Incompatibilities: Melted heptachlor with iron and rust.

Permissible Exposure Limits in Air
See also previous record for "Heptachlor."
ACGIH TLV®[1]: 0.05 mg/m^3 TWA[skin]; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC)
TEEL-0: 0.05 mg/m^3
PAC-1: 0.15 mg/m^3
PAC-2: 6 mg/m^3
PAC-3: 6 mg/m^3

Determination in Air: Heptachlor or heptachlor epoxide can be detected by smell at around 0.3 mg in a cubic meter of air (0.3 mg/m^3). Use NIOSH II(5), Method #S-287; OSHA Analytical Method 76448.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.0038 μg/L as a 24-h average, never to exceed 0.52 μg/L. *To protect saltwater aquatic life:* 0.0036 μg/L as a 24-h average, never to exceed 0.053 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is imposed by a concentration of 2.78 ng/L (0.00278 μg/L).[6] The US EPA has set health advisories[47] for heptachlor and heptachlor epoxide. The lifetime health advisory is 17.5 μg/L for heptachlor and 0.4 μg/L for heptachlor epoxide. Mexico[35] has set limits of 0.018 mg/L (18 μg/L) for both heptachlor and heptachlor epoxide in drinking water; 0.2 μg/L for heptachlor in coastal waters and 2.0 μg/L for heptachlor in estuaries. Russia has set a limit of 50 μg/L of heptachlor in water bodies used for domestic purposes.[35,43] WHO[35] has set a limit of 0.1 μg/L in drinking water for heptachlor. Several states have set guidelines and standards for heptachlor and heptachlor epoxide in drinking water.[61] Illinois has set a standard of 0.1 μg/L for both heptachlor and heptachlor epoxide. Guidelines have been set for heptachlor ranging from 0.02 μg/L (California) to 0.1 μg/L (Minnesota) to 0.104 μg/L (Kansas) to 0.23 μg/L (Maine) to 0.50 μg/L (Arizona). Guidelines have been set for heptachlor epoxide in drinking water[61] ranging from 0.006 μg/L (Kansas and Minnesota) to 0.10 μg/L (California). The EPA has recently[62] proposed drinking water maximum contaminant levels for heptachlor at 0.4 μg/L and heptachlor epoxide at 0.2 μg/L.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Heptachlor can cause a feeling of anxiety, headache, dizziness, weakness, a sensation of "pins and needles" on the skin, and muscle twitching. Heptachlor has been demonstrated to be highly toxic to aquatic life; to persist for prolonged periods in the environment; to bioconcentrate in organisms at various trophic levels; and to exhibit carcinogenic activity in mice. Exposure symptoms in animals include tremors, convulsions, and liver damage. The principal metabolite of heptachlor, heptachlor epoxide is more acutely toxic than heptachlor. LD_{50} = (oral-rat) 40 mg/kg.

Long Term Exposure: High or repeated exposure may cause brain damage with personality changes, decreased memory, difficult coordination and concentration. Higher levels can cause tremor, seizures, unconsciousness, and death. This substance is possibly carcinogenic to humans. There is limited evidence that heptachlor may damage the developing fetus. May cause liver and kidney damage.

Points of Attack: Central nervous system, liver. Cancer site in animals: liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Evaluation for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from ferrous metals. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s minimum for primary combustion; 1760°C, 1.0 s for secondary combustion) with adequate scrubbing and ash disposal facilities. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (1980). *Heptachlor: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Heptachlor, Health and Environmental Effects Profile No. 108*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Heptachlor Epoxide, Health and Environmental Effects Profile No. 109*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 76−78 (1981) and 6, No. 5, 16−49 (1986)

US Public Health Service. (October 1987). *Toxicological Profile for Heptachlor/Heptachlor Epoxide*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

n-Heptane H:0160

Molecular Formula: C_7H_{16}

Common Formula: $CH_3(CH_2)_5CH_3$

Synonyms: Dipropal methane; Dipropyl methane; Dipropylmethane; *n*-Heptane; Heptyl hydride; Normal heptane; Skelly-Solve C

CAS Registry Number: 142-82-5
RTECS® Number: MI7700000
UN/NA & ERG Number: UN1206/128
EC Number: 205-563-8 [*Annex I Index No.:* 601-008-00-2]
Regulatory Authority and Advisory Bodies
Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: Risk phrases: F, Xn, N; R11; R38; R65; R67; R50/53; Safety phrases: S2; S9; S16; S29; S33; S60; S61; S62 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *n*-Heptane is a clear liquid which is highly flammable and volatile with a mild, gasoline-like odor. The odor threshold is 40−547 ppm; also reported at 230 ppm. Molecular weight = 100.23; Specific gravity (H_2O:1) = 0.68; Boiling point = 98.3°C; Freezing/Melting point = −90.6°C; Vapor pressure = 40 mmHg at 25°C; Flash point = −4°C; Autoignition temperature = 204°C[17]; 285°C. Explosive limits: LEL = 1.1%; UEL = 6.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.0003%.

Potential Exposure: Compound Description: Drug; Human Data. *n*-Heptane is used in graphics, textiles, adhesives, and coatings; as an industrial solvent and in the petroleum refining process; as a standard in testing knock of gasoline engines.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings. May accumulate static electric charges that can ignite its vapors.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.10 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 500 ppm/2000 mg/m^3 TWA.
NIOSH REL: 85 ppm/350 mg/m^3 TWA; 440 ppm/1800 mg/m^3 [15 min] Ceiling Concentration.
ACGIH TLV®[1]: 400 ppm/1640 mg/m^3 TWA; 500 ppm/2050 mg/m^3 STEL.
NIOSH IDLH: 750 ppm.
Protective Action Criteria (PAC)
TEEL-0: 400 ppm
PAC-1: 440 ppm
PAC-2: 440 ppm
PAC-3: 750 ppm
DFG MAK: 500 ppm/2100 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.
Australia: TWA 400 ppm (1600 mg/m^3); STEL 500 ppm, 1993; Austria: MAK 500 ppm (2000 mg/m^3), 1999; Belgium: TWA 400 ppm (1640 mg/m^3); STEL 500 ppm, 1993; Denmark: TWA 200 ppm (820 mg/m^3), 1999; Finland: TWA 300 ppm (1200 mg/m^3); STEL 500 ppm (2000 mg/m^3), 1999; France: VME 400 ppm (1600 mg/m^3), 1999; Japan: 200 ppm (820 mg/m^3), 1999; the Netherlands: MAC-TGG 1200 mg/m^3, 2003; Norway: TWA 200 ppm (800 mg/m^3), 1999; the Philippines: TWA 500 ppm (2000 mg/m^3), 1993; Poland: MAC (TWA) 1200 mg/m^3, MAC (STEL) 2000 mg/m^3, 1999; Russia: TWA 200 ppm, 1993; Sweden: NGV 200 ppm (800 mg/m^3), KTV 300 ppm (1200 mg/m^3), 1999; Switzerland: MAK-W 400 ppm (1600 mg/m^3), KZG-W 800 ppm (3200 mg/m^3), 1999; Turkey: TWA 500 ppm (2000 mg/m^3), 1993; United Kingdom: LTEL 400 ppm (1600 mg/m^3); STEL 500 ppm, 1993: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 500 ppm. Several states have set guidelines or standards for heptane in ambient air[60] ranging from 7.0 mg/m^3 (Connecticut and South Dakota) to 16.0−20.0 mg/m^3 (North Dakota) to 24.5 mg/m^3 (Virginia) to 32.0 mg/m^3 (Florida and New York) to 38.095 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for Hydrocarbons, BP 36−126°C; OSHA Analytical Method 7.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.7$.

Routes of Entry: Inhalation of the vapor, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: *n*-Heptane irritates the eyes, skin, and respiratory tract. A narcotic at high concentrations. *n*-Heptane can cause dermatitis and mucous membrane irritation. Aspiration of the liquid may result in chemical pneumonitis, pulmonary edema, and hemorrhage. Systemic effects may arise without complaints of mucous membrane irritation. Exposure to high concentrations causes narcosis producing vertigo, a lack of coordination; intoxication characterized by hilarity, slight nausea, loss of appetite, and a persisting gasoline taste in the mouth. These effects may be first noticed on entering a contaminated area. *n*-Heptane may cause low order sensitization of the myocardium to epinephrine. Swallowing the liquid may cause chemical pneumonitis.

Long Term Exposure: The liquid defats the skin causing dryness and irritation. May affect the central nervous system, liver. Many petroleum solvents similar to heptane can cause brain damage that can affect memory, concentration, mood, sleep patters.

Points of Attack: Skin, respiratory system, lungs, peripheral nervous system.

Medical Surveillance: Preplacement examinations should evaluate the skin and general health, including respiratory, liver, and kidney function. Interview for brain effects. Consider cerebellar, autonomic and peripheral nervous system evaluation. Refer positive and borderline individuals for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact; **8 h**: nitrile rubber gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *750 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with heptane you should be trained on its proper handling and storage. Before entering confined space where heptane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind and use water spray to "knock down" vapor. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Document No. 77-151. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1. No. 6, 58−59

New Jersey Department of Health and Senior Services. (April, 2004). *Hazardous Substances Fact Sheet: Heptane*. Trenton, NJ

1-Heptanethiol H:0170

Molecular Formula: $C_7H_{16}S$

Synonyms: *n*-Heptylmercaptan; Heptyl mercaptan

CAS Registry Number: 1639-09-4

RTECS® Number: MJ1400000

UN/NA & ERG Number: UN1228/131

EC Number: 216-678-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1-Heptanethiol is a flammable, colorless liquid with a strong odor. Molecular weight = 132.29; Boiling point = 176°C; Freezing/Melting point = −43°C; Flash point = 46°C. Insoluble in water.

Potential Exposure: Used as a chemical intermediate for fuels, dyes, pharmaceuticals, and to make other chemicals.

Incompatibilities: Oxidizers, strong acids, strong bases, alkali metals, and reducing agents.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.5 ppm/2.7 mg/m^3 [15 min] Ceiling Concentration.

No TEEL available.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause headache, dizziness, nausea, and vomiting. High concentrations of mercaptans may cause cold extremities, rapid pulse, increased respiration, drowsiness, cyanosis, and unconsciousness.

Long Term Exposure: Unknown at this time.

Points of Attack: Eyes, skin, respiratory system, central nervous system, blood.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 5 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away

from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Mercaptans, liquid, flammable, toxic, n.o.s. require a label of "FLAMMABLE LIQUID, POISONOUS/ TOXIC MATERIALS." . It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including sulfur oxides, carbon monoxide, and hydrogen sulfide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: 1-Heptanethiol*. Trenton, NJ

Heptene H:0180

Molecular Formula: C_7H_{14}

Common Formula: $C_3H_7CH{=}CHC_2H_5$

Synonyms: 1-Ethyl-2-propyl ethylene; *n*-Heptene; 1-Heptene; 1-Heptylene; Heptylene

CAS Registry Number: 592-76-7

RTECS® Number: MU8815000

UN/NA & ERG Number: UN2278/128

EC Number: 209-767-8 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Heptene is a colorless liquid with a mild, gasoline-like odor. Molecular weight = 98.21; Boiling point = 94°C; Flash point $\leq 0°C$; Autoignition temperature = 260°C. Explosive limits: LEL = 1.0%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in use as a plant growth retardant or in organic synthesis.

Incompatibilities: Strong oxidizers can cause a fire and explosion hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1500 ppm

PAC-1: 5000 ppm

PAC-2: 40,000 ppm

PAC-3: 200,000 ppm

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Narcotic at higher concentrations; may act as a slight anesthetic. Inhalation can cause coughing, wheezing, and/or shortness of breath. May also act as simple asphyxiant.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with heptene you should be trained on its proper handling and storage. Before entering confined space where heptene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Spills on water may be handled with oil skimming equipment and sorbent (polyurethane) foams. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 29−30

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Heptene*. Trenton, NJ

Hexachlorobenzene H:0190

Molecular Formula: C_6Cl_6

Synonyms: Amatin; Anticarie; Benzene, hexachloro-; Bunt-Cure; Bunt-No-More; Ceku C.B.; Co-Op Hexa; Granox NM; HCB; Hexa C.B.; Hexachlorbenzol (German);

Hexaclorobenceno (Spanish); Julin's carbon chloride; No Bunt; No Bunt 40; No Bunt 80; No Bunt liquid; Pentachlorophenyl chloride; Perchlorobenzene; Saatbenizfungizid (German); Sanocid; Sanocide; Smut-Go; Snieciotox

CAS Registry Number: 118-74-1

RTECS® Number: DA2975000

UN/NA & ERG Number: UN2729/152

EC Number: 204-273-9 [*Annex I Index No.*: 602-065-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 2000; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Negative: Rodent dominant lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U127; D032.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.13 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 10.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (0.05); 8270 (10).

Safe Drinking Water Act: MCL, 0.001 mg/L; MCLG, zero.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87; Developmental/Reproductive toxin 1/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release) as HCB.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R45; R48/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hexachlorobenzene is a solid, crystallizing in needles. Molecular weight = 284.76; Boiling point = 323−326°C; Freezing/Melting point = 231°C; Flash point = 242°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Hexachlorobenzene was used as a fungicide, an additive for pyrotechnic compositions, and as wood preservative. It was used widely as a pesticide to protect seeds of onions and sorghum, wheat, and other grains against fungus until 1965. This material was used to make fireworks, ammunition for military uses, synthetic rubber, as a porosity controller in the manufacture of electrodes, as an intermediate in dye manufacture, in organic synthesis. It is formed as a by-product of making other chemicals, in the waste streams of chloralkali and wood-preserving plants, and when burning municipal waste. Currently, there are no commercial uses of hexachlorobenzene in the United States.

Incompatibilities: Reacts violently with oxidizers, dimethyl formamide above 65°C.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®[1]: 0.002 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.002 mg/m^3

PAC-1: 0.006 mg/m^3

PAC-2: 1.5 mg/m^3

PAC-3: 200 mg/m^3

DFG MAK: [skin]; Carcinogen Category 4; Pregnancy Risk Group D.

France: carcinogen, 1993; the Netherlands: MAC-TGG 0.03 mg/m^3, 2003; Poland: MAC (TWA) 0.5 mg/m^3, 1999; Russia: STEL 0.9 mg/m^3, [skin], 1993; United Kingdom: carcinogen, 2000. Russia set a MAC of 0.013 mg/m^3 in ambient air of residential areas. The Czech Republic[35] has set a TWA in work-place air of 1.0 mg/m^3 and an STEL of 2.0 mg/m^3. Several states have set guidelines or standards for hexachlorobenzene in ambient air[60] ranging from zero in North Dakota to 0.48 ppb (Pennsylvania) to 0.03 μg/m^3 (New York).

Determination in Air: Use NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons.

Permissible Concentration in Water: The US EPA recommended that drinking water should not contain more than 0.05 mg of hexachlorobenzene per liter of water (0.05 mg/L) in water that children drink and should not contain more than 0.2 mg/L in water that adults drink for longer periods (about 7 years). The EPA has set a maximum contamination level (MCL) of 0.001 mg/L in drinking water. Russia set a MAC of 0.05 mg/L in water bodies used for domestic purposes.[35,43] Several states have set guidelines for hexachlorobenzene in drinking water[61] ranging from 0.02 μg/L (Arizona) to 0.20 μg/L (Kansas) to 0.21 μg/L (Minnesota) to 5.4 μg/L (Maine). The World Health Organization (WHO)[35] has set a limit of 0.01 μg/L in drinking water.

Determination in Water: Methylene chloride extraction followed by concentration and gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625). Fish Tox = 1760.07814000 ppb MATC (VERY LOW).

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* Coughing, shortness of breath, and labored breathing have been reported from large, unmeasured doses or by decomposition to chlorine. *Skin:* Can cause irritation. Exposure to sunlight with (or soon after) exposure can increase effects. Following this reaction, changes in skin pigment and blistering may follow. Red or dark urine may be noticed. High doses may cause redness, pain, and serious burns. *Eyes:* May cause irritation. Higher doses may cause redness, pain, and blurred vision. *Ingestion:* Headache, dizziness, nausea, vomiting, numbness of hands and arms, apprehension, excitement, tremors, partial paralysis of arms and legs, loss of muscle control, loss of sensory perception, convulsions, and coma may result from high doses. Human Tox = 1.00000 ppb (HIGH).

Long Term Exposure: May affect the lungs, liver, skin, and nervous system. This substance causes cancer in laboratory animals, and may be carcinogenic to humans. May damage the developing fetus. May cause liver, thyroid, kidney, and immune system damage. High, prolonged or repeated exposure may affect the nervous system. Repeated skin exposure can lead to permanent skin changes and increased hair growth. Animal tests show that this substance possibly causes toxic effects upon human reproduction. Ingestion of contaminated grain, estimated at doses of 0.05−0.2 g/day, resulted in porphyria cutanea tarda (PCT) in Turkey, which is characterized by red-colored urine, skin sores, change in skin color, arthritis, and problems of the liver, nervous system, and stomach. The following symptoms were also reported: enlarged livers, porphyria in the blood, loss or appetite, weight loss, and wasting of skeletal muscles. Severe and long-standing poisoning caused abnormal hair growth, loss of vision, wasting of hands, black discoloration, and skin sores which became ulcerated, healing with pigmented scars. Breast-fed children developed “pink-sore,” a condition which was 95% fatal. Toxic effects on blood and active symptoms persisted up to 20 years. Studies in animals show that ingestion of this chemical can damage the liver, thyroid, nervous system, bones, kidneys, blood, immune and endocrine system.

Points of Attack: Liver, skin, thyroid.

Medical Surveillance: Liver function tests. Thyroid function tests. Evaluation by a qualified allergist and/or dermatologist. Iron as a dietary supplement could increase liver damage. consult a physician before taking supplements. Guard against sunlight exposure to contaminated skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For ingestions of less than 10 mg/kg body weight occurring less than an hour before treatment, induce emesis. For ingestions of more than 10 mg/kg body weight occurring less than an hour before treatment, use gastric lavage. For ingestion occurring more than an hour before treatment, use activated charcoal. There is no specific antidote, and supervision for at least 72 h is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, dimethyl formamide, and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including chlorine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration is most effective at 1300°C and 0.25 s. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Chlorinated Benzenes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (December 1979). *Status Assessment of Toxic Chemicals: Hexachlorobenzene*, Report EPA-600/2-79-210g. Cincinnati, OH

US Environmental Protection Agency. (April 30, 1980). *Hexachlorobenzene, Health and Environmental Effects Profile No. 110*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 88−92

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Hexachlorobenzene (HCB)*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Hexachlorobenzene*. Trenton, NJ

US Department of Health and Human Services. (September 1997). *ATSDR ToxFAQs, Hexachlorobenzene*. Atlanta, GA

Hexachlorobutadiene H:0200

Molecular Formula: C_4Cl_6

Common Formula: $CCl_2{=}CCl{-}CCl{=}CCl_2$

Synonyms: 1,3-Butadiene, 1,1,2,3,4,4-hexachloro-; Butadiene, hexachloro-; C46; Dolen-Pur; GP-40-66: 120; HCBD; 1,1,2,3,4,4-Hexachloro-1,3-butadiene; Hexachloro-1,3-butadiene; Hexachlorobutadiene; Hexaclorobutadieno (Spanish); Perchloro-1,3-butadiene; Perchlorobutadiene

CAS Registry Number: 87-68-3

RTECS® Number: EJ0700000

UN/NA & ERG Number: UN2279/151

EC Number: 201-765-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

NTP: Toxicity studies, RPT#TOX-01, October 2000.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U128; D033.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 5.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (5); 8270 (10).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hexachlorobutadiene is a clear, colorless liquid with a faint, turpentine-like odor. Molecular weight = 260.74; Specific gravity (H_2O:1) = 1.55; Boiling point = 212°C; Freezing/Melting point = −21.1°C; Vapor pressure = 0.2 mmHg at 20°C; Flash point = 90°C; Autoignition temperature = 610°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Hexachlorobutadiene is used as a solvent, heat-transfer fluid, transformer fluid, hydraulic fluid, as a solvent for elastomers, as a wash liquor for removing higher hydrocarbons.

Incompatibilities: Strong reaction with oxidizers, aluminum powder. Attacks aluminum, some plastics, rubber, and coatings

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.66 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.02 ppm/0.24 mg/m^3 TWA [skin]; suspected occupational carcinogen; limit exposures to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.02 ppm/0.21 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)*
TEEL-0: 0.02 ppm
PAC-1: **1** ppm
PAC-2: **3** ppm
PAC-3: **10** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin]; Carcinogen Category 3B.

Australia: TWA 0.02 ppm (0.24 mg/m^3), [skin], carcinogen, 1993; Austria [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.02 ppm (0.21 mg/m^3), [skin], carcinogen, 1993; Finland: carcinogen, 1999; the Netherlands: MAC-TGG 0.24 mg/m^3, 2003; Norway: TWA 0.02 ppm (0.24 mg/m^3), 1999; Switzerland: MAK-W 0.02 ppm (0.24 mg/m^3), [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[35, 43] has set a MAC value of 0.001 mg/m^3 for ambient air in residential areas on a momentary basis and 0.0002 mg on a daily average basis. Several states have set guidelines or standards for hexachlorobutadiene in ambient air[60] ranging from zero (North Dakota) to 0.72 μg/m^3 (Pennsylvania) to 0.80 μg/m^3 (New York) to 1.2 μg/m^3 (South Carolina) to 2.4 μg/m^3 (Connecticut, Florida and Virginia) to 6.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2543.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 90 μg/L on an acute toxicity basis and 9.3 μg/L on a chronic basis. *To protect saltwater aquatic life:* 32 μg/L on an acute toxicity basis. *For the protection of human health*: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is imposed by a concentration of 4.47 μg/L.[6] Russia[35,43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes. Kansas and Minnesota have set guidelines of 4.5 μg/L for hexachlorobutadiene in drinking water.[61]

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 4.88.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Hexachlorobutadiene can affect you when breathed in and by passing through your skin. The liquid is corrosive, contact can irritate and burn the skin and eyes. Vapors can irritate the eyes, skin, and respiratory tract.

Long Term Exposure: Hexachlorobutadiene should be handled as a carcinogen—with extreme caution. It may damage the developing fetus. Exposure can cause severe kidney damage. Hexachlorobutadiene may damage the liver. Repeated or prolonged contact may cause skin sensitization and allergy.

Points of Attack: Eyes, skin, respiratory system, kidneys. Cancer site in animals: kidney.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: kidney and liver function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.02 ppm*, use a MSHA/ NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard

EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers A regulated, marked area should be established where hexachlorobutadiene is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High temperature incineration with flue gas scrubbing.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Hexachlorobutadiene: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (1976). *Sampling and Analysis of Selected Toxic Substances. Task 1B—Hexachlorobutadiene*, EPA Report No. 560/6-76-015. Washington, DC: Office of Toxic Substances

US Environmental Protection Agency. (April 30, 1980). *Hexachlorobutadiene, Health and Environmental Effects Profile No. 111*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 71−75

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Hexachlorobutadiene*. Trenton, NJ

Hexachlorocyclohexanes H:0210

Molecular Formula: $C_6H_6Cl_6$

Synonyms: *Technical grade containing 68.7% α-BHC, 6.5% β-BHC, 13.5% γ-BHC:* BHC; Compound 666; DBH; ENT 8,601; Gammexane; HCCH; Hexa; Hexachlorocyclohexane; Hexachlorocyclohexane (mixed isomers); Hexachlorocyclohexane isomers; Hexacloran; Hexaclorociclohexano (Spanish); Hexaklon (in Sweden); Hexhexane; Hexylan; Jacutin; Latka-666 HCH

α-isomer: A13-09232; α-Benzenehexachloride; Benzene hexachloride-α-isomer; Benzene-*trans*-hexachloride; α-BHC; Cyclohexane 1,2,3,4,5,6-hexachloro-; Cyclohexane 1,2,3,4,5,6-hexachloro-α; Cyclohexane 1,2,3,4,5,6-hexachloro-a isomer; Cyclohexane 1,2,3,4,5,6-hexachloro-(a, dl); Cyclohexane 1,2,3,4,5,6-hexachloro-(1a,2a,3b,4a,5b,6b)-; Cyclohexane, α-1,2,3,4,5,6-hexachloro-; ENT9,232; Forlin; Gamaphex; α-HCH; α-Hexachloran; α-Hexachlorane; Hexachlorcyclohexan (German); α-1,2,3,4,5,6-Hexachlorcyclohexane; Hexachlorocyclohexan (German); α-Hexachlorocyclohexane; 1-a,2a,3b,4a,5b,6b-Hexachlorocyclohexane; 1,2,3,4,5,6-Hexachlorocyclohexane; 1a,2a,3b,4a,5b,6b-Hexachlorocyclohexane; Hexachlorocyclohexane; 1,2,3,4,5,6-Hexaclorociclohexano (Spanish); Isotox; Lindagam; α-Lindane; Silvano

β-isomer: β-Benzenehexachloride; β-BHC; ENT 9,233; β-HCH; β-1,2,3,4,5,6-Hexachlorocyclohexane; β-Hexachlorocyclohexane; 1-a,2-b,3-a,4-b,5-a,6-β-Hexachlorocyclohexane; β-Lindane

γ-isomer: see Lindane

δ-isomer: δ-Benzenehexachloride; δ-BHC; ENT9,234; δ-HCH; HCH, δ-; HCH-delta; δ-1,2,3,4,5,6-Hexachlorocyclohexane; δ-Hexachlorocyclohexane; 1-α,2-α,3-α,4-β,5-α,6-β-Hexachlorocyclohexane; δ-Lindane

CAS Registry Number: 608-73-1 (technical grade, mixture of α- and β-isomers); 319-84-6 (α-isomer); 319-85-7 (β-isomer); 58-89-9 (γ-isomer, see "Lindane"); 319-86-8 (δ-delta isomer); 6108-10-7 (δ epsilon-isomer)

RTECS® Number: GV3150000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 210-168-9 (BHC or HCH); 206-270-8 (α-isomer); 206-271-3 (β-isomer); 200-401-2 [*Annex I Index No.:* 602-043-00-6] (γ-isomer); 206-272-9 (δ-isomer)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal sufficient (*technical-grade & α-isomer; limited for the* β- & γ-*isomers*); Human Inadequate Evidence, Group 2B; NTP: Reasonably anticipated to be a human carcinogen. EPA (*technical grade, mixture of* α- *and* β-*isomers*): Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; EPA (β-isomer): Possible Human Carcinogen; EPA (δ- & ε-isomers): Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (many countries) (UN).[13]

Carcinogenicity: (Animal Positive) IARC.[9]

European/International Regulations (*technical grade*): Hazard Symbol: T, N; Risk phrases: R21; R25; R40; 5R0/53; Safety phrases: S1/2; S21; S36/37; S45-S60; S61.

All isomers:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Technical grade, mixture of α- and β-isomers:

Carcinogenicity: NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as HCH mixed isomers). See also lindane.

European/International Regulations (*technical grade*): Hazard Symbol: T, N; Risk phrases: R21; R25; R40; 5R0/53; Safety phrases: S1/2; S21; S36/37; S45-S60; S61; (*lindane*): Hazard Symbol: T, N; Risk phrases: R20/21; R25; R48/22; R64; R50/53; Safety phrases: S1/2; S13; S36/37; S45; S60; S61.

α-isomer:

Carcinogenicity: NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979.

US EPA Gene-Tox Program, Negative: *S. cerevisiae*—reversion.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.00014; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8250 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0.

List of Stockholm Convention POPs: Annex A (Elimination).

β-isomer:

Carcinogenicity: NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.00014; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8250 (40).

Reportable Quantity (RQ): 1 lb (0.454 kg).

List of Stockholm Convention POPs: Annex A (Elimination).

γ-isomer: See Lindane

δ-isomer:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (30).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Technical grade

California Proposition 65 Chemical: Cancer 10/1/87.

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*gamma*-isomer).

Description: BHC is a white-to-brownish crystalline solid with a musty, phosgene-like odor. Molecular weight = 290.82; Freezing/Melting point = 65°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. BCH consists of eight stereoisomers of which the gamma (γ) isomer is most insecticidally active and hence most important. See also "Lindane."

Potential Exposure: Compound Description: (technical grade) Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; (α-isomer) Agricultural Chemical; Tumorigen, Mutagen, Human Data; (β-isomer) Agricultural Chemical; Tumorigen; Reproductive Effector. The major commercial usage of BHC is based upon its insecticidal properties. α-BCH is used as an Agricultural Chemical; pesticide, pharmaceutical, and veterinary drug. The 7-isomer has the highest acute toxicity, but the other isomers are not without activity. It is generally advantageous to purify the 7-isomer from the less active isomers. The γ-isomer acts on the nervous system of insects, principally at the level of the nerve ganglia. As a result, lindane has been used against insects in a wide range of applications including treatment of animals, buildings, humans for ectoparasites, clothes; water for mosquitoes, living plants, seeds, and soils. Some applications have been abandoned due to excessive residues, e.g., stored foodstuffs. By voluntary action, the principal domestic producer of technical grade BHC requested cancellation of its BHC registrations on September 1, 1976. As of July 21, 1978, all registrants of pesticide products containing BHC voluntarily canceled their registrations or switched their former BHC products to lindane formulations.

Incompatibilities: Decomposes on contact with powdered iron, aluminum, zinc, and on contact with strong bases producing trichlorobenzene.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: as γ-isomer: 0.5 mg/m^3 [skin].

DFG MAK: as γ-isomer: 0.1 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(8) [skin] Carcinogen Category 4; Pregnancy Risk Group C (2006).

Technical grade, mixture of α-BHC (CAS: 319-84-6) and β-BHC (CAS: 319-85-7): 0.1 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(8) [skin].

Protective Action Criteria (PAC)

Technical grade

TEEL-0: 0.15 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 300 mg/m^3

DFG MAK (*concentration α-isomer* + *5*) + (*concentration β-isomer*): 0.5 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(8) [skin].

Australia: TWA 0.5 mg/m^3, [skin], 1993; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3, [skin], carcinogen, 1999; France: VME 0.5 mg/m^3, [skin], 1993; Hungary: TWA 0.5 mg/m^3; STEL 0.1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.05 mg/m^3, MAC (STEL) 0.4 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3; 0.1 mg/m^3; momentary and daily average [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999; United Kingdom: LTEL 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1993. Russia[43] set a MAC value of 0.03 mg/m^3 for ambient air in residential areas on a momentary and on a daily average basis.

α-isomer

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 0.5 mg/m^3, [skin], 1993; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3, [skin], carcinogen, 1999; France: VME 0.5 mg/m^3, [skin], 1993; Hungary: TWA 0.5 mg/m^3; STEL 0.1 mg/m^3, [skin], 1993; Russia: STEL 0.05 mg/m^3; [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999; United Kingdom: LTEL 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1993.

β-isomer

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 500 mg/m^3

Austria: MAK 0.5 mg/m^3, [skin], 1999; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999.

Determination in Air: Collection by filter/bubbler; workup with isooctane; analysis by gas chromatography/electrolytic conductivity detection; NIOSH Analytical Method (IV) #5502 (γ-isomer).

Permissible Concentration in Water: The EPA has set a limit in drinking water of 0.2 ppb. There are no criteria for the protection of freshwater or saltwater aquatic life from technical BHC (mixed isomers) due to insufficient data. *To protect human health:* preferably zero for technical product. An additional cancer risk of 1 in 100,000 is imposed by a concentration of 0.123 μg/L.[6] Russia[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes and zero in water bodies used for fishery purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. May affect the central nervous system, causing convulsions, respiratory failure, and collapse. Effects may be delayed. Exposure may result in death. See also below.

Long Term Exposure: Repeated or prolonged skin contact may cause irritation, redness. The effects of lindane and/or the α-, β-, and δ-isomers of HCH observed in humans are lung irritation, heart disorders, blood disorders, headache, convulsions, and changes in the levels of sex hormones. These effects have occurred in workers exposed to HCH vapors during pesticide formulation and/or in individuals exposed accidentally or intentionally to large amounts of HCH. Exposure to excessive amounts of HCH can also result in death in humans and animals. Convulsions and kidney disease have been reported in animals fed lindane or β-HCH. Liver disease has been reported in animals fed lindane and α-, β-, or technical grade HCH. Longer exposure to lindane and α-, β-, or technical-grade HCH has been reported to result in liver cancer. Reduced ability to fight infection was reported in animals fed lindane and injury to the ovaries and testes was reported in animals exposed to lindane or β-HCH. In animals, there is evidence that oral exposure to lindane during pregnancy results in an increased incidence of fetuses with extra ribs. HCH is processed by the body into other chemical products, some of which probably are responsible for the harmful effects. The Department of Health and Human Services has determined that HCH may reasonably be anticipated to be carcinogenic. Liver cancer has been seen in laboratory rodents that ate HCH for long periods of time.

Points of Attack: Eyes, skin, respiratory system, central nervous system, blood, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests for Lindane: whole blood (chemical/metabolite); blood serum; Complete blood count; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 mg/m^3*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 25 mg/m^3*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; GmFOv100 (APF = 50) [or any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 50 mg/m^3:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis, powdered iron, aluminum, and zinc. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound falls under the category of Organochlorine pesticides, solid, toxic, n.o.s. These compounds require a shipping label of "POISONOUS/TOXIC MATERIALS." These fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may be dissolved in flammable liquids. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A process has been developed for the destructive pyrolysis of benzene hexachloride at 400−500°C with a catalyst mixture which contains 5−10% of either cupric chloride, ferric chloride, zinc chloride, or aluminum chloride on activated carbon.

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Hexachlorocyclopentadiene H:0220

Molecular Formula: C_5Cl_6

Synonyms: C-56®; 1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-; Graphlox; HCCPD; Hex; 1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene; Hexachloro-1,3-cyclopentadiene; Hexaclorociclopentadieno (Spanish); HRS1655; NCI-C55607; PCL; Perchlorocyclopentadiene

CAS Registry Number: 77-47-4

RTECS® Number: GY1225000

UN/NA & ERG Number: UN2646/151

EC Number: 201-029-3 [*Annex I Index No.:* 602-078-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat; NTP: Carcinogenesis studies (inhalation); no evidence: rat; EPA: Not likely to be carcinogenic to humans; Evidence of noncarcinogenicity for humans.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U130.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 2.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (5); 8270 (10).

Safe Drinking Water Act: MCL, 0.05 mg/L; MCLG, 0.05 mg/L.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R22; R24; R26; R34; R50/53; Safety phrases: S1/2; S25; S39; S45; S53; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hexachlorocyclopentadiene is a pale-yellow to amber-colored, oily liquid with a pungent, unpleasant odor. The odor threshold is 0.15−0.33 ppm. Molecular weight = 272.75; Boiling point = 238.8°C; Freezing/Melting point = −8.9°C; Vapor pressure = 0.08 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1. Slightly soluble in water; solubility = 0.0002% at 25°C (reaction).

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen; Reproductive Effector; Primary Irritant. Hexachlorocyclopentadiene is used to produce the flame retardant chlorendic anhydride, which has applications in polyesters; and to produce chlorendic anhydride and chlorendic acid, which is used as a flame retardant in resins. Hexachlorocyclopentadiene is also used as an intermediate in the production of pesticides, such as aldrin, dieldrin, and endosulfan.

Incompatibilities: Reacts slowly with water to form hydrochloric acid; will corrode iron and most metals in presence of moisture. Explosive hydrogen gas may collect in enclosed spaces in the presence of moisture. Contact with sodium may be explosive.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.01 ppm/0.1 mg/m^3 TWA.
ACGIH TLV®[1]: 0.01 ppm/0.11 mg/m^3 TWA; not classifiable as a human carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 0.01 ppm
PAC-1: 0.025 ppm
PAC-2: 0.15 ppm
PAC-3: 0.15 ppm
DFG MAK: [skin] No numerical value established. Data may be available.
Australia: TWA 001 ppm (0.1 mg/m^3), 1993; Belgium: TWA 0.01 ppm (0.11 mg/m^3), 1993; Denmark: TWA 0.01 ppm (0.1 mg/m^3), 1999; Finland: TWA 0.1 ppm (1 mg/m^3); STEL 0.3 ppm (3 mg/m^3), [skin], 1999; France: VME 0.01 ppm (0.1 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 1 mg/m^3, 2003; Norway: TWA 0.01 ppm (0.1 mg/m^3), 1999; Russia: STEL 0.01 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for hexachtorocyclopentadiene in ambient air[60] ranging from 0.015 μg/m^3 (Massachusetts) to 0.33 μg/m^3 (New York) to 0.50 μg/m^3 (Indiana and South Carolina) to 0.6−10.0 μg/m^3 (North Carolina) to 1.0 μg/m^3 (Florida and North Dakota) to 2.0 μ/m^3 (Connecticut, Nevada and Virginia).

Determination in Air: Sample collection on Porapak® tube,[2] desorption with hexane and analysis by gas chromatography with electron capture detection. See NIOSH Analytical Method (IV) #2518.[18]

Permissible Concentration in Water: The US EPA regulates HCCPD in water. The MCL is 50 ppb. EPA recommends that exposure in children should not exceed 2 ppm in water for 10-day periods or no more than 0.7 ppm for up to 7 years. EPA requires that spills or accidental releases of 10 lb or more of HCCPD be reported to the EPA. Russia[35, 43] set a MAC of 0.001 mg/L (1 μg/L) in water bodies used for domestic purposes. Kansas has set a guideline of 206 μg/L for drinking water.[61]

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This compound is very toxic and may be fatal if inhaled, swallowed, or absorbed through the skin. Eye contact may result in severe irritation. Contact of liquid with the skin may cause blistering and burning. Inhalation of mist is highly irritating to mucous membranes, causing tearing, sneezing, and salivation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Headaches and throat irritation have also been reported as a result of exposure to this compound. The probable human lethal dose is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb (70-kg) person. Severe exposure induces pulmonary hyperemia and edema, degenerative and necrotic changes in brain, heart, and adrenal glands; and necrosis of liver and kidney tubules.

Long Term Exposure: May damage the liver, kidneys, nervous system, and heart. Can irritate the lungs. Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver and kidney function tests. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: lung, liver, and kidney function tests. Examination of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from the skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber/Neoprene™ and PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.01 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a

NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water. Protect containers from physical damage. In the presence of moisture, hexachlorocyclopentadiene will corrode iron and other metals.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Ventilate area of spill or leak after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.3/0.5

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hexachlorocyclopentadiene itself does not burn. Poisonous gases, including chlorine, hydrogen chloride, phosgene, and carbon monoxide, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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Hexachloroethane H:0230

Molecular Formula: C_2Cl_6

Common Formula: CCl_3CCl_3

Synonyms: Avlothane; Carbon hexachloride; Distokal; Distopan; Distopin; Egitol; Ethane hexachloride; Ethane, hexachloro-; Ethylene hexachloride; Falkitol; Fasciolin; HCE; Hexachloraethan (German); Hexachlorethane; 1,1,1,2,2,2-Hexachloroethane; Hexachloroethylene; Hexacloroetano (Spanish); Mottenhexe; NCI-C04604; Perchloroethane; Phenohep

CAS Registry Number: 67-72-1

RTECS® Number: K14025000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-666-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: rat; NTP: Carcinogenesis Studies (gavage); clear evidence: rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

NTP: Toxicity studies, RPT#TOX-45, October 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15) as chlorinated ethanes.

US EPA Hazardous Waste Number (RCRA No.): U131; D034.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 3.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (0.5); 8270 (10).

Safe Drinking Water Act: Priority List (55 FR 1470).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hexachloroethane is a white solid with a camphor-like odor. It gradually evaporates when it is exposed to air. Molecular weight = 236.72; Boiling point = (sublimes) at 183−187°C; Freezing/Melting point = (sublimes) 187°C; Vapor pressure = 0.2 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.005% at 25°C.

Incompatibilities: Incompatible with strong oxidizers, strong bases.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector. In the United States, about half of the HCE is used by the military for smoke-producing devices. It is also used to remove air bubbles in melted aluminum. It may be present as an ingredient in some fungicides, insecticides, lubricants, and plastics. It is no longer made in the United States, but it is formed as a by-product in the production of some chemicals. Can be formed by incinerators when materials containing chlorinated hydrocarbons are burned. Some HCE can also be formed when chlorine reacts with carbon compounds in drinking water. As a medicinal, HCE is used as an anthelmintic to treat fascioliasis in sheep and cattle. It is also added to the feed of ruminants, preventing methanogenesis and increasing feed efficiency. HCE is used in metal and alloy production, mainly in refining aluminum alloys. It is also used for removing impurities from molten metals, recovering metals from ores or smelting products and improving the quality of various metals and alloys. HCE is contained in pyrotechnics. It inhibits the explosiveness of methane and the combustion of ammonium perchlorate. Smoke containing HCE is used to extinguish fires. HCE has various applications as a polymer additive. It has flameproofing qualities, increases sensitivity to radiation crosslinking, and is used as a vulcanizing agent. Added to polymer fibers, HCE acts as a swelling agent and increases affinity for dyes.

Incompatibilities: Incompatible with metals, such as aluminum, cadmium, hot iron, mercury, or zinc. Alkalis forms spontaneously explosive chloroacetylene. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.68 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/10 mg/m^3 TWA [skin].

NIOSH REL: NIOSH REL: 1 ppm/10 mg/m^3 TWA [skin]; a potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 1 ppm/9.7 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: Potential occupational carcinogen 300 ppm.
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 30 ppm
PAC-2: 200 ppm
PAC-3: 300ppm
DFG MAK: 1 ppm/9.8 mg/m^3 TWA; Peak Limitation Category II(2).
Australia: TWA 10 ppm (100 mg/m^3), 1993; Austria: MAK 1 ppm (10 mg/m^3), 1999; Belgium: TWA 1 ppm (9.7 mg/m^3), 1993; Denmark: TWA 1 ppm (10 mg/m^3) [skin] 1999; Finland: TWA 1 ppm (10 mg/m^3), short-term exposure limit 3 ppm (30 mg/m^3) [skin] 1999; France: VME 1 ppm, VLE 10 ppm, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; the Philippines: TWA 1 ppm (10 mg/m^3) [skin] 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 30 mg/m^3, 1999; Switzerland: MAK-W 1 ppm (10 mg/m^3) [skin] 1999; United Kingdom: TWA 5 ppm (49 mg/m^3), vapor, 2000; TWA 10 mg/m^3, total inhalable dust; TWA 4 mg/m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for hexachloroethane in ambient air[60] ranging from 0.18 μg/m^3 (Massachusetts) to 50.0 μg/m^3 (Connecticut) to 238.095 μg/m^3 (Kansas) to 1000 μg/m^3 (North Dakota) to 1600 μg/m^3 (Virginia) to 2381 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated; OSHA Analytical Method 7.

Permissible Concentration in Water: The US EPA suggests that water consumed over a lifetime contain no more than 1 part HCE per billion parts of water. (1 ppb). In an older citation, the EPA suggested the following: *To protect freshwater aquatic life:* 118,000 μg/L based on acute toxicity and 20,000 μg/L based on chronic toxicity. *To protect saltwater aquatic life:* 113,000 μg/L based on acute toxicity. *To protect human health:* 9.4 μg/L to keep lifetime cancer risk below 5−10 μg/L.[6] Russia[35,43] set a MAC of 0.01 mg/L (10 μg/L) in water bodies used for domestic purposes. States which have set guidelines for hexachloroethane in drinking water[61] include Kansas (1.9 μg/L) and Minnesota (24.6 μg/L).

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the eyes and skin. Exposure can irritate the respiratory tract. High levels of exposure can cause dizziness, lightheadedness, and unconsciousness. Irritation occurs when there is an excessive amount of hexachloroethane dust in the air or when it is heated and vapors are formed. Hexachloroethane acts primarily as a central nervous system depressant; and in high concentrations it causes tremors and narcosis. It should be noted that the low vapor pressure of this compound as well as its solid state minimize its inhalation hazards.

Long Term Exposure: A potential occupational carcinogen. May cause kidney and liver damage.

Points of Attack: Eyes, skin, respiratory system, kidneys. Cancer site in animals: liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. More than light alcohol consumption can exacerbate liver damage. Sample of blood, urine, or feces can be tested for exposure to HCE. These tests are useful only if exposure occurred 24−48 h prior to testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Hexachloroethane must be stored to avoid contact with hot iron, zinc, aluminum, and alkalis since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in DOT/UN Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hexachloroethane itself does not burn. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Chlorinated Ethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Hexachloroethane*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Hexachloroethane, Health and Environmental Effects Profile No. 116*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 75−78 (1982) and 6, No. 4, 70−83 (1986)

US Department of Health and Human Services. (September 1997). *ATSDR ToxFAQs, Hexachloroethane*. Atlanta, GA

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Hexachloroethane*. Trenton, NJ

Hexachlorophene H:0240

Molecular Formula: $C_{13}H_6Cl_6O_2$

Common Formula: $C_6H(OH)Cl_3CH_2C_6H(OH)Cl_3$

Synonyms: Acigena; AI3-02372; Almederm; AT-17; AT-7; B 32; B&B flea kontroller (for dogs only); Bilevon; Bis(2-hydroxy-3,5, 6-trichlorophenyl)methane; Bis(3,5,6-trichlor *o*-2-hydroxyphenyl)methane; Blockade anti bacterial finish; Brevity blue liquid bacteriostatic scouring cream; Brevity blue liquid sanitizing scouring cream; Compound G-11; Cotofilm; Dermadex; 2,2′-Dihydroxy-3,3′,5,5′,6,6′-hexachlorodiphenylmethane; 2,2′-Dihydroxy-3,5,6,3′,5′,6′-hexachlorodiphenylmethane; Distodin; Enditch pet shampoo; EN-Viron D concentrated phenolic disinfectant; Esaclorofene; Exofene; Fesia-Sin; Fomac; Fostril; G-11; Gamophen; Gamophene; Germa-Medica; HCP; Hexabalm; 2,2′,3,3′,5,5′-Hexachloro-6,6′-dihydroxydiphenylmethane; Hexachlorophane; Hexachlorophen; Hexachlorophene; Hexaclorofeno (Spanish); Hexafen; Hexaphene-LV; Hexide; Hexophene; Hexosan; Hilo cat flea powder; Hilo flea powder; Hilo flea powder with rotenone and dichlorophrene; Isobac; Isobac 20; Methane, bis(2,3,5-trichloro-6-hydroxyphenyl); 2,2′-Methylenebis(3,4,6-trichlorophenol); 2,2′-Methylenebis(3,5,6-trichlorophenol); Nabac; Nabac 25 EC; NCI-C02653; Neosept V; NSC4911; Pedigree dog shampoo bar; Phenol, 2,2′-methylenebis(3,4,6-trichloro)-; Phenol, 2,2′-methylenebis(3,5,6-trichloro-); Phisodan; Phisohex; Ritosept; Septisol; Septofen; Staphene O; Steral; Steraskin; Surgi-Cen; Surgi-Cin; Surofene; Tersaseptic; Trichlorophene; Turgex

CAS Registry Number: 70-30-4; *(alt.)* 8054-98-6; *(alt.)* 139411-96-4

RTECS® Number: SM0700000

UN/NA & ERG Number: UN2875/151

EC Number: 200-733-8 [*Annex I Index No.:* 604-015-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: rat; IARC: Animal Inadequate Data; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1997.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (in pharmaceuticals) (UN).[13]

FDA—over-the-counter and proprietary drug.

Reportable Quantity (RQ): 100 lb (45.4 kg).

US EPA Hazardous Waste Number (RCRA No.): U132.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R24/25; R50/53; Safety phrases: S1/2; S20; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexachlorophene is a crystalline compound. Molecular weight = 406.89; Freezing/Melting point = 165°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug; Reproductive Effector; Human Data; Primary Irritant. HCP has been used as an antibacterial agent in a wide variety of consumer products, including soaps and deodorants, as a disinfectant. It has also been used as an antifungal agent to treat various citrus fruits and vegetables.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 50 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 150 mg/m^3

Russia: STEL 0.1 mg/m^3, [skin], 1993. Massachusetts[61] has set a guideline of zero for ambient air.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been calculated by NAS/NRC as 0.008 mg/L. An ADI was calculated on the basis of the available chronic toxicity data to be 0.0012 mg/kg/day. Russia set a MAC of 0.03 mg/L in water bodies used for domestic purposes. Maine has set a guideline of 2.0 μg/L for drinking water.[61]

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Hexachlorophene may irritate the eyes and skin, and may cause a skin allergy to develop. May cause permanent eye damage. Inhalation can irritate the respiratory tract. May affect the central nervous system, causing dizziness, weakness, convulsions (fits), coma, or death. Exposure can cause loss of appetite, nausea, vomiting, cramps, and diarrhea. LD_{50} = (oral-rat) 56 mg/kg; (oral-mouse) 67 mg/kg.

Long Term Exposure: There is an association between exposure to pregnant women to hexachlorophene and birth defects. There is limited evidence that hexachlorophene is a teratogen in animals. May cause an asthma-like allergy. May cause liver damage. Repeated exposure may cause brain damage leading to paralysis and blindness.

Points of Attack: Nervous system, skin, liver, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system and eye. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. More than light alcohol consumption may exacerbate liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to hexachlorophene, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hexachlorophene itself does not burn. Extinguish fire using an agent suitable for surrounding fire. Poisonous gases, including chlorine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Hexachlorophene, Health and Environmental Effects Profile No. 116*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 2, 62−66

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Hexachlorophene*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Hexafluoroacetone H:0250

Molecular Formula: C_3F_6O

Common Formula: CF_3COCF_3

Synonyms: 6FK; Acetone, hexafluoro-; HFA; NCI-C56440; 2-Propanone, 1,1,1,2,2,2-hexafluoro-

CAS Registry Number: 684-16-2

RTECS® Number: UC2450000

UN/NA & ERG Number: UN2420/125

EC Number: 211-676-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥15.67% concentration).

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical Developmental/Reproductive toxin (male).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexafluoroacetone is a colorless, nonflammable poison gas. Musty odor. Shipped as a liquefied compressed gas. Molecular weight = 163.00; Boiling point = −28 to −26°C; Freezing/Melting point = −122°C; Relative vapor density (air = 1) = 5.76; Vapor pressure = 5.8 atm at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Reacts with water.

Potential Exposure: Compound Description: Reproductive Effector. Hexafluoroacetone is used as a chemical intermediate. A gas at room temperature, it forms various hydrates with water which are used as solvents for resins and polymers. Other derivatives are used to make water repellent coatings for textiles and also to produce polymers.

Incompatibilities: Reacts with water, oxidizers, strong acids. Hygroscopic (i.e., absorbs moisture from the air); reacts with moisture to form a highly acidic sesquihydrate and considerable heat.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 ppm/0.7 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 ppm/0.68 mg/m^3 TWA [skin].

Protective Action Criteria (PAC)*

TEEL-0: 0.1 ppm

PAC-1: 0.1 ppm

PAC-2: **0.2** ppm

PAC-3: **80** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Several states have set guidelines or standards for hexafluoroacetone in ambient air[60] ranging from 7.0 $\mu g/m^3$ (North Dakota) to 11.0 $\mu g/m^3$ (Virginia) to 14.0 $\mu g/m^3$ (Connecticut) to 17.0 $\mu g/m^3$ (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can severely irritate the eyes, nose, throat, and skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, nausea, vomiting, dizziness, and lightheadedness. Skin or eye contact with the liquid can cause frostbite.

Long Term Exposure: There is a limited evidence that this chemical is a teratogen in animals. It may damage the testes (male reproductive glands) and affect sperm production. Hexafluoroacetone can damage the liver, kidneys, and lungs. Repeated exposure may cause bronchitis. Prolonged exposure may affect blood cells.

Points of Attack: Eyes, skin, respiratory system, kidneys, reproductive system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, reproductive history for men. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 0.1 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. (2) Color Code—Blue (*poison gas*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from direct sunlight, water, heat, reducing agents, nitrates, and nitric acid. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Hexafluoroacetone requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. If hexafluoroacetone gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.9/1.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 5.2/8.4
Night 7.0+ /11.0+

Fire Extinguishing: HFA is nonflammable reactive gas. Poisonous gases, including carbon monoxide and hydrogen fluoride, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Hexafluoroacetone*. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 75−76

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Hexafluoroacetone*. Trenton, NJ

Hexafluoroethane H:0260

Molecular Formula: C_2F_6

Synonyms: Ethane, hexafluoro-; F116; Freon 116; Perfluoroethane; R-116

CAS Registry Number: 76-16-4

RTECS® Number: KI4110000

UN/NA & ERG Number: UN2193/126

EC Number: 200-939-8 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexafluoroethane is a colorless and odorless gas or liquid under pressure. Molecular weight = 138.02; Boiling point = −78°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: It is used as a coolant, in dielectric fluids, as a propellant, and as a refrigerant.

Incompatibilities: Active metals. Keep away from heat and sunlight.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 40,000 ppm
PAC-1: 40,000 ppm
PAC-2: 40,000 ppm
PAC-3: 40,000 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Hexafluoroethane can affect you when breathed in. Contact with the liquefied gas could cause frostbite. High levels in the air can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause suffocation from lack of oxygen and death. Overexposure may also cause abnormal heart rhythms and even cause the heart to stop.

Points of Attack: Heart.

Medical Surveillance: Special 24-h EKG (Holter monitor). Consider chest X-ray following acute overexposure.

NIOSH lists the following tests as (F): chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles unless full face-piece respiratory protection is worn. Wear splash chemical goggles and face shield when working with the liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues.

Respirator Selection: Where there is potential for exposures to hexafluoroethane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals, including aluminum, zinc, and beryllium, and from open flames or temperatures above 52°C. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hexafluoroethane is a nonflammable liquid and gas. Use extinguishing agents suitable for type of surrounding fire. Poisonous gases, including hydrofluoric acid and other fluoride gases, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March, 1999). *Hazardous Substances Fact Sheet: Hexafluoroethane*. Trenton, NJ

1,1,1,3,3,3-Hexafluoro-2-propanol H:0265

Molecular Formula: $C_3H_2F_6O$

Synonyms: Bis(trifluoromethyl)methanol; 1,1,1,3,3,3-Hexafluoro-2-hydroxypropane; 1,1,1,3,3,3-Hexafluoroisopropanol; Hexafluoroisopropanol; Hexafluoroisopropyl alcohol; 1,1,1,3,3,3-Hexafluoroisopropyl alcohol; 2,2,2-Trifluoro-1-(trifluoromethyl)ethanol; HFIP

CAS Registry Number: 920-66-1
RTECS Number: UB6450000
UN/NA & ERG Number: UN1760 (Corrosive liquid, n.o.s.)/154
EC Number: 213-059-4
Regulatory Authority and Advisory Bodies
Listed in the TSCA inventory.
SARA 311/312 codes: Immediate.
Canada: WHMIS Classification: D1B, E; Found on DSL list.
European/International Regulations: Hazard Symbol: T,C; Risk phrases: R20/21; R25; R34; R41; Safety phrases: S36; S37/39 (see Appendix 4).

Description: 1,1,1,3,3,3-Hexafluoro-2-propanol (HFIP) is a clear, colorless, oily, combustible liquid. Odor is described as aromatic. Molecular weight = 168.04; Specific gravity = 1.596 at 20°C; Freezing/Melting point = −4°C; Boiling point = 59°C at 760 mmHg; Vapor pressure: 556 mmHg at 51°C; 1468 mmHg at 75°C; Flash point: >93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3; Flammability 0; Reactivity 0. Water soluble; solubility = $\geq$ 100 mg/mL at 20°C.

Potential Exposure: A specialty solvent for some polymers; a lavatory reagent.

Incompatibilities: HFIP is incompatible with acids, acid chlorides, and oxidizing agents.

Permissible Exposure Limits in Air:
Protective Action Criteria (PAC)
TEEL-0: 7.5 ppm
PAC-1: 25 ppm
PAC-2: 150 ppm
PAC-3: 750 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.66.

Routes of Entry: Ingestion, inhalation, or absorbed through the skin. Causes burns by all exposure routes.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive; causes burns to all internal or external area of contact. Dangerous if inhaled, swallowed, or absorbed through skin. Highly toxic by inhalation. Severe overexposure can result in death. Can cause blindness; immediate washing of the eye may not lessen the magnitude of eye damage. Prolonged skin contact may cause large blisters. Depending on the intensity and duration of exposure, this chemical can cause severe destruction of tissues of the mucous membranes and upper respiratory tract. Symptoms of exposure to this compound may include severe skin and eye irritation, irritation of the mucous membranes and upper respiratory tract, burning feeling, laryngitis, coughing and wheezing, shortness of breath, headache, nausea, and vomiting, blurred vision, incoordination. Inhalation of this chemical can be fatal, resulting from inflammation, bronchial pneumonia, edema of the larynx, bronchi, and pulmonary tract. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. LD_{50} = (oral-rat) 1500 mg/kg.

Long Term Exposure: The chronic properties of this material have not been fully investigated. May cause permanent skin damage; scarring. Repeated exposure to a highly toxic material such as HFIP may result in general deterioration of health and possible organ damage.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin or respiratory tract allergy.

First Aid: *Eyes*: Check the victim for contact lenses and remove. Flush victim's eyes with water or normal saline solution for 20−30 min, occasionally lifting lower and upper eyelids. Remove contaminated clothing and shoes. Get medical attention immediately. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water and wash for at least 15 min. Remove and isolate all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician. Transport the victim to a hospital for treatment. *Inhalation*: Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. *Ingestion*: *Do not induce vomiting*. If the victim is conscious and not convulsing, give large amount of water to dilute the chemical. Never give anything by mouth to an unconscious person. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician. In all cases get medical attention immediately. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body.

Personal Protective Methods: Maintain eyewash fountain and quick-drench facilities in work area. Unless full facepiece respiratory protection is worn, wear splash-proof protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Wear Tyvek-type disposable protective clothing or other impervious protective clothing, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical.

Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When working with this chemical, wear a NIOSH-approved full face chemical cartridge respirator equipped with the appropriate organic vapor cartridges. If that is not available, a half face respirator similarly equipped plus airtight goggles can be substituted. However, please note that half face respirators provide a substantially lower level of protection than do full face respirators.

Storage: Color Code—White stripe (store separately): Contact Hazard; not compatible with materials in solid white category. Storage precautions: you should store this chemical in a refrigerator and keep it away from oxidizing materials. Store away from sources of ignition. Protective clothing (minimum protective clothing): if Tyvek-type disposable protective clothing is not worn during handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves.

Shipping: Corrosive liquids, n.o.s. require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Nonfire response small spills and leakage: if you spill this chemical, first remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. Seal the absorbent paper, as well as any of your clothing which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Wash any surfaces you may have contaminated with a soap and water solution. Do are a not reenter the contaminated area.

Fire Extinguishing: When heated to decomposition, HFIP emits toxic fumes of fluorine. On fire involving this compound, use dry chemical, carbon dioxide, or Halon extinguisher.

Disposal Method Suggested: May be incinerated. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Hexamethylenediamine H:0270

Molecular Formula: $C_6H_{16}N_2$
Common Formula: $H_2N(CH_2)_6NH_2$
Synonyms: 1,6-Diaminohexane; 1,6-Hexamethylenediamine; Hexamethylenediamine; 1,6-Hexanediamine; HMDA; NCI-C61405
CAS Registry Number: 124-09-4
RTECS® Number: MO1180000
UN/NA & ERG Number: UN2280 (solid)/153; UN1783 (solution)/153
EC Number: 204-679-6 [*Annex I Index No.:* 612-104-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R21/22; R34; 37; Safety phrases: S1/2; S22; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: HMDA is a hygroscopic, colorless solid (pellets or flakes). Weak, fishy odor. odor threshold = 0.004 mg/m^3; Molecular weight = 116.13; Boiling point = 199°C; Freezing/Melting point = 39−42°C; Flash point = 71°C; 81°C (solution); Autoignition temperature = 310°C. Explosive limits: LEL = 0.7%; UEL = 6.3%. Soluble in water.

Potential Exposure: Compound Description: Reproductive Effector. HMDA is used as a textile intermediate; a raw material for nylon fiber and plastics; in wet strength resins; in the manufacture of oil-modified and moisture-area types of urethane coatings; in the manufacture of polyamides for printing inks, dimer acids, and textiles; and as an oil and lubricant additive (probably as a corrosion inhibitor); as boiler feed water additives; also used in paints and as a curing agent for epoxy resins; in making adhesives.

Incompatibilities: Forms explosive mixture with air. The aqueous solution is a strong base. A strong reducing agent. Reacts violently with oxidizers, acids, acid chlorides, acid anhydrides, carbon dioxide. Reacts with ethylene dichloride, organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc and alloys. Absorbs carbon dioxide and water from air. Store under Nitrogen.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®[1]: 0.5 ppm/2.3 mg/m^3 TWA *as 1,6-hexanediamine*.

AIHA WEEL: 1 ppm TWA.

No TEEL available.

Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 2.3 mg/m^3, 2003; Russia: STEL 0.1 mg/m^3, 1993. Russia set a MAC of 0.001 mg/m^3 in the ambient air of residential areas on a momentary and a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Harmful Effects and Symptoms

Short Term Exposure: A very corrosive substance. Severely irritates and burns the eyes, skin, and respiratory tract. Can cause permanent eye damage. Inhalation can cause nosebleeds, sore throat, hoarseness, cough, phlegm, and/or difficult breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 750 mg/kg (slightly toxic).

Long Term Exposure: Repeated or prolonged exposure can cause dermatitis, eczema, and liver damage, including hepatitis. There is limited evidence that this chemical can damage the developing fetus. Repeated exposure may cause bronchitis.

Points of Attack: Lungs, skin, liver.

Medical Surveillance: Lung function tests, liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If convulsions are not present, give a glass or two of water or milk to dilute the substance. Do not induce vomiting. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Store under nitrogen. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry place away from oxidizers, strong acids, acid chlorides, acid anhydrides, carbon dioxide, and metals. Preferably store under an inert atmosphere in a tightly closed container.

Shipping: Solid or solution of HMDA requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Solid:* This chemical as a solid may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: This chemical in solution is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

US Environmental Protection Agency. (June 6, 1978). *Chemical Hazard Information Profile: 1,6-Diaminohexane*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 1. 30−31 (1982) and 8, No. 1, 46−50 (1988).

Hexamethylene diiso-cyanate H:0280

Molecular Formula: $C_8H_{12}N_2O_2$

Common Formula: $OCN(CH_2)_6NCO$

Synonyms: AI3-28285; Desmodur H; Desmodur N; Diisocianto de hexametileno (Spanish); 1,6-Diisocyanatohexane; HDI; Hexamethyl 1,6-diisocyanate; 1,6-Hexamethylene diisocyanate; Hexamethylene 1,6-diisocyanate; 1,6-Hexane diisocyanate; Hexane, 1,6-diisocyanato-; 1,6-Hexanediol diisocyanate; 1,6-Hexylene diisocyanate; HMDI; Isocyanic acid, diester with 1,6-hexanediol; Isocyanic acid, hexamethylene ester; Metyleno-bis-fenyloizocyjanian; NSC 11687; TL78

CAS Registry Number: 822-06-0; 66368-96-5

RTECS® Number: MO1740000

UN/NA & ERG Number: UN2281/156

EC Number: 212-485-8 [*Annex I Index No.:* 615-011-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations (*822-06-0*): Hazard Symbol: T; Risk phrases: R23; R36/37/38; R42/43; Safety phrases: S1/2; S26; S28; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hexamethylene diiso-cyanate is a colorless liquid with a sharp, irritating odor. Molecular weight = 168.22; Specific gravity (H_2O:1) = 1.04; Boiling point = 212.8°C; Freezing/Melting point = −67.2°C; Relative vapor density (air = 1): 5.8; Vapor pressure = 0.5 mmHg at 25°C; Flash point = 140°C; Autoignition temperature = 454°C. Explosive limits: LEL = 0.9%; UEL = 9.5. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Reacts with water.

Potential Exposure: Compound Description: Agricultural Chemical. Used to make other chemicals, coatings, and polyurethane. It is also used as a hardener in automobile and airplane paints.

Incompatibilities: Reacts violently with alcohols, amines, oxidizers, strong bases, carboxylic acids, organotin catalysts. Reacts slowly with water to form carbon dioxide, amines, and polyureas. Temperatures above 200°C can cause polymerization. Attacks copper.

Permissible Exposure Limits in Air

822-06-0

OSHA PEL: None.

NIOSH REL: 0.005 ppm/0.035 mg/m^3 TWA; 0.020 ppm/0.140 mg/m^3 [10 min] Ceiling Concentration.

ACGIH TLV®[1]: 0.005 ppm/0.034 mg/m^3 TWA.

Protective Action Criteria (PAC)

822-06-0

TEEL-0: 0.005 ppm

PAC-1: 0.03 ppm

PAC-2: 2 ppm

PAC-3: 2 ppm

DFG MAK: 0.005 ppm/0.035 mg/m^3 TWA; Peak Limitation Category I(1), a momentary value of 0.01 mL/m^3/0.070 mg/m^3 should not be exceeded; Danger of sensitization of the airways and skin; Pregnancy Risk Group D.

Belgium: TWA 0.005 ppm (0.034 mg/m^3), 1993; Denmark: TWA 0.005 ppm (0.035 mg/m^3), 1999; France: VME 0.01 ppm (0.075 mg/m^3), VLE 0.02 ppm (0.15 mg/m^3), 1999; Hungary: TWA 0.05 mg/m^3; STEL 0.1 mg/m^3, 1993; Japan; 0.005 ppm (0.034 mg/m^3), 1999; the Netherlands:

MAC-TGG 0.04 mg/m^3, 2003; Poland: MAC (TWA) 0.05 mg/m^3; STEL 0.15 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, [skin], 1993; Sweden: NGV 0.005 ppm (0.03 mg/m^3), TGV 0.01 ppm (0.07 mg/m^3), 1999; Switzerland: MAK-W 0.01 ppm (0.07 mg/m^3), KZG-W 0.02 ppm (0.14 mg/m^3), 1999; United Kingdom: TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.005 ppm. The state of Connecticut has set a guideline of 0.7 μg/m^3 for hexamethylene diisocyanate in ambient air.[60]

Determination in Air: Use NIOSH (IV), Methods, #5521, #5522,#5525; OSHA Analytical Method 42.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.1$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Hexamethylene diiso-cyanate can affect you when breathed in and by passing through your skin. Contact can irritate and may burn the eyes and skin. Skin contact may cause skin blisters. Eye contact may cause corneal damage. Exposure can cause headache, nausea, vomiting, and irritability. Just a few breaths of high levels of hydrogen sulfide in air can cause death. High levels can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Respiratory sensitization may result from high levels of exposure.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy with itching and skin rash. Repeated or prolonged inhalation exposure may cause a lung allergy (asthma) to develop. Once allergy develops, future exposure can cause cough, wheezing, and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.05 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 0.125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.25 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hexamethylene diisocyanate should be stored away from moisture or water. This contact will cause it to polymerize and explode its container. Hexamethylene diiso-cyanate must be stored to avoid contact with amines, carboxylic acids, strong bases, and alcohols since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area at temperatures below 93°C/200°F.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, nitrogen oxides, and hydrogen cyanide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Hexamethylene Diisocyanate*. Trenton, NJ

US Department of Health and Human Services. (August 1999). *ATSDR ToxFAQs, Hexamethylene Diisocyanate*. Atlanta, GA

Hexamethylphosphoric triamide

H:0290

Molecular Formula: $C_6H_{18}N_3OP$

Common Formula: $[(CH_3)_2N]_3PO$

Synonyms: Eastman inhibitor HPT; ENT 50,882; Hempa; Hexametapol; Hexamethylorthophosphoric triamide; Hexamethylphosphoramide; Hexamethylphosphoric acid triamide; *N,N,N,N,N,N*-Hexamethylphosphoric triamide; Hexamethylphosphoric triamide; Hexamethylphosphorotriamide; Hexamethylphosphotriamide; HMPA; HMPT; HMPTA; HPT; Memta; Phosphoric acid hexamethyltriamide; Phosphoric hexamethyltriamide; Phosphoric triamide, hexamethyl-; Phosphoric tris(dimethylamide); Phosphoryl hexamethyltriamide; Triamida hexametilfosforica (Spanish); Tris(dimethyamino)phosphorus oxide; Tris (dimethylamino) phosphine oxide

CAS Registry Number: 680-31-9

RTECS® Number: TD0875000

UN/NA & ERG Number: UN3082/171

EC Number: 015-106-00-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: Rodent dominant lethal; Mammalian micronucleus; Positive: Sperm morphology—mouse; Sperm morphology—rabbit; Positive: *D. melanogaster* sex-linked lethal.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (Sweden).[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88; male 10/1/94.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexamethylphosphoric triamide is a colorless liquid with a spicy odor. Molecular weight = 179.24; Specific gravity (H_2O:1) = 1.03; Boiling point = 232.8°C; Freezing/Melting point = 6.1°C; Relative vapor density (air = 1) = 6.18; Vapor pressure = 0.03 mmHg at 20°C; Flash point = 104.4°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Hexamethylphosphoric triamide is a material possessing unique solvent properties and is widely used as a solvent; in small quantities, in organic and organometallic reactions in laboratories. This is the major source of occupational exposure to HMPA in the United States. It is also used as a processing solvent in the manufacture of aramid fibers. HMPA has been evaluated for use as an ultraviolet light absorber or inhibitor in polyvinyl chloride formulations; as an additive for antistatic effects; as a flame retardant; and as a deicing additive for jet fuels. Hexamethylphosphoric triamide has also been extensively investigated as an insect chemosterilant.

Incompatibilities: Violent reactions with oxidizers, strong acids, chemically active metals.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: No numerical value; [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.015 ppm

PAC-1: 0.05 ppm

PAC-2: 0.35 ppm

PAC-3: 40 ppm

DFG MAK: [skin]; Pregnancy risk Group C; Carcinogen Category 2.

Australia [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: [skin], carcinogen, 1993; Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; Switzerland: [skin], Carcinogen 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for HMPA in ambient air[60] ranging from zero (North Dakota) to 0.0024 ppb (Pennsylvania) to 0.03 μg/m^3 (New York) to 3.0 μg/m^3 (Virginia) to 14.5 μg/m^3 (South Carolina).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Hexamethylphosphoramide can affect you when breathed in and by passing through your skin. Exposure may irritate and damage the nose, throat, and lungs, causing a nasal discharge and lung changes. Very high levels may cause kidney and lung damage.

Long Term Exposure: Potential occupational carcinogen. May cause cancer of the nose. Hexamethylphosphoramide may cause mutations. Handle with extreme caution. There is limited evidence that HEMPA may damage the testes of males and affect sperm production. Repeated exposure may severely damage the kidneys and lungs. May damage the nose, causing chronic nasal discharge.

Points of Attack: Eyes, skin, respiratory system, central nervous system, gastrointestinal tract. Cancer site in animals: nasal cavity.

Medical Surveillance: For those with frequent or potentially high exposure (or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nose. Lung function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue (*potential human carcinogen*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Hexamethylphosphoramide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), and chemically active metals (such as potassium, sodium, magnesium, and zinc) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials. Sources of ignition, such as smoking and open flames, are prohibited where hexamethylphosphoramide is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphine, nitrogen oxides, phosphorus oxides, are produced in fire. Use dry chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (October 24, 1975). *Current Intelligence Bulletin No. 6: Hexamethylphosphoric Triamide (HMPAI)*. Rockville, MD

US Environmental Protection Agency. (August, 1976). *Chemical Hazard Information Profile: Hexamethylphosphoramide*. Washington, DC

National Institute for Occupational Safety and Health. (December, 1979). *Information Profiles on Potential Occupational Hazards—Single Chemicals: Hexamethylphosphoramide*. Rockville, MD, pp. 106−113

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Hexamethylphosphoramide*. Trenton, NJ

n-Hexane (& isomers) H:0300

Molecular Formula: C_6H_{14}

Common Formula: $CH_3(CH_2)_4CH_3$

Synonyms: Exxsol hexane; Genesolv 404 azeotrope; Gettysolve-B; Hexane; *n*-Hexano (Spanish); Hexano (Spanish); Hexyl hydride; NCI-C60571; NSC68472; Skellysolve B

CAS Registry Number: 110-54-3

Other hexane isomers except n-hexane

107-83-5 (*2-methylpentane*); 96-14-0 (*3-methylpentane*); 75-83-2 (*2,2-dimethylbutane*); 79-29-8 see 2,3-Dimethylbutane at D:1120; 96-37-7 see also Methyl cyclopentane at M:0830

RTECS® Number: MN9275000

UN/NA & ERG Number: UN1208

EC Number: 203-777-6 [*Annex I Index No.:* 601-037-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Inadequate information to assess carcinogenic potential.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

NTP: Toxicity studies, RPT#TOX-02, October 2000.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*n-HEXANE*): Hazard Symbol: F, Xn, N; Risk phrases: R11; R38; R48/20; R62; R65; R67; R51/53; Safety phrases: S2; S9; S16; S29; S33; S36/37; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (CAS: 110-54-3).

Description: Hexane is a highly flammable, colorless, volatile liquid with a gasoline-like odor. The water/odor threshold is 0.0064 mg/L and the air/odor threshold is 230−875 mg/m^3. Molecular weight = 86.20; Specific gravity (H_2O:1) = 0.66; Boiling point = 68.9°C; Freezing/Melting point = −139.4°C; Relative vapor density (air = 1) = 3.0; Vapor pressure = 124 mmHg at 20°C; Flash point = − 21.6°C (cc); Autoignition temperature = 225°C. Explosive limits: LEL = 1.1%, UEL = 7.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.002%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. *n*-Hexane is an industrial chemical, an emulsifier, used in the manufacture of plastics, resins; as a solvent, particularly in the extraction of edible fats and oils; as a laboratory reagent; and as the liquid in low-temperature thermometers. Technical and commercial grades consist of 45−85% hexane, as well as cyclopentanes, isohexane, and 1−6% benzene.

Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers may cause fire and explosions. Contact with dinitrogen tetraoxide may explode at 28°C. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 500 ppm/1800 mg/m^3 TWA [skin].

NIOSH REL: 50 ppm/180 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/176 mg/m^3 TWA [skin]; BEI: 5 mg [2,5-Hexanedione]/g creatinine in urine at end-of-shift; *n*-Hexane in end-exhaled air during shift.

NIOSH IDLH: 1100 ppm [LEL].

Protective Action Criteria (PAC)*

TEEL-0: 50 ppm

PAC-1: 400 ppm

PAC-2: **3300** ppm

PAC-3: **8600** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK (*n-hexane only*): 50 ppm/180 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group C; BAT: 5 mg [hexane-2,5-dione + 4,5-dihydroxy-2-hexanone]/L in urine at end-of-shift.

Australia: TWA 50 ppm (180 mg/m^3), 1993; Austria: MAK 50 ppm (180 mg/m^3), 1999; Belgium: TWA 50 ppm (176 mg/m^3), 1993; Denmark: TWA 25 ppm (90 mg/m^3), 1999; Finland: TWA 50 ppm (180 mg/m^3); STEL 150 ppm (530 mg/m^3), 1999; France: VME 50 ppm (170 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 90 mg/m^3, 2003; Norway: TWA 25 ppm (90 mg/m^3), 1999; the Philippines: TWA 500 ppm (1800 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 400 mg/me, 1999; Russia: TWA 40 ppm; STEL 300 mg/m^3, 1993; Sweden: NGV 25 ppm (90 mg/m^3), KTV 50 ppm (180 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (180 mg/m^3), KZG-W 100 ppm (360 mg/m^3), 1999; Turkey: TWA 500 ppm (1800 mg/m^3), 1993; United Kingdom: TWA 20 ppm (72 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm [skin]. Russia[35, 43] set a MAC of 60 mg/m^3 in ambient air in residential areas on a momentary basis.

Hexane, other isomers other than n-hexane

OSHA PEL: None.

NIOSH REL: 100 ppm/350 mg/m^3 TWA; 510 ppm/1800 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 500 ppm/1750 mg/m^3 TWA; 1000 ppm/3500 mg/m^3 STEL.

All hexane isomers except n-hexane:

DFG MAK: 500 ppm/1800 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Determination in Air: Use NIOSH Analytical Method: for Hydrocarbons, Boiling point = 36−126°C, #1500, for Hydrocarbons, Boiling point = 36−126°C; #3800; OSHA Analytical Method 7. See also NIOSH Analytical Method: Volatile organic compound, #2549.

Permissible Concentration in Water: The EPA[48] has set a health advisory for *n*-hexane involving the calculation of a NOAEL of 570 mg/kg/day which results in a long-term health advisory of 14.3 mg/L for an adult. A health-based maximum contaminant level of 33 μg/L has been derived by the state of New Jersey[59] based on neurotoxic effects observed in rats exposed to *n*-hexane by inhalation. Arizona and Maine[61] have set guidelines of 4000 μg/L for *n*-hexane in drinking water.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.9.

Routes of Entry: Inhalation of vapor, ingestion, eye and skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, nose, and respiratory tract. Exposure can cause lightheadedness, giddiness, headaches, and nausea. High levels can lead to unconsciousness and death. *Inhalation:* Exposure to levels above 500 ppm may cause headaches, abdominal cramps, a burning feeling of the face, numbness and weakness of the fingers and toes. Levels above 1300 ppm may cause the above plus nausea and irritation of the nose and throat. Levels above 1500 ppm may cause the above plus blurred vision, loss of appetite, and loss of weight. Most symptoms disappear within a few months if exposure ceases. Breathing liquid into the lungs may cause chemical pneumonia. *Skin:* Contact may cause irritation, redness, swelling, blisters, and pain. Skin exposure may contribute to symptoms listed under inhalation. *Eyes:* Levels over 880 ppm may cause irritation. *Ingestion:* May contribute to symptoms listed under inhalation. Estimated lethal dose is 1 oz to one pint.

Long Term Exposure: High or repeated exposure can damage the nervous system, causing numbness, tingling, and/or muscle weakness in the hands, feet, arms, and legs. Repeated skin contact can cause irritation, dryness and cracking, and can lead to rash. May cause symptoms listed under inhalation. Exposure to levels above 650 ppm for 2−4 months can result in weakness and numbness of the arms and legs. Symptoms go away within a few months if exposure stops. Use by older children in the United States and Europe who have "sniffed" household chemicals containing *n*-hexane in an attempt to get "high" has caused paralysis of the arms and legs. In laboratory studies, animals exposed to high levels of *n*-hexane had signs of disturbed sleep, lung damage, and damage to the sperm-forming cells.

Points of Attack: Eyes, skin, respiratory system, central nervous system, peripheral nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), during exposure, expired air, expired air, during exposure; neurologic examination/electromyography; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol, Viton™, polyurethane, Teflon™, Viton™/chlorobutyl rubber, Silvershield™, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* Sa (APF = 10) (any supplied-air respirator). *1100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. *n*-Hexane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where *n*-hexane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gallons or more of *n*-hexane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of *n*-hexane.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (May 13, 1977). *Clinical Hazard Information Profile: n-Hexane*. Washington, DC

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Document No. 77-151. Washington, DC

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Hexane*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 59−61

New Jersey Department of Health and Senior Services. (April, 2004). *Hazardous Substances Fact Sheet: n-Hexane*. Trenton, NJ

Hexanol H:0310

Molecular Formula: $C_6H_{14}O$

Common Formula: $CH_3(CH_2)_4CH_2OH$

Synonyms: Alcohol C-6; *n*-Amyl carbinol; Amylcarbinol; Caproyl alcohol; Epal-6; *n*-Hexanol; *n*-Hexyl alcohol; Hexyl alcohol; 1-Hydroxyhexane; Pentyl carbinol

CAS Registry Number: 111-27-3

RTECS® Number: MQ4025000

UN/NA & ERG Number: UN2282/129

EC Number: 203-852-3 [*Annex I Index No.:* 603-059-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hexanol is a flammable, colorless liquid. Molecular weight = 102.20; Boiling point = 157°C; Flash point = 63°C. Explosive limits: LEL = 1.2%; UEL = 7.7%.[41] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Those using hexanol as a solvent or in the synthesis of pharmaceuticals and textile chemicals. Also used as a plasticizer intermediate, specialty, ethoxylate intermediate, and a defoamer.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, caustics, aliphatic amines, isocyanates, strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 ppm

PAC-1: 2 ppm

PAC-2: 15 ppm

PAC-3: 75 ppm

DFG MAK: No numerical value established. Data may be available.

Russia has set a TLV of 2.4 ppm (10 mg/m^3).[43]

Determination in Air: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; IV (#1500, Hydrocarbons).

Permissible Concentration in Water: A value of 0.03 mg/L is the maximum allowed in drinking water.[11]

Routes of Entry: Skin contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Vapor irritates the eyes, skin, and respiratory tract. Contact causes smarting of the skin and first-degree burns on short exposure; may cause second-degree burns on long exposure. Believed to be moderately toxic upon ingestion. Exposure can cause headache, dizziness, confusion, muscle weakness, nausea, vomiting, and diarrhea.

Long Term Exposure: Repeated exposure may damage the nervous system.

Points of Attack: Skin, eyes, nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexanol you should be trained on its proper handling and storage. Before entering confined space where hexanol may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 32−33 (1982) and 7, No. 6, 65−67 (1987)

New Jersey Department of Health and Senior Services. (May, 1999). *Hazardous Substances Fact Sheet: n-Hexanol*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Hexazinone H:0320

Molecular Formula: $C_{11}H_{20}O_2N_3$

Synonyms: Brushkiller; 3-Cyclohexyl-6-dimethylamino-1-methyl-1,2,3,4-tetrahydro-1,3,5-triazine-2-,4-dione; 3-Cyclohexyl-6-(dimethylamino)-1-methyl-*s*-triazine-2,4(1H,3H)-dione; 3-Cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione; 3-Cyclohexyl-1-methyl-6-(dimethylamino)-*s*-trazine-2,4(1H,3H)-dione; DPX 3674; *s*-Triazine-2,4(1H,3H)-dione, 3-cyclohexyl-6-(dimethylamino)-1-methyl-; 1,3,5-Triazine-2,4(1H,3H)-dione, 3-cyclohexyl-6-(dimethylamino)-1-methyl-; Velpar; Velpar weed killer

CAS Registry Number: 51235-04-2
RTECS$^{®}$ Number: XY7850000
UN/NA & ERG Number: UN2753/151
EC Number: 257-074-4 [*Annex I Index No.:* 613-132-00-4]

Regulatory Authority and Advisory Bodies

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R36; R50/53; Safety phrases: S2; S41; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hexazinone is a white crystalline solid that is practically odorless. Molecular weight = 252.36; Boiling point = decomposes; Freezing/Melting point = 115−117°C; Vapor pressure = 3.0×10^{-7} mmHg. Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this contact and residual herbicide. It is a broad spectrum herbicide used in industrial and government right-of-way weed control for pipelines, drainage ditches, etc.[23]

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: The EPA has analyzed data on hexazinone and developed a no-observed-adverse-effect-level (NOAEL) of 25 mg/kg/day based on studies of dogs which resulted in a long-term health advisory of 8.75 mg/L. A NOAEL of 10 mg/kg/day was developed based on studies of rats which yielded a lifetime health advisory of 0.21 mg/L.

Determination in Water: Solvent extraction with methylene chloride followed by analysis by gas chromatography with a thermionic bead detector. Fish Tox = 24566.31408000 bbp MATC (VERY LOW). Octanol−water coefficient: Log K_{ow} = −4.4.

Routes of Entry: Skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: May cause eye and skin irritation. The acute oral LD_{50} for rats is 1690 mg/kg (slightly toxic). In experience with humans, only one report was available on hexazinone. It involved a 26-year-old woman who inhaled hexazinone dust. Vomiting occurred within 24 h. Human Tox = 400.00000 ppb (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area above 32°C.

Shipping: Hexazinone is classified as Triazine pesticides, solid, toxic n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only

respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory: Hexazinone*. Washington, DC: Office of Drinking Water

1-Hexene H:0330

Molecular Formula: C_6H_{12}
Common Formula: $CH_3(CH_2)_3CH{=}CH_2$
Synonyms: Butyl ethylene; Butylethylene; 1-*n*-Hexene; 1-Hexene; Hexylene
CAS Registry Number: 592-41-6
RTECS® Number: MP6601000
UN/NA & ERG Number: UN2370/128
EC Number: 209-753-1
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Hexene is a colorless liquid. Molecular weight = 84.14; Boiling point = 63−65°C; Freezing/Melting point = −140°C; Flash point = −7°C; Autoignition temperature = 253°C. Explosive Limits: LEL = 1.2%; UEL = 6.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.
Potential Exposure: Those involved in its use in organic synthesis. Used in fuels, and to make flavors, perfumes, dyes, and plastic resins.
Incompatibilities: Forms explosive mixture with air. Violent reaction with oxidizers, strong acids.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: None.
ACGIH TLV®[1]: 50 ppm/172 mg/m^3 TWA.
Protective Action Criteria (PAC)*
TEEL-0: 50 ppm
PAC-1: 75 ppm
PAC-2: **500** ppm
PAC-3: **5000** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Irritation of skin, eyes, and respiratory tract causing coughing and wheezing. Death may occur. Ingestion may cause chemical pneumonitis. Exposure may affect the central nervous system. Exposure can cause headache, nausea, dizziness, and unconsciousness.
Long Term Exposure: Removes the skin's natural oils, causing dryness and cracking.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Use organic vapor respirator or air line. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. mask. Wear protective goggles or face shield.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexene you should be trained on its proper handling and storage. Before entering confined space where hexene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used,

handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid contact with liquid or vapor. Stay upwind and use water spray to "knock down" vapor. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil skimming equipment and sorbent (urethane) foams may be used for spills on water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Water may be ineffective. Use alcohol or polymer foam, dry chemical, or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*. 1, No. 8, 78−79 (1981) and 3, No. 2, 50−51 (1983).

sec-Hexyl acetate H:0340

Molecular Formula: $C_8H_{16}O_2$

Common Formula: $CH_3COOCH(CH_3)CH_2CH(CH_3)CH_3$

Synonyms: Acetic acid-1,3-dimethylbutyl ester; 1,3-Dimethylbutyl acetate; Hexyl acetate; MAAC; Methylamyl acetate; Methylisoamyl acetate; Methylisobutylcarbinol acetate; Methylisobutylcarbinyl acetate; 4-Methyl-2-pentanol, acetate; 4-Methyl-2-pentyl acetate

CAS Registry Number: 108-84-9

RTECS® Number: A10875000

UN/NA & ERG Number: UN1233/130

EC Number: 203-621-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *sec*-Hexyl acetate is a colorless liquid with a mild, pleasant, fruity odor. Molecular weight = 144.24; Specific gravity (H_2O:1) = 0.86; Boiling point = 147.2°C; Freezing/Melting point = −63.8°C; Relative vapor density (air = 1) = 5.0; Vapor pressure = 3 mmHg: Flash point = 45°C; Autoignition temperature = 266°C. Explosive limits: LEL = 0.9%; UEL = 5.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. This material is used as a solvent in the spray lacquer industry. It is a good solvent for cellulose esters and other resins.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, strong alkalis, nitrates, strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.90 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/300 mg/m^3 TWA.

NIOSH REL: 50 ppm/300 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/295 mg/m^3 TWA.

NIOSH IDLH: 500 ppm.

No TEEL available.

Australia: TWA 50 ppm (300 mg/m^3), 1993; Austria: MAK 50 ppm (300 mg/m^3), 1999; Belgium: TWA 50 ppm (295 mg/m^3), 1993; Denmark: TWA 50 ppm (300 mg/m^3), 1999; Finland: TWA 50 ppm (300 mg/m^3); STEL 75 ppm (450 mg/m^3), 1999; France: VME 50 ppm (300 mg/m^3), 1999; the Netherlands: MAC-TGG 300 mg/m^3, 2003; the Philippines: TWA 50 ppm (300 mg/m^3), 1993; Switzerland: MAK-W 50 ppm (300 mg/m^3), KZG-W 100 ppm (600 mg/m^3), 1999; Turkey: TWA 50 ppm (300 mg/m^3), 1993; United Kingdom: TWA 50 ppm (299 mg/m^3); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 50 ppm TWA. Several states have set guidelines and standards for *sec*-hexyl acetate in ambient air[60] ranging from 3.0 mg/m^3 (North Dakota) to 6.0 mg/m^3 (Connecticut) to 7.143 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, gas chromatography/flame ionization. Use NIOSH Analytical Method 1450 for Esters; OSHA Analytical Method 7.[18]

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes and respiratory tract. May affect the central nervous system causing headache, dizziness, nausea, narcosis.

Long Term Exposure: May cause skin drying and cracking.

Points of Attack: Eyes, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *Up to 500 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator); SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexyl acetate you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Oil-skimming equipment may be used to remove slicks from water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or

federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Water may be ineffective. Use alcohol foam, CO_2, or dry chemical extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Methyl Amyl Acetate*. Trenton, NJ

Hexylene glycol H:0350

Molecular Formula: $C_6H_{14}O_2$

Common Formula: $(CH_3)_2C(OH)CH_2CHOHCH_3$

Synonyms: 2,4-Dihydroxy-2-methylpentane; Diolane; 1,2-Hexanediol; Isol; 2- Methylpentane-2,4-diol; 2-Methyl-2,4-pentanediol; 4-Methyl-2,4-pentanediol; 2,4-Pentanediol, 2-methyl-; Pinakon; α,α,α′-trimethylene glycol

CAS Registry Number: 107-41-5

RTECS® Number: SA0810000

UN/NA & ERG Number: No citation.

EC Number: 203-489-0 [*Annex I Index No.*: 603-053-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/38; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hexylene glycol is a colorless liquid with a mild, sweet odor. The odor threshold is 50 ppm. Molecular weight = 118.20; Specific gravity (H_2O:1) = 0.92; Boiling point = 197.8°C; Freezing/Melting point = −50°C (sets to glass); Vapor pressure = 0.05 mmHg at 20°C; Flash point = 98.3°C; Autoignition temperature = 260°C; 306°C. Explosive limits: LEL = 1.3%; UEL = 7.4%.[41] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Hexylene glycol is used in metal working fluids; the formulation of hydraulic brake fluids; in making printing inks. It is used as a fuel and lubricant additive; as an emulsifying agent; and as a cement additive.

Incompatibilities: Incompatible with strong acids, caustics, aliphatic amines, isocyanates, strong oxidizers. Hygroscopic (i.e., absorbs moisture from the air).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.83 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 25 ppm/125 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 25 ppm/121 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 10 ppm

PAC-2: 25 ppm

PAC-3: 350 ppm

DFG MAK: 10 ppm/49 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 25 ppm (125 mg/m^3), 1993; Belgium: STEL 25 ppm (121 mg/m^3), 1993; Denmark: TWA 25 ppm (125 mg/m^3), 1999; Finland: TWA 25 ppm (125 mg/m^3); STEL 40 ppm (190 mg/m^3), 1993; France: VLE 25 ppm (125 mg/m^3), 1999; the Netherlands: MAC 125 mg/m^3, 2003; Norway: TWA 20 ppm (100 mg/m^3), 1999; Switzerland: MAK-W 25 ppm, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 25 ppm. States which have set guidelines or standards for hexylene glycol in ambient air[60] include 1.25 mg/m^3 (North Dakota) and 2.976 mg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2101.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.6.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact can irritate and may burn the eyes and skin. Exposure may affect the central nervous system. Eye and throat irritation and respiratory discomfort were slight upon exposure to 100 ppm but more pronounced at

1000 ppm. Ingestion produces central nervous system depression. High exposure can cause dizziness, loss of coordination, and unconsciousness. Extremely high exposures can cause coma and kidney damage. Toxicity by Ingestion: Grade 2; $LD_{50} = 0.5-5$ g/kg.[CHRIS]

Long Term Exposure: Repeated exposure may cause dry skin, rash, sensitization, and allergy. May damage the kidney and liver, and may affect the nervous system. Many similar petroleum-based solvents have been shown to cause brain and nerve damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist. Evaluate for brain effects and refer positive and borderline individuals for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 25 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as peroxides, perchlorates, chlorates, permanganates, and nitrates). Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Hexylene glycol is not cited in DOT'S Performance-Oriented Packaging Standards.[19]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 33−35

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April, 2004). *Hazardous Substances Fact Sheet: Hexylene Glycol*. Trenton, NJ

Hexyl trichlorosilane H:0360

Molecular Formula: $C_6H_{13}Cl_3Si$
Common Formula: $C_6H_{13}SiCl_3$
Synonyms: Silane, trichlorohexyl-; Trichlorohexylsilane
CAS Registry Number: 928-65-4
RTECS® Number: VV4320000
UN/NA & ERG Number: UN1784/156
EC Number: 213-178-1
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Hexyl trichlorosilane is a colorless liquid which fumes in moist air. Molecular weight = 219.63; Boiling point = 191−192°C; Flash point = 85°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Reacts with water.
Potential Exposure: Used in the manufacture of other silicon chemicals.
Incompatibilities: Reacts violently with strong oxidizers. Reacts violently with water, moisture, and steam producing chlorine and hydrogen chloride. Attacks active metals (e.g., aluminum and magnesium). Chlorosilanes on contact with ammonia forms a self-igniting product.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.2 ppm
PAC-1: **0.6** ppm
PAC-2: **7.3** ppm
PAC-3: **33** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Hexyl trichlorosilane can affect you when breathed in. Hexyl trichlorosilane is a corrosive chemical and can cause severe skin and eye burns leading to permanent eye damage. Exposure can severely irritate the respiratory tract causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.
Long Term Exposure: Highly irritating substances can cause lung irritation and bronchitis with cough, phlegm, and/or shortness of breath.
Points of Attack: Lungs.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposure to hexyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and steam. Hexyl trichlorosilane can give off corrosive hydrogen chloride gas on contact with water, steam, or moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Hexyl trichlorosilane requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.9/1.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine and hydrogen chloride, are produced in fire. *Do not use water*, as poisonous and corrosive gases will form. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Hexyl Trichlorosilane*. Trenton, NJ

Hydrazine H:0370

Molecular Formula: H_4N_2

Common Formula: ($H_2N{-}NH_2$); $N_2H_4.H_2O$ (hydrate)

Synonyms: Amerzine; Diamide; Diamine; Diamine, hydrazine base; Hidrazina (Spanish); Hydrazine base; Levoxine; Mannitol mustard; Oxytreat 35; SCAV-OX; SCAV-OX 35%; SCAV-OX II; Ultra Pure

CAS Registry Number: 302-01-2; 7803-57-8 (hydrate)

RTECS® Number: MU7175000

UN/NA & ERG Number: UN2029 (anhydrous or with >64% hydrazine, by mass)/132; UN3293 (with not >37% hydrazine, by mass)/152; UN2030 (hydrate or with not <37% but not >64% hydrazine, by mass)/153

EC Number: 206-114-9 [*Annex I Index No.*: 007-008-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): 10,000.

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Inconclusive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (Belgium, Denmark) (UN).[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

US EPA Hazardous Waste Number (RCRA No.): U133.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations (*302-01-2*): Hazard Symbol: T, N; Risk phrases: R45; R10; R23/24/25; R34; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*hydrazine and hydrate*).

Description: Hydrazine is a colorless, oily liquid with an ammoniacal odor. The odor threshold is 3.7 ppm. Molecular weight = 32.06; Specific gravity (H_2O:1) = 1.01; Boiling point = 113.3°C; Freezing/Melting point = 2.2°C; Relative vapor density (air = 1) = 1.1; Vapor pressure = 10 mmHg at 20°C; Flash point = 38°C (cc); Autoignition temperature = from 24°C (on a rusty iron surface) to 270°C (on a glass surfaces). Explosive limits: LEL = 2.9%; UEL = 98%.[17] Hazard Identification (based on NFPA-704 M Rating System) (*anhydrous*): Health 4, Flammability 4, Reactivity 3. Soluble in water. The hydrate is a 64% solution in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Because of its strong reducing capabilities, hydrazine is used as an intermediate in chemical synthesis, and in photography and metallurgy. It is also used as a rocket fuel; in the preparation of anticorrosives; textile agents; pesticides; and as a scavenging agent for oxygen in boiler water. Hydrazine is widely used in pharmaceutical synthesis.

Incompatibilities: Forms explosive mixture with air. A highly reactive reducing agent and a medium strong base. Can ignite SPONTANEOUSLY on contact with oxidizers or porous materials, such as earth, wood, and cloth. Air or oxygen is not required for decomposition. Oxidizers, hydrogen peroxide, nitric acid, metallic oxides, acids, halogens can cause fire and explosions. Attacks cork, glass, some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.31 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/1.3 mg/m^3 TWA [skin].

NIOSH REL: 0.03 ppm/0.04 mg/m^3 [120 min] Ceiling Concentration; A potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 ppm/0.013 mg/m^3 [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 50 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.01 ppm

PAC-1: 0.1 ppm

PAC-2: **13** ppm

PAC-3: **35** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK; [skin] danger of skin sensitization; Carcinogen Category 2; TRK: [skin]; danger of skin sensitization; Sampling time: end of exposure or end-of-shift; 380 μg [creatinine]/L urine hydrazine; 340 μg/L plasma hydrazine.

Australia: TWA 0.1 ppm (0.1 mg/m^3), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 0.1 ppm (0.13 mg/m^3), [skin], 1999; Finland: TWA 0.1 ppm; STEL 0.3 ppm, [skin], carcinogen, 1999; Japan: 0.01 ppm (0.013 mg/m^3), [skin], 1999; Norway: TWA 0.1 ppm (0.13 mg/m^3), 1999; the Philippines: TWA 1 ppm (1.3 mg/m^3), [skin], 1993; Poland: MAC (TWA) 0.05 mg/m^3, MAC (STEL) 0.1 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, [skin], 1993; Sweden: NGV 0.1 ppm, KTV 0.3 ppm, [skin], carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.13 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 1 ppm (1.3 mg/m^3), [skin], 1993; United Kingdom: TWA 0.03 mg/m^3; STEL 0.13 mg/m^3, [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic[35]: MAC 0.05 mg/m^3. Several states have set guidelines or standards for hydrazine in ambient air[60] ranging from zero (North Carolina and North Dakota) to 0.003 μg/m^3 (Rhode Island) to 0.018 mg/m^3 (Massachusetts) to 0.24 μg/m^3 (Pennsylvania) to 0.33 μg/m^3 (New York) to 0.5 μg/m^3 (South Carolina) to 1.0 μg/m^3 (Connecticut, Florida and Virginia) to 2.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #3503 for hydrazine[18]; OSHA Analytical Method 20 or 108.[58]

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 18 μg/L based on health effects. Russia[35,43] set a MAC of 0.01 mg/L (10 μg/L) in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -3.1$.

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Hydrazine is corrosive to the eyes, skin, and respiratory tract. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the liver, kidneys, and central nervous system. Exposure may result in death. The effects may be delayed. Signs and symptoms of acute exposure to hydrazine may include severe eye irritation, facial numbness, facial swelling, and increased salivation. Hydrazine vapor may immediately irritate the nose and throat. Headache, twitching, seizures, convulsions, and coma may also occur. Gastrointestinal signs and symptoms include anorexia, nausea, and vomiting. Pulmonary edema and hypotension (low blood pressure) are common. Hydrazine is toxic to the liver, ruptures red blood cells, and may cause kidney damage. Dermal contact may result in irritation or severe burns. Target organs include central nervous system, respiratory system, skin, and eyes. Chronic exposure in humans may cause pneumonia, liver and kidney damage. Liver damage may be more severe than kidney damage. It is a suspected human carcinogen.

Long Term Exposure: Repeated or prolonged contact may cause sensitization and skin allergy. Hydrazine may affect the liver, kidneys, and central nervous system. A probable carcinogen in humans. Can irritate the lungs and may cause bronchitis. Can damage the nervous system causing weakness, shaking, and loss of balance and coordination. Exposure can cause blood damage and may cause anemia.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys. Cancer site in animals: lungs, liver, blood vessels, and intestine.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: complete blood count. Liver and kidney function tests. Lung function tests. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may also be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Consider pyridoxine (25 mg/kg), which has been shown to be an effective anticonvulsant for hydrazine poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, Silvershield™, PVC, Neoprene™, and butyl rubber are among the recommended protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red Stripe (*hydrazine and hydrazine hydrate*): Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where hydrazine may be present, check to make sure that an explosive concentration does not exist. Hydrazine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric); hydrogen peroxide, and metal oxides since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where hydrazine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever hydrazine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: (1) Hydrazine, anhydrous or hydrazine aqueous solutions with >64% hydrazine, by mass, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I. (2) Hydrazine hydrate or hydrazine aqueous solutions, with not <37% but not >64% hydrazine, by mass, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group II. (3) Hydrazine, aqueous solution, with not >37% hydrazine, by mass, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup

is complete. Remove all ignition sources. Stay upwind; keep out of low areas. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including ammonia fumes, hydrogen and nitrogen oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and protective clothing. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Move container from fire area if you can do so without risk. Dike fire control water for later disposal, do not scatter material. Spray cooling water on containers that are exposed to flames until well after fire is out. It is a flammable/combustible material and may be ignited by heat, sparks, or flames. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with facilities for effluent scrubbing to abate any nitrogen compounds formed in the combustion process.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines*, NIOSH Document No. 78-172, Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 45−46 (1981) and 3, No. 4, 65−68 (1983)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrazine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Hydrazine*. Trenton, NJ

Hydrazine sulfate H:0380

Molecular Formula: $H_4N_2 \cdot H_2O_4S$

Synonyms: HS; Hydrazine hydrogen; Hydrazine monosulfate; Hydrazine sulphate; Hydrazinium sulfate; Hydrazonium sulfate; NSC-150014

CAS Registry Number: 10034-93-2; *(alt)* 1184-66-3

RTECS® Number: MV9625000

UN/NA & ERG Number: UN3260 (Corrosive solid, acidic, inorganic, n.o.s.)/154

EC Number: 233-110-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical: Cancer.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hydrazine sulfate is a white or colorless, crystalline powder; Freezing/Melting point = 254°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Soluble in water.

Potential Exposure: Used in analysis and refining of minerals, rare metals, determination of arsenic in metals, as a catalyst and an antioxidant, and in fungicides, germicides, and blood tests. Used as a catalyst for making acetate fibers.

Incompatibilities: A strong reducing agent. Reacts with oxidizers, bases.

Permissible Exposure Limits in Air

NIOSH REL: [for hydrazines] 0.03 ppm/0.04 mg/m^3 2-h Ceiling Concentration.

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 250 mg/m^3

Determination in Air: Use OSHA Analytical Method #20 or NIOSH Analytical Method #3503, Hydrazine.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Highly corrosive. Irritates and burns the eyes, skin, and respiratory tract. Exposure can affect the brain and nervous system, causing dizziness and lightheadedness at first, followed by trembling and convulsions. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours.

Long Term Exposure: Hydrazine sulfate has been shown to cause liver and lung cancers in animals. Exposure can damage the liver and kidneys. Repeated exposure can damage blood cells, causing a low blood count (anemia). It can also cause methemoglobinemia with fatigue, shortness of breath, and even a bluish color to the nose, finger tips, and lips. May cause skin allergy to develop.

Points of Attack: Liver, kidneys, blood, central nervous system, skin.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC). Examination of the nervous system. Blood methemoglobin level. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine. Pyridoxine (25 mg/kg) is an effective anticonvulsant for hydrazine poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (3) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, bases.

Shipping: Hydrazine sulfate must be labeled "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Hydrazine Sulfate*. Trenton, NJ

Hydrazoic acid H:0390

Molecular Formula: HN_3
Synonyms: Azoimide; Diazoimide; Hydrogen azide; Hydronitric acid; Stickstoffwasserstoffsaeure (German); Triazoic acid
CAS Registry Number: 7782-79-8
RTECS® Number: MW2800000
EC Number: 231-965-8
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: The pure and concentrated material is highly unstable and potentially explosive; should be handled only by experts. Hydrazoic acid is a colorless liquid with an intolerable, pungent odor. Molecular weight = 43.03; Boiling point = 37°C; Freezing/Melting point = −80°C. Soluble in water.

Potential Exposure: May be used in organic synthesis. Used in making heavy metal azide detonators for explosives.

Incompatibilities: Explosive when dry; a highly sensitive explosive hazard when subject to shock or exposed to heat. Forms unstable compounds (heavy metal azides) with heavy metals. Forms explosive salts with carbon disulfide. Violent reaction with cadmium, copper, nickel, nitric acid, fluorine, heat, and shock.

Permissible Exposure Limits in Air
No TEEL available.
DFG MAK: 0.1 ppm/0.18 mg/m^3 TWA; Peak Limitation Category I(2).

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin, eyes, and respiratory tract. Continued inhalation causes, cough, headache, dizziness, weakness, fall in blood pressure, chills and fever, and collapse. Prolonged exposure to high concentration can cause fatal convulsions and death. Highly toxic.

Long Term Exposure: Chronic exposure can affect the central nervous system, hypotension, palpitation, ataxia, and weakness.

Points of Attack: Central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: *Unstable and unpredictable explosive material.* Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Protect from heat and shock.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a dangerously explosive material. Poisonous gases, including nitrogen oxides, are produced in fire. Containers may explode in fire.

Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be destroyed by converting hydrazoic acid to sodium azide and the reaction mixture decomposed with nitrous acid (National Research Council, 1983).

Hydriodic acid H:0395

Molecular Formula: HI

Synonyms: Hydriodic acid solution; Hydrogen iodide

CAS Registry Number: 10034-85-2

RTECS® Number: MW3760000

UN/NA & ERG Number: UN1787 (solution)/154; UN2197 (anhydrous)/125

EC Number: 233-109-9 [*Annex I Index No.:* 053-002-00-9]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: C; Risk phrases: R35; Safety phrases: S1/2; S9; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 500 (≥95.33% concentration).

Description: Hydriodic acid is colorless when freshly made but rapidly turns yellowish or brown on exposure to light or air. Aqueous solution of hydrogen iodide, which is a gas (anhydrous) at room temperature. Molecular weight = 127.91; Boiling point = −35.4°C at 5 mmHg; Freezing/Melting point = −51°C; Relative vapor density (air = 1) = 4.42. Hazard Identification (based on NFPA-704 M Rating System) (*50% solution*): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Hydriodic acid is used as a disinfectant, an analytical reagent, raw material for pharmaceuticals, and to make iodine salts.

Incompatibilities: Contact with water forms toxic and corrosive fumes. A strong reducing agent. Violent actions with strong acids, chemically active metals, magnesium, phosphorus, perchloric acid, strong oxidizers. Explodes on contact with ethyl hydroperoxide. Protect from moisture, heat, and shock.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.35 ppm

PAC-1: **1.0** ppm

PAC-2: **22** ppm

PAC-3: **120** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to skin, eyes, and mucous membranes. Skin or eye contact can cause severe burns and permanent damage. Inhalation causes, cough, headache, fall in blood pressure, chills and fever and collapse, irritation of the nose and throat, and can cause spasms of the windpipe, which can be fatal. High concentration can cause fatal convulsions. A Japanese source[24] states that HI is painful at 0.15−0.2 ppm; intolerable at 0.3 ppm.

Long Term Exposure: Chronic exposure can cause injury to kidneys and spleen; can cause hypotension, palpitation, ataxia, and weakness. Highly irritating substances may cause lung damage. Prolonged absorption of iodides can cause skin rash, headache, irritation of mucous membranes with running nose.

Points of Attack: Lungs, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests, chest X-ray following acute overexposure, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to hydriodic acid, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Hydriodic acid must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), chemically active metals (such as potassium, sodium, magnesium, and zinc), and strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. Protect storage containers from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Hydriodic acid solution requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Hydrogen iodide, anhydrous, requires a shipping label of "POISON GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Neutralize with chemically basic substances, such as sodium bicarbonate, soda ash, or slaked lime. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including iodine, are produced in fire. Use water on fires in which hydriodic acid is involved. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to a large amount of soda ash and slaked lime in solution with stirring. Flush resulting solution to a sewer.[24]

Reference

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Hydriodic Acid*. Trenton, NJ

Hydrogen H:0400

Molecular Formula: H_2

Synonyms: Hidrogeno (Spanish); Para Hydrogen; Hydrogen, compressed; Hydrogen, refrigerated liquid; Liquid hydrogen

CAS Registry Number: 1333-74-0

RTECS® Number: MW8900000

UN/NA & ERG Number: UN1049 (Hydrogen, compressed)/115; UN1966 (Hydrogen, refrigerated liquid)/115

EC Number: 215-605-7 [*Annex I Index No.:* 001-001-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Highly Reactive Substance and Explosive (World Bank).[15]

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Hydrogen is a highly flammable, colorless liquid or gas. Molecular weight = 2.02; Boiling point = −252°C; Autoignition temperature = 500−571°C. Explosive limits: LEL = 4.0%; UEL = 75%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 4, Reactivity 0. Slightly soluble in water.

Potential Exposure: Hydrogen is used as a fuel in weeding, as a raw material for ammonia manufacture, and in organic hydrogenation reactions.

Incompatibilities: Vapors form explosive or combustible mixture with air over a wide range of concentrations. Heating may cause violent reaction, combustion, or explosion. Ignites easily with oxygen. Violent reaction with strong oxidizers, halogens, acetylene, bromine, chlorine, fluorine, nitrous oxide, and other gases; metal catalysts (e.g., platinum and nickel) greatly enhance these reactions. Mild steel and most iron alloys become brittle at liquid hydrogen temperatures.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: Simple asphyxiant.

Note: The health effects caused by exposure to hydrogen are much less serious than its fire and explosion risk.

Protective Action Criteria (PAC)

TEEL-0: 65,000 ppm

PAC-1: 65,000 ppm

PAC-2: 230,000 ppm

PAC-3: 400,000 ppm

Hydrogen is classed as a simple asphyxiant.[1,33] Large amounts of hydrogen will decrease the amount of available oxygen. Oxygen content should be tested to ensure that it is at least 19% by volume in confined spaces.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Exposure to high levels can cause suffocation from lack of oxygen. Contact with liquid hydrogen can cause severe burns and frostbite.

Medical Surveillance: There are no special tests.

First Aid: *Contact With Liquid Hydrogen:* Put affected part into warm water. Seek medical attention. *Breathing:* Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: *Clothing:* Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn.

Respirator Selection: Exposure to hydrogen is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hydrogen must be stored to avoid contact with heat, flames, sparks, and oxygen. Sources of ignition, such as smoking and open flames, are prohibited where hydrogen is used, handled, or stored. Metal containers involving the transfer of 5 gallons or more of hydrogen should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of hydrogen. Wherever hydrogen is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Hydrogen, compressed, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1. Hydrogen, refrigerated liquid, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: If hydrogen gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid hydrogen is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stop the leak or move the container to a safe area and allow the liquid to evaporate. Keep hydrogen out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

Fire Extinguishing: If spill has not ignited, use water spray to direct flammable gas−air mixtures away from sources of ignition. If it is desirable to evaporate a spill quickly, water spray may be used to increase the rate of evaporation, if the increased vapor evolution can be controlled. Do not discharge solid streams into liquid. Because of danger of reignition, hydrogen fires normally should not be extinguished until the supply of hydrogen has been shut off. If liquid hydrogen has ignited, use water to keep fire-exposed containers cool and to protect workers stopping the source of a spill. If it is necessary to extinguish small hydrogen fires, use dry chemical, carbon dioxide, or halogenated extinguishing agent. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Combustion.

Reference

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Hydrogen*. Trenton, NJ

Hydrogenated terphenyls H:0410

Molecular Formula: $(C_6H_n)_3$

Common Formula: $C_6H_{11}{-}C_6H_4{-}C_6H_5$

Synonyms: Hydrogenated diphenylbenzenes; Hydrogenated phenylbiphenyls; Hydrogenated triphenyls

CAS Registry Number: 61788-32-7

RTECS® Number: WZ6535000

EC Number: 262-967-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hydrogenated terphenyls are a complex mixture of partially hydrogenated terphenyl isomers. They are clear, oily, pale-yellow liquids with a faint odor. Molecular weight = 241.00; 298.00 (40% hydrogenated); Specific gravity (H_2O:1) = 1.00; Boiling point = 340°C (40% hydrogenated); Freezing/Melting point = 148°C (40% hydrogenated); Vapor pressure = 13 Pa at 25°C; Flash point = 157°C (cc); Autoignition temperature = 374°C. Insoluble in water.

Potential Exposure: These materials are used as high-temperature heat-transfer media and as plasticizers.

Incompatibilities: Strong oxidizers. When heated, irritating vapors will be released.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 12.19 mg/m^3 (40% hydrogenated) at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.5 ppm/5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.5 ppm/4.9 mg/m^3 (nonirradiated) TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.5 ppm

PAC-1: 1.5 ppm

PAC-2: 2.5 ppm

PAC-3: 600 ppm

Australia: TWA 0.5 ppm (5 mg/m^3), 1993; Belgium: TWA 0.5 ppm (4.9 mg/m^3), 1993; Denmark: TWA 0.4 ppm (4.4 mg/m^3), 1999; France: VME 0.5 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 0.5 ppm (5 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm. States which have set guidelines or standards for hydrogenated terphenyls in ambient air include Virginia at 80.0 μg/m^3, Connecticut at 100.0 μg/m^3, and Nevada at 119.0 μg/m^3.[60]

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes, skin, respiratory system. Potential acute hazards consist of damage to the lungs and damage to the skin and eyes from burns from the hot coolant.

Long Term Exposure: Potential chronic hazards comprise damage to liver, kidney, and blood-forming organs with the possibility of induction of metabolic disorders and cancer.[53]

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, hemato system.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC). Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a

NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Irritating vapors are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Hydrogen bromide H:0420

Molecular Formula: HBr

Synonyms: Acide bromhydrique (French); Anhydrous hydrobromic acid; Bromwasserstoff (German); HBr; Hydrobromic acid; Hydrobromic acid, anhydrous; Hydrogen bromide, anhydrous

CAS Registry Number: 10035-10-6

RTECS® Number: MW3850000

UN/NA & ERG Number: UN1048 (anhydrous)/125; UN1788 (hydrobromic acid solution)/154

EC Number: 233-113-0 [*Annex I Index No.:* 035-002-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 500 (≥95.33% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R35; R37; Safety phrases: S1/2; S7/9; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hydrogen bromide is a corrosive colorless gas with a sharp, irritating odor. The odor threshold is 2−6.6 ppm. Molecular weight = 80.92; Boiling point = −66.7°C (anhydrous); Freezing/Melting point = −86.7°C (anhydrous); Relative vapor density (air = 1) = 2.81; Vapor pressure = 20 atm. Soluble in water; solubility = 49%. A constant boiling dihydrate melts at −11°C and boils at 126°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2. Shipped as a liquefied compressed gas. Often used in an aqueous solution.

Potential Exposure: Hydrogen bromide gas and its aqueous solutions are used in the manufacture of organic and inorganic bromides; as a reducing agent and catalyst in controlled oxidations; in the alkylation of aromatic compounds; and in the isomerization of conjugated diolefins. It is used as an intermediate for pharmaceuticals, dyes, photographic chemicals.

Incompatibilities: The aqueous solution is a strong acid. Violent reaction with strong oxidizers, strong caustics, and many organic compounds, causing fire and explosion hazard. Reacts with water, forming toxic hydrobromic acid. Incompatible with aliphatic amines, alkanolamines, alkylene oxides, aromatic amines, amides, ammonia, ammonium hydroxide, calcium oxide, epichlorohydrin, fluorine, isocyanates, oleum, organic anhydrides, sulfuric acid, sodium tetrahydroborate, vinyl acetate. Hydrobromic acid is highly corrosive to most metals forming flammable hydrogen.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.31 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 3 ppm/10 mg/m^3 TWA.

NIOSH REL: 3 ppm/10 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 2 ppm/6.8 mg/m^3 TWA Ceiling Concentration (2001).
NIOSH IDLH: 30 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 1 ppm
PAC-1: **1.0** ppm
PAC-2: **22** ppm
PAC-3: **120** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 2 ppm/6.7 mg/m^3 TWA; Peak Limitation value I(1); Pregnancy Risk Group D.
Australia: TWA 3 ppm (10 mg/m^3), 1993; Austria: MAK 3 ppm (10 mg/m^3), 1999; Belgium: STEL 3 ppm (9.9 mg/m^3), 1993; Denmark: TWA 3 ppm (10 mg/m^3), 1999; Finland: STEL 3 ppm (10 mg/m^3) [skin]1999; Norway: TWA 3 ppm (10 mg/m^3), 1999; the Philippines: TWA 3 ppm (10 mg/m^3), 1993; Poland: MAC (TWA) 7 mg/m^3, MAC (STEL) 21 mg/m^3, 1999; Russia: STEL 2 mg/m^3, 1993; Switzerland: MAK-W 3 ppm (10 mg/m^3), KZG-W 6 ppm (20 mg/m^3), 1999; Turkey: TWA 5 ppm (17 mg/m^3), 1993; United Kingdom: STEL 3 ppm (10 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 3 ppm. Several states have set guidelines or standards for hydrogen bromide in ambient air[60] ranging from 80.0 μg/m^3 (Virginia) to 100.0 μg/m^3 (North Dakota) to 200.0 μg/m^3 (Connecticut and New York) to 238.0 μg/m^3 (Nevada).
Determination in Air: Collection using Si gel; workup with $NaHCO_3/Na_2CO_3$; Analysis by ion chromatography; NIOSH (IV), Method #7903, Inorganic Acids; OSHA Analytical Method ID-165SG.
Routes of Entry: Inhalation, ingestion, eye and/or skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Hydrogen bromide is a corrosive chemical and contact can severely burn the eyes, with permanent damage. It can cause severe burns of the skin. Exposure can irritate the eyes, nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. Contact with liquid can cause frostbite.
Long Term Exposure: Long-term exposure can irritate the lungs and cause a chronic discharge. Bronchitis may develop with cough, phlegm, and/or shortness of breath. It may damage the sense of smell. Long-term exposure can also cause chronic indigestion and may damage the nervous system. Repeated skin contact can cause an acne-like rash to develop.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Serum bromine level. Examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Wear splash-proof chemical goggles and face shield when working with the liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *30 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprAg (APF = 25) [any powered, air-purifying respirator with acid gas cartridge(s)] or GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:*

GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Corrosive poison gas. (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (3) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Hydrogen bromide must be stored to avoid contact with strong oxidizers, caustics, metals, and moisture because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Anhydrous hydrogen bromide requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Hydrobromic acid, with >49% hydrobromic acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II or III.

Hydrobromic acid, with *not* >49% hydrobromic acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1048:

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 2.8/4.5

Fire Extinguishing: Hydrogen bromide is noncombustible. Reacts with water to produce toxic hydrobromic acid. Fight surrounding fire with an agent appropriate for surrounding fire. Poisonous gases, including bromine and hydrogen bromide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Soda ash/slaked lime is added to give a neutral bromide solution which is discharged to sewers or streams with water dilution.

References

US Environmental Protection Agency. (November 1, 1976). *Chemical Hazard Information Profile: Bromine and Bromine Compounds*. Washington, DC

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Hydrogen Bromide*. Trenton, NJ

Hydrogen chloride H:0430

Molecular Formula: HCl

Synonyms: Acide chlorhydrique (French); Anhydrous hydrochloric acid; Aqueous hydrogen chloride; Chlorohydric acid; Chlorwasserstoff (German); HCl; Hydrochloric acid; Hydrochloric acid, anhydrous; Hydrochloride; Hydrogen chloride; Muriatic acid; Spirits of salt

CAS Registry Number: 7647-01-0

RTECS® Number: MW9610000; MW4025000

UN/NA & ERG Number: UN1050 (anhydrous)/125; UN1789 (solution)/157; UN2186 (refrigerated liquid)/125

EC Number: 231-595-7 [*Annex I Index No.:* 017-002-00-2]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration). (1.00% concentration); *Theft hazard* 500 (commercial grade) (*anhydrous*); *Release hazard* 15,000 (≥37.00% concentration) (*hydrochloric acid*).

Carcinogenicity: IARC: Animal Inadequate Data; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1992.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Toxic Substance (World Bank).[13]

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Note: Nonaerosol forms of hydrochloric acid have been deleted from EPCRA/SARA 313 reporting, 7/29/96 (FR vol. 61, No. 146, p. 39356-39357).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, C; Risk phrases: R23; R35; Safety phrases: S1/2; S9; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hydrogen chloride is a colorless to slightly yellow gas or fuming liquid with a pungent, irritating odor. May be shipped and stored as a cryogenic liquid. The aqueous solution is known as hydrochloric acid or muriatic acid and may contain as much as 38% HCl. Shipped as a liquefied compressed gas. The odor threshold is 0.77 ppm. Molecular weight = 36.46; Boiling point = −85°C; Freezing/Melting point = −114.4°C; Relative vapor density (air = 1) = 1.27; Vapor pressure = 40.5 atm. Hazard Identification (based on NFPA-704 M Rating System) (*40%*): Health 3, Flammability 0, Reactivity 2. Highly corosive. Soluble in water; solubility = 67% at 30°C.

Potential Exposure: Hydrogen chloride itself is used in the manufacture of pharmaceutical hydrochlorides, chlorine, vinyl chloride from acetylene; alkyl chlorides from olefins; arsenic trichloride from arsenic trioxide; in the chlorination of rubber; as a gaseous flux for babbitting operations; and in organic synthesis involving isomerization, polymerization, alkylation, and nitration reactions. The acid is used in the production of fertilizers, dyes, dyestuffs, artificial silk, and paint pigments; in refining edible oils and fats; in electroplating; leather tanning; ore refining; soap refining; petroleum extraction; pickling of metals; and in the photographic, textile, and rubber industries. It has been used as a choking/pulmonary agent.

Incompatibilities: The aqueous solution is a strong acid. Corrosive fumes emitted on contact with air. Reacts violently with bases, oxidizers forming toxic chlorine gas. Reacts, often violently, with acetic anhydride, active metals, aliphatic amines, alkanolamines, alkylene oxides, aromatic amines, amides, 2-aminoethanol, ammonia, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, ethylene diamine, ethyleneimine, epichlorohydrin, isocyanates, metal acetylides, oleum, organic anhydrides, perchloric acid, 3-propiolactone, uranium phosphide, sulfuric acid, vinyl acetate, vinylidene fluoride. Highly corrosive to most metals, forming flammable hydrogen gas. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.49 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/7 mg/m^3 Ceiling Concentration.

NIOSH REL: 5 ppm/7 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 2 ppm/2.98 mg/m^3 Ceiling Concentration; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 0.5 ppm

PAC-1: **1.8** ppm

PAC-2: **22** ppm

PAC-3: **100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/3 mg/m^3; Peak Limitation Category I (2); Pregnancy Risk Group C.

NIOSH IDLH: 50 ppm.

Several states have set guidelines or standards for HCl in ambient air[60] ranging from 10 μg/m^3 (Massachusetts) to 70 μg/m^3 (North Dakota) to 120 μg/m^3 (Virginia) to 140 μg/m^3 (New York and South Dakota) to 167 μg/m^3 (Nevada) to 175 μg/m^3 (South Carolina) to 600−2000 μg/m^3 (Rhode Island) to 700 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH (IV), Method #7903, Inorganic Acids; OSHA Analytical Method ID-165SG.

Routes of Entry: Inhalation of gas or mist, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Signs and symptoms of acute ingestion of hydrogen chloride may be severe and include salivation, intense thirst, difficulty in swallowing, chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of hydrogen chloride. Acute inhalation exposure of hydrogen chloride may result in sneezing, hoarseness, choking, laryngitis, and respiratory tract irritation. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, bronchitis, pneumonia, dyspnea (shortness of breath), chest pain, and pulmonary edema may also occur. If the eyes have come in contact with hydrogen chloride, irritation, pain, swelling, corneal erosion, and blindness may result. Dermal exposure may result in dermatitis (red, inflamed skin), severe burns, and pain.

Short Term Exposure: HCl is corrosive to the eyes, skin, and respiratory tract. Inhalation of high concentrations of vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May cause inflammation and destruction of the nasal passages, dental erosion, loss of voice, coughing, pneumonia, headaches, and rapid throbbing of the heart. May cause death in the range of 1000−2000 ppm. Skin contact can cause irritation or burns of the skin. Eye contact may cause irritation and severe damage to the surface of the eye, severe burns, and loss of sight. Contact with the liquid may cause frostbite. Ingestion may cause irritation of mouth, throat, and stomach; salivation, nausea, vomiting, chills and fever; holes in the intestinal tract; inflammation of the kidneys; and shock.

Long Term Exposure: Irritates the lungs, causing chronic bronchitis. May cause irritation and skin rash. Long-term exposure to low levels (greater than 5 ppm) of hydrogen chloride can cause some dental erosion. Aside from such dental erosions, no significant abnormalities have been associated with long-term low-level exposures. There is limited evidence that workers involved in the manufacturing of hydrogen chloride have an increased risk of respiratory cancers.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Decontamination*:* This is very important, and you have to decontaminate as soon as you can. The gas is very soluble in water, forming hydrochloric acid. Since the more concentrated the acid, the more dangerous it is; consequently, the acid must be diluted as much as possible. Decontamination must be started quickly before it has time to do much damage. Extra minutes before decontamination can make a big difference. Although hydrogen chloride is a gas, the victim cannot spread the agent to others. But, if the victim is wet, or the victim's clothes are wet, hydrochloric acid may be spread to others outside the hot and warm zones. So wash a victim thoroughly so that he cannot spread the acid to others. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. *Do not use household bleach or other bleach products* to decontaminate the victim. Wash the victim with warm water and soap. After decontamination, treat the acid burns as you would with burns from a fire. Decontaminate with water or with soap and water. Be sure that you have decontaminated the victims as much as you can before they leave the area. If you get any of the acid on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can following the incident.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrS* (APF = 10) (any NIOSH/MSHA- or European Standard EN 149-approved chemical cartridge respirator with cartridge(s) providing protection against the compound of concern) or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Hydrogen chloride must be stored to avoid contact with any alkali or active metals (such as potassium, sodium, and zinc) because violent reactions occur. Store in tightly closed containers in cool, well-ventilated area away from heat. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Anhydrous hydrogen chloride requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Hydrogen chloride, *refrigerated liquid*, requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 8. Hydrochloric acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: *Gas:* If hydrogen chloride gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If hydrogen chloride solution is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Collect material in a convenient manner and deposit in sealed containers. If necessary, dilute and/or neutralize the material before collection. It may be necessary to contain and dispose of hydrogen chloride as a hazardous waste. Contact the NJ Department of Environmental Protection (DEP) of the federal Environmental Protection Agency (EPA) for specific recommendations.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Hydrogen chloride, anhydrous, used as a weapon—not covered in the current DOT tables.

UN1050 Hydrogen chloride, anhydrous

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.9/1.5

Hydrogen chloride, refrigerated liquid

Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)
First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 1.7/2.8
Night 6.3/10.2

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. (The material itself does not burn, but contact with metals produces hydrogen gas which will increase the chance of explosion). Poisonous gases, including chlorine and hydrogen chloride, are produced in fire. Use extinguishers suitable for surrounding fires other than water. Contact with water will produce heat and hydrochloric acid. If water is used, it must be used in flooding quantities. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not apply water to cryogenic liquid containers. If cryogenic liquid containers are exposed to direct flame or elevated temperatures for prolonged periods, withdraw to a secure location. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Soda ash—slaked lime is added to form the neutral solution of chloride of sodium and calcium. This solution can be discharged after dilution with water.[22] Alternatively, hydrogen chloride can be recovered from a variety of process waste streams.

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Hydrogen cyanide (Agent AC, WMD) H:0440

Molecular Formula: CHN
Common Formula: HCN

Synonyms: AC (military designation); Acide cyanhydrique (French); Aero liquid HCN; Blausaeure (German); Cyanwasserstoff (German); Cyclon; CycloneB; Formonitrile; HCN; Hydrocyanic acid; Prussic acid; Zaclon Discoids

CAS Registry Number: 74-90-8
RTECS® Number: MW6825000

UN/NA & ERG Number: UN1051 (anhydrous, stabilized)/117; UN1613 (less than 20% solution)/154; UN1614 (stabilized with <3% water and absorbed in a porous inert material)/152

EC Number: 200-821-6 [*Annex I Index No.:* 006-006-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥4.67% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg).

Banned of Severely Restricted (Belgium, E. Germany, Philippines) (UN).[13]

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): P063.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: F+, T+, N; R12; R26; R50/53; Safety phrases: S1/2; S7/9; S16; S36/37; S38; S45; S60; S61. (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hydrogen cyanide (AC) is a volatile, colorless or pale-blue liquid; or a colorless gas. AC gas has a distinctive bitter almond odor (others describe a musty “old sneakers smell”), but a large proportion of people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. It also has a bitter burning taste and is often used as a solution in water. The odor threshold is 0.58 ppm. Odor is *not* a reliable indicator of toxic amounts of vapor. Often used as a 96% solution in water. It is intensely poisonous, highly flammable, and explosive. Molecular weight = 27.03; Specific gravity (H_2O:1) = 0.69 (liquid); Boiling point = 25.6°C (96%); Freezing/Melting point = −13.9°C (96%); Vapor pressure = 630 mmHg at 20°C; Flash point = −17.8°C (cc) (96%); Autoignition temperature = 537.8°C (96%). Explosive limits: LEL = 5.6%; UEL = 40.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Human Data. Hydrogen cyanide is used in chemical synthesis of sequestrants, polymers, weed killers, and pharmaceuticals; as a fumagant; in electroplating, mining, chemical synthesis, and the production of synthetic fibers, plastics, dyes, and pesticides; in chemical synthesis of acrylates and nitriles, particularly acrylonitrile. It may be generated in blast furnaces, gas works, and coke ovens. Cyanide salts have a wide variety of uses, including steel hardening, gold and silver extraction from ores. AC is used as a chemical warfare agent (blood agent); systemic agent. It forms cyanide in the body.

Incompatibilities: Unless stabilized and maintained, samples stored more than 90 days are hazardous. The gas can form an explosive mixture with air. Material containing more than 2−5% water are less stable than dry material and can be self-reactive, forming an explosive mixture with air. Heat above 50−60°C or contact with heat, water, alkaline material, amines, or strong bases can cause polymerization. The aqueous solution is a weak acid. Violent reaction with oxidizers, acetaldehyde, acids, hydrogen chloride in alcoholic mixtures, sodium carbonate, caustic substances, causing fire and explosion hazard. Incompatible with amines, strong acids, sodium hydroxide, calcium hydroxide, sodium carbonate, ammonia. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 1.10 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm/11 mg/m^3 TWA [skin].
NIOSH REL: 4.7 ppm/5 mg/m^3 STEL [skin].
ACGIH TLV®[1]: 4.7 ppm/5 mg [CN]/m^3 Ceiling Concentration [skin].
NIOSH IDLH: 50 ppm.
Protective Action Criteria (PAC) AC 74-90-8*
TEEL-0: 1.9 ppm
PAC-1: **2** ppm
PAC-2: **7.1** ppm
PAC-3: **15** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Emergency Response Planning Guidelines (AIHA)
ERPG-1: Not appropriate
ERPG-2: 10 ppm
ERPG-3: 25 ppm
DFG MAK: 1.9 ppm/2.1 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C.
Arab Republic of Egypt: TWA 10 ppm (10 mg/m^3), 1993; Australia: TWA 10 ppm (10 mg/m^3), [skin], 1993; Austria: MAK 10 ppm (11 mg/m^3), [skin], 1999; Denmark: TWA 5 ppm (5 mg/m^3), [skin], 1999; Finland: STEL 10 ppm (11 mg/m^3), [skin], 1999; France: VME 2 ppm (2 mg/m^3), VLE 10 ppm (10 mg/m^3), 1999; Hungary: TWA 0.3 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; the Netherlands: MAC 11 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (5 mg/m^3), 1999; the Philippines: TWA 10 ppm (11 mg/m^3), [skin], 1993; Poland: MAC (TWA) 0.3 mg/m^3, ceiling 10 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 0.3 mg/m^3, 1993; Sweden: ceiling 5 mg/m^3, [skin], 1999; Switzerland: MAK-W 10 ppm (11 mg/m^3), KZG-W 20 ppm (22 mg/m^3), [skin], 1999; Thailand: TWA 10 ppm (11 mg/m^3), 1993; Turkey: TWA 10 ppm (11 mg/m^3), [skin], 1993; United Kingdom: STEL 10 ppm (11 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 4.7 ppm [CN] [skin]. Several states have set guidelines or standards for hydrogen cyanide in ambient air[60] raging from 33 μg/m^3 (New York) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (North Dakota) to 220 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada) to 250 μg/m^3 (South Carolina) to 120−1000 μg/m^3 (North Carolina). The Czech Republic: MAC 0.3 mg/m^3. In ambient air in residential areas, Russia set a MAC of 0.01 mg/m on a daily average basis. In ambient air in residential areas, the

Czech Republic[35] has set 0.008 mg/m^3 on both a momentary and daily average basis.

Determination in Air: Use NIOSH (IV), Method #6010; #6017. Also Use NIOSH Analytical Method #7904 Cyanides (aerosol and gas).

Permissible Concentration in Water: A USPHS drinking water criterion for alternate source selection is 100 μg/L.[32]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.25$.

Routes of Entry: Inhalation of vapor; percutaneous absorption of liquid and concentrated vapor; ingestion; and eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Hydrogen cyanide can irritate and burn the skin and eyes. Inhalation can irritate the respiratory tract. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Can cause dizziness, headache, weakness, anxiety, confusion, pounding heart, difficult breathing and nausea. These can rapidly lead to convulsions and death unless exposure is immediately stopped and proper first aid is applied. High exposure can cause sudden death. Signs and symptoms of acute exposure to hydrocyanic acid may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood may be noted. Cardiac arrhythmias and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) may be observed. Weakness, headache, vertigo (dizziness), agitation, giddiness, salivation, nausea, and vomiting; may be followed by combative behavior, convulsions, paralysis, protruding eyeballs, dilated and unreactive pupils, and coma. Tachypnea (rapid, shallow respirations) or hyperpnea (rapid, deep respirations) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may also occur. *Inhalation:* At less than 20 ppm, exposure to hydrogen cyanide may produce headache, dizziness, nausea, and vomiting. Concentrations greater than 50 ppm may cause difficulty in breathing, rapid throbbing of the heart, paralysis, unconsciousness, respiratory arrest, or death. 30-min exposure to 135 ppm may cause death and to 270 ppm has caused immediate death. *Skin:* Hydrogen cyanide is readily absorbed through the skin. Symptoms are similar to above. *Eyes:* Hydrogen cyanide is irritating to the eye and rapidly absorbed. *Ingestion:* Symptoms are similar to above. Death has resulted from ingestion of 570 mg/kg or 1.4 oz for a 150-lb person.

Long Term Exposure: Repeated exposure can interfere with thyroid function and can cause goiter. Itching, scarlet rash, red bumps, severe nose itch leading to bleeding, and possibly holes in the nose may result from long-term exposure to hydrogen cyanide. Headache, nausea, vomiting, weakness, and enlarged thyroid gland have also been reported at exposures from 4 to 12 ppm. May damage the nervous system.

Points of Attack: Central nervous system, cardiovascular system, thyroid, blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), lactic acid, pH (Hydrogen ion concentration), carboxyhemoglobin; blood plasma, bicarbonate, electrocardiogram, on workers over 40 years; expired air. Preplacement and periodic examinations should include the cardiovascular and central nervous systems, liver and kidney function, blood, history of fainting or dizzy spells. Blood cyanide test. Evaluation of thyroid function. Examination of the nervous system. Urinary thiocyanate levels have been used but are nonspecific and are elevated in smokers.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let anything get into the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Be sure that you have decontaminated the victims as much as you can before they leave the area so that they do not spread the agent. If you get some of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal and other items.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. 47 ppm:* Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials and conditions (see above). Store outdoors, if possible, or indoors in standard combustible liquid storage room or cabinet, away from sources of ignition. Protect containers against physical damage. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Hydrocyanic acid, aqueous solutions or Hydrogen cyanide, solutions with not >20% hydrogen cyanide requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Hydrogen cyanide, stabilized, with <3% water requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Hydrogen cyanide, stabilized, with <3% water and absorbed in a porous inert material requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stay upwind; keep out of low areas. Ventilate closed spaces before entering. Use water spray to reduce vapors. Do not touch spilled material; stop leak if you can do it without risk. Shut off ignition; no flares, smoking, or flames in hazard area. Isolate area until gas is dispersed. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

AC, when used as a weapon

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 2.4/3.8
Night 4.5/7.2

Hydrogen cyanide; Hydrocyanic acid

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 2.5/4.1

Fire Extinguishing: Poisonous gases, including cyanide, are produced in fire. If material is on fire and conditions permit, do not extinguish; combustion products are less toxic than the material itself. Cool exposures using unattended monitors. *Do not use water* directly on fire as cyanide gas may form. Use water to control only vapors. May react with itself without warning with explosive violence.

Gas: This chemical is a flammable gas. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Evacuate area endangered by gas. See isolation distance above if tank car or truck is involved in fire. Use dry chemicals, alcohol-resistant (AFFF) foam, or carbon dioxide. *Small fires*: let burn unless leak can be stopped immediately. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Stay away from ends of tanks. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Cool container with water using unmanned device until well after fire is out. Isolate area until gas has dispersed. Firefighting should be done from a safe distance. A few whiffs of gas, or liquid penetrating firefighter's protective clothing, could be fatal. Only special protective clothing should be worn.

Liquid: This chemical is a flammable liquid. Use dry chemical, carbon dioxide, or alcohol-resistant (AFFF) foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames of the surface of the burning liquid. Do not direct straight streams into the liquid. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chemical conversion to ammonia and carbon dioxide using chlorine or hypochlorite in a basic media. Controlled incineration is also adequate to totally destroy cyanide.[22] Alternatively, HCN can be recovered from ammonoxidation process waste streams, for example. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Cyanide*, NIOSH Document No. 77-108

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrocyanic Acid*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Hydrogen Cyanide*. Version 3. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 61–64

New Jersey Department of Health and Senior Services. (June 2006). *Hazardous Substances Fact Sheet: Hydrogen Cyanide*. Trenton, NJ

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0, United Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C)*. Washington, DC: United States Coast Guard and the Department of Homeland Security.

Hydrogen fluoride H:0450

Molecular Formula: HF
Synonyms: Acido fluorhidrico (Spanish); Anhydrous hydrofluoric acid; Antisal 2B; C-P 8 solution; Doped poly etch; Fluorhydric acid; Fluoric acid; Fluoruro de hidrogeno (Spanish); Freckle etch; Hydrofluoric acid; Hydrofluoric acid gas; Hydrogen fluoride, anhydrous; Implanter fumer; KTI buffered oxide etch 50: 1; KTI buffered oxide etch 6: 1; KTI oxide etch 10: 1; KTI oxide etch 5: 1; KTI oxide etch 50: 1; Mae etchants; Mixed acid etch; Poly etch 95%; Rubigine; Silicon etch solution
CAS Registry Number: 7664-39-3
RTECS® Number: MW7875000
UN/NA & ERG Number: UN1052 (anhydrous)/125; UN1790 (solution)/157
EC Number: 231-634-8 [*Annex I Index No.:* 009-002-00-6]
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release Hazard* 1000 (≥50.00% concentration).
US EPA Gene-Tox Program, Positive: *D. melanogaster* sex-linked lethal.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Toxic Substance (World Bank).[15]
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg).
Hydrogen fluoride:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U134.
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, *HF* (*concentration* ≥ *50%*).
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); (conc. 50% or greater, or anhydrous) Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 1000 lb (454 kg).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U134.
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T+, C; Risk phrases: R26/27/28; R35; Safety phrases: S1/2; S7/9; S26; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Hydrogen fluoride is a colorless, fuming liquid below 19.4°C or gas with a strong, irritating odor. Hydrogen fluoride mixes readily with water, forming hydrofluoric acid. odor threshold = 0.03 mg/m^3. Molecular weight = 20.01; Specific gravity (H_2O:1) = 1 (liquid at 19.5°C); Boiling point = 19.5°C; Freezing/Melting point = −83°C; Vapor pressure = 783 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2₩. Highly soluble in water.
Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Primary Irritant. Hydrogen fluoride, its aqueous solution hydrofluoric acid, and its salts, are used in special metallurgical process; nuclear engineering; making organic and inorganic fluorine compounds, such as fluorides and plastics; as a catalyst, particularly in paraffin alkylation in the petroleum industry; as an insecticide; and to arrest the fermentation in brewing. It is utilized in the fluorination processes, especially in the aluminum industry; in separating uranium isotopes; in cleaning cast iron, copper, and brass; in removing efflorescence from brick and stone; in removing sand from metallic castings; in frosting and etching glass and enamel; in polishing crystal; in decomposing cellulose; in enameling and galvanizing iron; in working silk; in dye and analytical chemistry; and to increase the porosity of ceramics.
Incompatibilities: A super-strong acid; aqueous solutions are less strong. Reacts violently with bases. Reacts, possibly with violence, with many compounds including acetic anhydride, aliphatic amines, alcohols, alkanolamines, alkylene oxides, aromatic amines, amides, 2-aminoethanol, ammonia, ammonium hydroxide, arsenic trioxide, bismuthic acid, calcium oxide, ethylene diamine, ethyleneimine, epichlorohydrin, isocyanates, metal acetylides, nitrogen trifluoride, oleum, organic anhydrides, oxygen difluoride, phosphorous pentoxide, sulfuric acid, strong oxidizers, vinyl acetate, vinylidene fluoride. Attacks glass, concrete, ceramics, and other silicon-containing compounds. Attacks metals, some plastics, rubber, and coatings.
Permissible Exposure Limits in Air
As fluorides
OSHA PEL: 3 ppm/2.5 mg [F]/m^3 TWA.
NIOSH REL: 3 ppm/2.5 mg [F]/m^3 TWA; 6 ppm/5 mg [F]/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 5 ppm/0.41 mg [F]/m^3 TWA; 2 ppm/1.64 mg [F]/m^3 Ceiling Concentration; [skin]; not classifiable as a human carcinogen; BEI: 3 mg [F]/g creatinine in urine *prior* to end-of-shift; 10 mg [F]/g creatinine in urine end-of-shift.

NIOSH IDLH: 30 ppm.

Protective Action Criteria (PAC) HF*

TEEL-0: 0.527 ppm

PAC-1: **1.0** ppm

PAC-2: **24** ppm

PAC-3: **44** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: 2 ppm

ERPG-2: 20 ppm

ERPG-3: 50 ppm

DFG MAK: 1 ppm/0.83 mg [F]/m^3, [skin]; Peak Limitation Category I(2); Pregnancy Risk Group C; BAT: 7.0 mg [F]/g creatinine in urine at end-of-shift; 4.0 mg [F]/g creatinine in urine at the beginning of the next shift.

Arab Republic of Egypt: TWA 2 ppm (2 mg/m^3), 1993; Australia: TWA 3 ppm (2.5 mg/m^3), 1993; Austria: MAK 3 ppm (2.5 mg/m^3), 1999; Belgium: STEL 3 ppm (2.6 mg/m^3), 1993; Denmark: TWA 2 ppm (1.6 mg/m^3), 1999; Finland: ceiling 3 ppm [skin] 1999; France: VLE 3 ppm (2.5 mg/m^3), 1999; Hungary: TWA 0.5 mg/m^3; STEL 1 mg/m^3, 1993; Japan: 3 ppm (2.5 mg/m^3), 1999; Norway: TWA 0.8 ppm (0.6 mg/m^3), 1999; the Philippines: TWA 3 ppm (2 mg/m^3), 1993; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 4 mg/m^3, 1999; Russia: TWA 3 ppm (0.1 mg/m^3); STEL 0.5 mg/m^3, 1993; Sweden: ceiling 2 ppm (1.7 mg/m^3), 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg/m^3), KZG-W 3.6 ppm (3.0 mg/m^3), 1999; Turkey: TWA 3 ppm (2 mg/m^3), 1993; United Kingdom: STEL 3 ppm (2.5 mg[F]/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 3 ppm[F]. Several states have set guidelines or standards for hydrogen fluoride in ambient air[60] ranging from 3.4 μg/m^3 (Massachusetts) to 8.3 μg/m^3 (New York) to 20.0 μg/m^3 (Virginia) to 25.0 μg/m^3 (North Dakota and South Carolina) to 30.0 μg/m^3 (Rhode Island) to 50.0 μg/m^3 (Connecticut and South Dakota) to 60.0 μg/m^3 (Nevada) to 25.0−250.0 μg/m^3 (North Carolina) to 830.0 μ/m^3 (Kentucky).

Determination in Air: Use NIOSH Analytical Method #3800, #7902, #7903, #7906; OSHA Analytical Method ID-110.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.23$.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Hydrogen fluoride is corrosive to the eyes, skin, and the respiratory tract. Eye burns may not be immediately painful. Inhalation of this gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High levels of exposure can cause death. Acute exposure to hydrogen fluoride will result in irritation, burns, ulcerous lesions, and necrosis of the eyes, skin, and mucous membranes. Total destruction of the eyes is possible. Other effects include nausea, vomiting, diarrhea, pneumonitis (inflammation of the lungs), and circulatory collapse. Ingestion of an estimated 1.5 g produced sudden death without gross pathological damage. Repeated ingestion of small amounts resulted in moderately advanced hardening of the bones. Contact of skin with anhydrous liquid produces severe burns. Inhalation of anhydrous hydrogen fluoride or hydrogen fluoride mist or vapors can cause severe respiratory tract irritation that may be fatal. Hydrogen fluoride may induce hypocalcemia, causing cardiac and renal failure.

Long Term Exposure: The substance may cause fluorosis. Can irritate the lungs and may cause bronchitis. Long-term exposure may damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, bones.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray; electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once (contact lenses *should not be worn* when working with HF) and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and flush immediately with large amounts of water. Immerse exposed skin area in iced 70% ethyl alcohol. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should *not* be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 ppm:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SA* (any supplied-air respirator) or SCBA (any self-contained breathing apparatus). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Hydrogen fluoride must be stored to avoid contact with metals, concrete, glass, and ceramics because it can severely corrode these materials. See also "Incompatibilities;" listed above. Contact with metals may form a flammable gas. Keep away from heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Hydrogen fluoride, anhydrous, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I.

Hydrofluoric acid, with >60% strength, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I.

Hydrofluoric acid, with *not* >60% strength, requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of spill or leak. If a gas, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If in liquid form, allow to vaporize and disperse the gas, or cover with sodium carbonate or an equal mixture of soda ash and slaked lime. After mixing, add water if necessary to form a slurry. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1052, anhydrous

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.2/3.5

Fire Extinguishing: Hydrogen fluoride is a noncombustible liquid or gas. Contact with metals may form flammable hydrogen gas which can cause fire and explosion. Use chemical extinguishers. Poisonous gases, including fluorine, are produced in fire. Vapors are slightly lighter than air. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Do not extinguish the fire unless the flow of the gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use dry chemicals, foam, carbon dioxide. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reaction with excess lime followed by lagooning and either recovery or landfill disposal of the separated calcium fluoride. The supernatant liquid from this process is diluted and discharged to the sewer.[22] Alternatively, hydrogen can be recovered and recycled in many cases. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Fluoride*, NIOSH Document No. 76-143

US Environmental Protection Agency. (April 30, 1980). *Hydrofluoric Acid, Health and Environmental Effects Profile No. 117*. Washington, DC: Office of Solid Waste

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US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrogen Fluoride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Hydrogen Fluoride*. Trenton, NJ

Hydrogen peroxide H:0460

Molecular Formula: H_2O_2

Synonyms: Albone; Carro's acid; Dihydrogen dioxide; Hydrogen dioxide; Hydroperoxide; Hyoxyl; Inhibine; Lea Ronal NP-A/NP-B solder stripper; Nanostrip; Oxydol; Patclin 948 solder stripper; Perhydrol; Perone; Peroxan; Peroxide; Peroxido de hidrogeno (Spanish); Peroxyde d'hydrogene (French); Piranha etch; RCA Clean (steps 1 and 2); Superoxol

CAS Registry Number: 7722-84-1

RTECS® Number: MX0900000 (90%); MX0899500 (60%); MX0899000 (30%) MX0887000 (3%)

UN/NA & ERG Number: UN2984 [8−19% solution (stabilized as necessary)]/140; UN2015 (>60%, stabilized)/143; UN2014 [>20%<60%, solution (stabilized as necessary)]/140

EC Number: 231-765-0 [*Annex I Index No.:* 008-003-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (≥35.00% concentration).

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999 (90%).

US EPA Gene-Tox Program, Positive: *N. crassa*—reversion; *E. coli* polA without S9; Positive: *In vitro* UDS—human fibroblast; *S. pombe*—reversion EPA; Inconclusive: Histidine reversion—Ames test (30%).

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Conc. >52%:

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg) (Conc. >52%).

Reportable Quantity (RQ): 1000 lb (454 kg) (Conc. >52%).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, C; Risk phrases: R5; R8; R20/22; R34; Safety phrases: S1/2; S17; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Hydrogen peroxide is a colorless liquid with a sharp odor and bitter taste. Molecular weight = 34.02; Specific gravity (H_2O:1) = 1.39; Boiling point = 141°C (90%); 125°C (70%); 106°C (30%); Freezing/Melting point = −39°C (70%); −11°C (90%); Vapor pressure = 5 mmHg at 30°C. Hazard Identification (based on NFPA-704 M Rating System): (30% solution) Health 3, Flammability 0, Reactivity 1 (Oxidizer) . Hydrogen peroxide is completely miscible with water and is commercially sold in concentrations of 3%, 35%, 50%, 70%, and 90% solutions. It is not flammable.

Potential Exposure: Compound Description: Drug, Tumorigen, Mutagen, Human Data; Hormone, Primary Irritant (90%); Mutagen, Human Data (20%). Hydrogen peroxide is used in the manufacture of acetone, antichlor, antiseptics, benzoyl peroxide, buttons, disinfectants, pharmaceuticals, felt hats, plastic foam, rocket fuel, sponge rubber, and pesticides; as a food and feed additive; flavor; as a packaging material; in bleaching bone; feathers, flour, fruit, fur, gelatin, glue, hair, ivory, silk, soap, straw, textiles, wax, and wood pulp; and as an oxygen source in respiratory protective equipment. Other specific occupations with potential exposure include liquor and wine agers, dyers, electroplaters, fat refiners, photographic film developers, wool printers, veterinarians, and water treaters.

Incompatibilities: Contact with combustible material may result in SPONTANEOUS combustion. A powerful oxidizer; attacks many substances. Attacks many organic substances, such as wood, textile, and paper. Contact with most organic, readily oxidizable materials, reducing agents, and combustibles causes fire and explosions, particularly in the presence of metals. Contact with iron, copper, brass, bronze, chromium, zinc, lead, manganese, silver, and catalytic metals (and their salts), especially in a basic (pH 7 or above) environment, causes rapid decomposition with evolution of oxygen gas, which increases fire hazard. Attacks, and may ignite, some plastics, rubber, and coatings. Decomposes slowly at ordinary temperatures and builds up pressure in a closed container. The rate of decomposition doubles for each 50°F/10°C rise (1.5 times for each 10°C rise) in temperature and becomes self-sustaining at 285°F/141°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.39 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/1.4 mg/m^3 TWA.

NIOSH REL: 1 ppm/1.4 mg/m^3 TWA.

ACGIH TLV®[1] 1 ppm/1.4 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 75 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **10** ppm

PAC-2: **50** ppm

PAC-3: **100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Protective Action Criteria (PAC) (30%)

TEEL-0: 3.33 ppm

PAC-1:33.3 ppm

PAC-2: 167 ppm

PAC-3: 333 ppm

DFG MAK: 0.5 ppm/0.71 mg/m^3 TWA; Peak Limitation Category I(1); Carcinogen Category 4; Pregnancy Risk Group C.

Australia: TWA 1 ppm (1.5 mg/m^3), 1993; Belgium: TWA 1 ppm (1.4 mg/m^3), 1993; Finland: TWA 1 ppm (1.4 mg/m^3); STEL 3 ppm (4.2 mg/m^3), 1999; France: VME 1 ppm (1.5 mg/m^3), 1993; the Netherlands: MAC-TGG 1.4 mg/m^3, 2003; Norway: TWA 1 ppm (1.4 mg/m^3), 1999; the Philippines: TWA 1 ppm (1.4 mg/m^3), 1993; Turkey: TWA 1 ppm (1.4 mg/m^3), 1993; United Kingdom: TWA 1 ppm (1.4 mg/m^3; STEL 2 ppm (2.8 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for hydrogen peroxide in ambient air[60] ranging from 15 μg/m^3 (North Dakota) to 25 μg/m^3 (Virginia) to 28 μg/m^3 (Connecticut) to 36 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #ID126SG.

Routes of Entry: Inhalation of vapor or mist, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Hydrogen peroxide is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Signs and symptoms of acute exposure to hydrogen peroxide may be severe and include irritation or burns to the skin, eyes, respiratory tract, mouth, esophagus, stomach, and intestines. Distension or rupture of the stomach and other hollow viscera may occur; vomiting is common. Corneal ulceration may develop.

Long Term Exposure: Because this is a mutagen, handle it as a possible cancer-causing substance—with extreme caution. Can irritate the lungs. Repeated exposure may cause bronchitis. Repeated skin contact can cause a rash with redness and blisters.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected: consider chest X-ray if pulmonary edema is suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For hydrogen peroxide (30−70%), Neoprene™ + Natural rubber; and Neoprene™/natural rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Where fumes or vapor are excessive, workers should be provided with gas masks with full face-pieces and proper canisters or supplied-air respirators. Additional health hazards may occur from the decomposition of hydrogen peroxide. Oxygen, possibly at high pressure, may form, which may create an explosion hazard. Hydrogen peroxide is generally handled in a closed system to prevent contamination. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *75 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White (30% solution): Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Hydrogen peroxide must be stored to avoid contact with iron, copper, chromium, brass, bronze, lead, silver, manganese, and their salts since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from alcohols, glycerol, organic materials, and radiant heat, including sunlight. Containers should be protected from physical and mechanical disturbances. Sources of ignition, such as smoking and open flames, are prohibited where hydrogen peroxide is used, handled, or stored in manner that could create a potential fire or explosion hazard. Wherever hydrogen peroxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Hydrogen peroxide, stabilized, or hydrogen peroxide *aqueous solutions*, stabilized with >60% hydrogen peroxide, require a shipping label of “OXIDIZER, CORROSIVE.” It falls in Hazard Class 5.1 and Packing Group I.

Hydrogen peroxide, *aqueous solutions with >40% but not >60% hydrogen peroxide* (stabilized as necessary), requires a shipping label of “OXIDIZER, CORROSIVE.” It falls in Hazard Class 5.1 and Packing Group II.

Hydrogen peroxide, aqueous solutions with not <20% but not >40% hydrogen peroxide (stabilized as necessary), requires a shipping label of “OXIDIZER, CORROSIVE.” It falls in Hazard Class 5.1 and Packing Group II.

Hydrogen peroxide, aqueous solutions with not <8% but <20% hydrogen peroxide (stabilized as necessary), requires a shipping label of “OXIDIZER” It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use a large quantity of water to wash down spills and reduce the flammable vapors. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible, but highly reactive and can increase the intensity of fire. Fires should be fought only with water. Do not use dry chemical, carbon dioxide, or foams. *Large fires:* flood fire area with water. Flammable vapors may accumulate in storage areas and containers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilution with water to release the oxygen. After decomposition, the waste stream may be discharged safely.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrogen Peroxide (>52%)*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Hydrogen Peroxide*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Hydrogen Peroxide*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 66−68

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Hydrogen selenide H:0470

Molecular Formula: H_2Se

Synonyms: Anhydrous hydrogen selenide; Electronic E-2; Selane; Selenium dihydride; Selenium hydride; Seleniuro de hidrogeno (Spanish)

CAS Registry Number: 7783-07-5

RTECS® Number: MX1050000

UN/NA & ERG Number: UN2202/117

EC Number: 231-978-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 500 lb (227 kg).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hydrogen selenide is a colorless, flammable gas with a very offensive odor, resembling decayed horseradish. The odor threshold is 0.3 ppm (higher than the occupational exposure limits); many people rapidly lose the ability to detect the odor of hydrogen selenide, so it is not a reliable warning of exposure. Molecular weight = 80.98; Specific gravity (H_2O:1) = 2.1 (liquid); Boiling point = −41°C; Freezing/Melting point = −66°C; Relative vapor density (air = 1): 2.80; Vapor pressure = 9.5 atm at 21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 0. Soluble in water; solubility = 0.9% at 22.7°C.

Potential Exposure: Hydrogen selenide is used in semiconductor manufacture. Also, it may be produced by the reaction of acids or water and metal selenides, or hydrogen and soluble selenium compounds.

Incompatibilities: Forms an explosive mixture with air. Contact with air causes the emission of toxic and corrosive fumes of selenium dioxide. A strong reducing agent. Reacts violently with oxidizers, causing fire and explosion hazard. Incompatible with strong acids, water, halogenated hydrocarbons. Decomposes above 100°C, forming toxic and flammable products including selenium and hydrogen.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.31 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.05 ppm[Se]/0.2 mg/m^3 TWA.

NIOSH REL: 0.05 ppm/0.2 mg/m^3 TWA.

ACGIH TLV®[1]: 0.05 ppm/0.16 mg/m^3 TWA.

NIOSH IDLH: 1 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.05 ppm

PAC-1: 0.1 ppm

PAC-2: **0.73** ppm

PAC-3: **2.2** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.015 ppm/0.050 mg/m^3 TWA; Peak Limitation Category I(2); Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 0.05 ppm (0.2 mg/m^3), 1993; Austria: MAK 0.05 ppm (0.2 mg/m^3), 1999; Belgium: TWA 0.05 ppm (0.16 mg/m^3), 1993; Denmark: TWA 0.01 ppm (0.05 mg/m^3), 1999; Finland: STEL 0.01 ppm (0.03 mg/m^3), 1999; France: VME 0.02 ppm (0.08 mg/m^3), 1999; Japan: 0.05 ppm (0.17 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg[Se]/m^3, 2003; Norway: TWA 0.01 ppm (0.05 mg/m^3), 1999; the Philippines: TWA 0.05 ppm (0.2 mg/m^3), 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, MAC (STEL)

0.3 mg[Se]/m^3, 1999; Russia: TWA 0.05 ppm, 1993; Switzerland: MAK-W 0.05 ppm (0.17 mg/m^3); STEL 0.1 ppm, 1999; Turkey: TWA 0.05 ppm (0.2 mg/m^3), 1993; United Kingdom: TWA 0.05 ppm (0.17 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 0.05 ppm. Several states have set guidelines or standards for H_2Se in ambient air[60] ranging from 2 g/m^3 (North Dakota) to 3 μ/m^3 (Virginia) to 4 μg/m^3 (Connecticut) to 5 μg/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: No criteria set, but EPA[32] suggests a permissible ambient goal of 10 μg/L (the same as for selenium) based on health effects.

Routes of Entry: Inhalation, eye and/or skin contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause dizziness, fatigue, nausea, vomiting, and diarrhea. *Inhalation:* The odor of hydrogen selenide in small concentrations (e.g., below 1 ppm) disappears rapidly because of olfactory fatigue. The odor and irritating effects are not a reliable warning to gradually increasing concentrations. Low levels have caused coughing, sneezing, and difficulty in breathing. Levels of 0.2 ppm may cause nausea, vomiting, a metallic taste in the mouth, and garlic breath. Levels of 1.5 ppm may cause intolerable irritation of mouth and nose. Inhalation of the gas may cause pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* May cause irritation and red coloration of nails. Contact can cause a burning sensation on contact and rash. Contact with liquid may cause freezing burns. *Eyes:* Levels of 1.5 ppm are described as intolerable.

Long Term Exposure: Repeated exposure can cause garlic odor on breath, dizziness, nausea, vomiting, labored breathing, bluing of skin, pulmonary edema, metallic taste, coughing, nasal secretion, pain in the chest, difficulty in breathing, irritation of the eyes, irritation of the respiratory tract resulting in bronchitis and conjunctivitis. It may also cause anemia. Animal studies suggest that liver damage and lung impairment are also possible.

Points of Attack: Eyes, respiratory system, liver, blood.

Medical Surveillance: Consider the points of attack in replacement and periodic physical examinations. Liver function tests. Complete blood count (CBC). Urine test for selenium (normal is less than 100 μg/L of urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Wear splash-proof chemical goggles and face shield when working with the liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 1 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (2) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with hydrogen selenide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store at room temperature away from contact with oxidizers, acids, water, and halogenated hydrocarbons. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Hydrogen selenide requires a shipping label of "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Warn other workers of leak. Evacuate area. Put on proper protective clothing and equipment. Stop flow of gas. Ventilate area. Remove sources of ignition. If leak cannot be stopped, move leaking cylinder to safe place out of doors. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 2.9./4.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 5.4/8.7
Night 7.0+ /11.0+ distance can be larger in certain atmospheric conditions

Fire Extinguishing: This chemical is a flammable gas. Do not extinguish fire unless flow of gas can be stopped. *Small fires:* dry chemical or carbon dioxide. Stay upwind and uphill; keep out of low areas. Wear self-contained breathing apparatus and full protective clothing. Use water in flooding quantities as fog. Cool containers that are exposed to flames with water until well after the fire is out. Decomposes above 100°C forming toxic and flammable selenium and hydrogen. Gas is heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrogen Selenide*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Hydrogen Selenide*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Hydrogen Selenide*. Trenton, NJ

Hydrogen sulfide H:0480

Molecular Formula: H_2S

Synonyms: Acide sulhydrique (French); Dihydrogen monosulfide; Dihydrogen sulfide; Hydrogene sulfure (French);

Hydrogen sulfuric acid; Hydrogen sulphide; Hydrosulfuric acid; Sewer gas; Shwefelwasserstoff (German); Stink damp; Sulfureted hydrogen; Sulfur hydride; Sulfuro de hidrogeno (Spanish)

CAS Registry Number: 7783-06-4

RTECS® Number: MX1225000

UN/NA & ERG Number: UN1053/117

EC Number: 231-977-3 [*Annex I Index No.:* 016-001-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1500 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U135.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313: Currently under administrative stay and is not currently reportable.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, T+, N; Risk phrases: R12; R26; R50; Safety phrases: S1/2; S9; S16; S28; S36; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Hydrogen sulfide is a flammable, colorless gas with a characteristic rotten egg odor. The odor threshold is 0.008 ppm. Sense of smell becomes rapidly fatigued and CANNOT be relied upon to warn of the continuous presence of H_2S. Shipped as a liquefied compressed gas. Molecular weight = 34.08; Boiling point = −60.6°C; Freezing/Melting point = −85.6°C; Vapor pressure = 17.6 atm at 25°C; Relative vapor density (air = 1) = 1.19; Autoignition temperature = 260°C. Explosive limits: LEL = 4.0%; UEL = 44.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 0. Soluble in water; solubility = 0.45% at 20°C.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Hydrogen sulfide is used in the synthesis of inorganic sulfides, sulfuric acid, and organic sulfur compounds; as an analytical reagent; as a disinfectant in agriculture; and in metallurgy. It is generated in many industrial processes as a by-product and also during the decomposition of sulfur-containing organic matter, so potential for exposure exists in a variety of situations. Hydrogen sulfide is found in natural gas, volcanic gas, and in certain natural spring waters. Its may also be encountered in the manufacture of barium carbonate, barium salt, cellophane, depilatories, dyes, pigments, felt, fertilizer, adhesives, viscose rayon, lithopone, synthetic petroleum products; in the processing of sugar beets; in mining, particularly where sulfide ores are present; in sewers and sewage treatment plants; during excavation of swampy or filled ground for tunnels, wells, and caissons; during drilling of oil and gas wells; in purification of hydrochloric acid and phosphates; during the low-temperature carbonization of coal; in tanneries, breweries, slaughterhouses; in fat rendering; and in lithography and photoengraving.

Incompatibilities: A highly flammable and reactive gas; heating may cause violent combustion or explosion. Forms explosive mixture with air. Incompatible with acetaldehyde, barium pentafluoride; chlorine monoxide; chlorine trifluoride; chromic anhydride; copper, lead dioxide; nitric acid; nitrogen iodide; nitrogen trichloride; nitrogen trifluoride; oxygen difluoride; oxidizers, phenyl diazonium chloride; sodium, sodium peroxide. Reacts with alkali metals. Attacks some plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.40 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm Ceiling Concentration; 50 ppm [10-min maximum peak; once per 8-h shift].

NIOSH REL: 10 ppm/15 mg/m^3 [10 min] Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/1.4 mg/m^3 TWA; 5 ppm/7 mg/m^3 STEL.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.51 ppm

PAC-1: **0.51** ppm

PAC-2: **27** ppm

PAC-3: **50** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/7.1 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 10 ppm (14 mg/m^3), 1993; Australia: TWA 10 ppm (14 mg/m^3), STEL 15 ppm, 1993; Austria: MAK 10 ppm (15 mg/m^3), 1999; Belgium: TWA 10 ppm (14 mg/m^3); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (15 mg/m^3), 1999; Finland: TWA 10 ppm (15 mg/m^3); STEL 15 ppm (20 mg/m^3), [skin], 1999; France: VME 5 ppm (7 mg/m^3), VLE 10 ppm (14 mg/m^3), 1999; Japan: 10 ppm (14 mg/m^3), 1999; the Netherlands: MAC-TGG 15 mg/m^3, 2003; Norway: TWA 10 ppm (15 mg/m^3), 1999; the Philippines: TWA 10 ppm (15 mg/m^3), 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 20 mg/m^3, 1999; Russia: TWA 10 ppm, STEL 10 mg/m^3, 1993; Sweden:

NGV 10 ppm (14 mg/m^3), KTV 15 ppm (20 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (15 mg/m^3), KZG-W 20 ppm (30 mg/m^3), 1999; Thailand: STEL 20 ppm, 1993; Turkey: TWA 10 ppm (15 mg/m^3), 1993; United Kingdom: TWA 10 ppm (14 mg/m^3), STEL 15 ppm (21 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm. Russia[43] set a MAC of 0.008 mg/m^3 in ambient air of residential areas on both a momentary and a daily average basis. Several states have set guidelines or standards for hydrogen sulfide in ambient air[60] ranging from 14.0 μg/m^3 (South Carolina) to 230.0 μ/m^3 (Virginia) to 280.0 μg/m^3 (Connecticut) to 333.0 μg/m^3.

Determination in Air: Use NIOSH (IV), Method #6013; OSHA Analytical Method ID-141.

Permissible Concentration in Water: EPA[32] suggests a permissible ambient goal of 207 μg/L based on health effects. EPA has established that hydrogen sulfide is a regulated toxic substance and is a hazardous substance defined under the Federal Water Pollution Control Act.

Routes of Entry: Inhalation of gas, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Signs and symptoms of acute exposure to hydrogen sulfide may include tachycardia (rapid heart rate) or bradycardia (slow heart rate), hypertension (low blood pressure), cyanosis (blue tint to skin and mucous membrane), cardiac palpitations, and cardiac arrhythmias. Dyspnea (shortness of breath), tachypnea (rapid respiratory rate), bronchitis, pulmonary edema, respiratory depression, and respiratory paralysis may occur. Neurological effects include giddiness, irritability, drowsiness, weakness, confusion, delirium, amnesia, headache, sweating, and dizziness. Muscle cramping, tremor, excessive salivation, cough, convulsions, and coma may be noted. Nausea, vomiting, and diarrhea are commonly seen. Exposure to hydrogen sulfide gas may result in skin irritation, lacrimation (tearing), inability to detect odors, photophobia (heightened sensitivity to light), and blurred vision.

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Levels of 20 ppm may cause headache, loss of appetite, and dizziness. 50 ppm may cause muscle fatigue. 300 ppm may cause muscle cramps, low blood pressure, and unconsciousness after 20 min. Levels of 500 ppm can cause immediate loss of consciousness, slowed respiration, and death in 30−60 min. At levels of 700 ppm and above, respiratory paralysis and death can occur in seconds. Nonfatal cases may recover fully or may experience abnormal reflexes, dizziness, sleep disturbances, and loss of appetite that last for months or years. *Skin:* Readily absorbed. May cause irritation, reddening, and swelling. Contact with liquid can cause freezing burns. *Eyes:* Irritation may be felt at levels as low as 0.1 ppm. Levels of 10 ppm and above can cause irritation, pain, tearing, and increased light sensitivity. Liquid may cause freezing burns.

Long Term Exposure: Long-term exposure to low levels can cause pain and redness of the eyes with blurred vision. Repeated exposure can cause fatigue, loss of appetite, headaches, irritability, poor memory, dizziness, troubled sleeping, and nausea. Can cause irritation of the lungs and bronchitis with cough, phlegm, and/or shortness of breath. Animals studies showed that pigs that ate food containing hydrogen sulfide had diarrhea after a few days and weight loss after about 105 days.

Points of Attack: Eyes, lungs.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), carboxyhemoglobin; blood plasma; chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood sulfide level (normal is less than 0.05 mg/L).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Because of poor warning signs, it may cause olfactory paralysis, and some persons are congenitally unable to smell H_2S. Accidental exposure may occur when workers enter sewage tanks and other confined areas in which hydrogen sulfide is formed by decomposition. In a number of cases workers enter unsuspectingly and collapse almost immediately. Workers, therefore, should not enter enclosed spaces without proper precautions. All federal standard and other safety precautions must be observed when tanks or other confined spaces are to be entered. In areas where the exposure to hydrogen sulfide exceeds the standards, workers should be provided with full-face canister gas masks or preferable supplied-air respirators. When liquid H_2S is involved, wear clothing to prevent skin freezing. Wear eye protection to prevent any reasonable probability of eye contact. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 100 ppm:* PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with hydrogen sulfide you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hydrogen sulfide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and nitric acid since violent reactions occur. Outdoor or detached storage is preferred. Indoors, store in a cool, well-ventilated area. Sources of ignitions, such as smoking and open flames, are prohibited where hydrogen sulfide is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of hydrogen sulfide. Wherever hydrogen sulfide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Hydrogen sulfide requires a shipping label of "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (*from a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (*from a large package or from many small packages*)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.3/2.0
Night 3.9/6.2

Fire Extinguishing: A very flammable gas. This chemical is a flammable gas. Poisonous gases, including sulfur dioxide, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas.

Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrogen sulfide can be recovered as such or converted to elemental sulfur or sulfuric acid. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Sulfide*, NIOSH Document No. 77-158

US Environmental Protection Agency. (April 30, 1980). *Hydrogen Sulfide, Health and Environmental Effects Profile No. 118*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 68−73

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Hydrogen Sulfide*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Hydrogen Sulfide*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Department of Health and Human Services. (June 1999). *ATSDR ToxFAQs, Hydrogen Sulfide*. Atlanta, GA

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Hydrogen Sulfide*. Trenton, NJ

Hydroquinone H:0490

Molecular Formula: $C_6H_6O_2$
Common Formula: $C_6H_4(OH)_2$

Synonyms: Arctuvin; Benzene, *p*-dihydroxy-; *p*-Benzenediol; 1,4-Benzenediol; Benzohydroquinone; Benzoquinol; Black and white bleaching cream; Boydes PTS developer; Cronaflex PDC developer; DIAK5; Dihydroquinone; *p*-Dihydroxybenzene; 1,4-Dihydroxybenzene; Dihydroxybenzene; 1,4-Dihydroxy-benzol (German); *p*-Dioxobenzene; *p*-Dioxybenzene; Eldopaque; Eldoquin; HE5; Hidroquinona (Spanish); Hydroquinol; α-Hydroquinone; *p*-Hydroquinone; *p*-Hydroxyphenol; 4-Hydroxyphenol; Kodagraph liquid developer; Kodak 55/66 developer; NCI-C55834; PD-86 developer; Phiaquin; Pyrogentisic acid; β-Quinol; Quinol; SR-201; Tecquinol; Tenox HQ; Tequinol

CAS Registry Number: 123-31-9

RTECS® Number: MX3500000

UN/NA & ERG Number: UN2662/153

EC Number: 204-617-8 [*Annex I Index No.:* 604-005-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NTP: Carcinogenesis Studies (gavage); some evidence: mouse, rat; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases R22; R40; R41; R43; R50; Safety phrases: S2; S36/37/39; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Hydroquinone is light-tan, light-gray, or colorless crystals. Molecular weight = 110.12; Specific gravity (H_2O:1) = 1.33; Boiling point = 285°C; Freezing/Melting point = 170°C; Vapor pressure = 0.00001 mmHg at 20°C; Flash point = 165°C (molten); Autoignition temperature = 516°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = 7%; 5.9% at 15°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Hydroquinone is a reducing agent and is used as an industrial chemical, chemical intermediate, pharmaceutical, and veterinary drug; as a photographic developer; and as an antioxidant or stabilizer for certain materials, which polymerize in the presence of oxidizing agents. Many of its derivatives are used as bacteriostatic agents, and others, particularly 2,5-

bis(ethyleneimino) hydroquinone, have been reported to be good antibiotic and tumor-inhibiting agents.

Incompatibilities: Hydroquinone is a reducing agent. Dust forms an explosive mixture with air. May explode on contact with oxygen. Incompatible with strong oxidizers, caustics; reacts violently with sodium hydroxide. May be oxidized to quinone at room temperatures in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: 2 mg/m^3 TWA.

NIOSH REL: 2 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 1 mg/m^3 TWA; danger of sensitization; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Category 3A.

Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3; STEL 4 mg/m^3 [skin] 1999; France: VME 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; the Philippines: TWA 2 mg/m^3, 1993; Poland: MAC (TWA) 2 mg/m^3, MAC (STEL) 4 mg/m^3, 1999; Sweden: NGV 0.5 mg/m^3, KTV 1.5 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3, KZG-W 4 mg/m^3, 1999; Turkey: TWA 2 mg/m^3, 1993; United Kingdom: LTEL 2 mg/m^3; STEL 4 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC of 0.02 mg/m^3 in ambient air in residential areas on a once-daily basis.[35] Several states have set guidelines or standards for hydroquinone in ambient air[60] ranging from 6.67 μg/m^3 (New York) to 20.0 μg/m^3 (Florida and South Carolina) to 20.0−40.0 μg/m^3 (North Dakota) to 35.0 μg/m^3 (Virginia) to 40.0 μg/m^3 (Connecticut) to 48.0 μg/m^3 (Nevada).

Determination in Air: NIOSH (IV), Method #5004; OSHA Analytical Method PV-2094.

Permissible Concentration in Water: Russia set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.60$.

Routes of Entry: Inhalation of dust, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Can cause conjunctivitis, keratitis (inflammation of the cornea). Can affect the central nervous system and cause excitement. Signs and symptoms of acute exposure to hydroquinone may be severe and include dyspnea (shortness of breath); a sense of suffocation; increased respiratory rate; and respiratory failure. Pallor (paleness of skin); cyanosis (blue tint to skin and mucous membranes); and cardiovascular collapse may also occur. Neurologic effects include headache, tinnitus (ringing in the ears), dizziness, delirium, muscle twitching, tremor, and convulsions. Nausea, vomiting, and the production of green to brown-green urine may also occur. Ingestion may cause respiratory failure. This material is very toxic; the probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb person. Fatal human doses have ranged from 5 to 12 g but 300−500 mg has been ingested daily for 3−5 months without ill effects. Death is apparently initiated by respiratory failure or anoxia.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Hydroquinone causes changes in color of the conjunctiva, cornea, and skin. Over the years this can cause clouding of the eyes and permanent vision damage. May cause genetic damage, mutations in humans. Such chemicals have a cancer risk.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: NIOSH lists the following tests: ophthalmic examination; pulmonary function tests. Careful examination of the eyes, including visual acuity and slit lamp examinations, should be carried out in preplacement and periodic examinations. Also, the skin should be examined. Hydroquinone is excreted in the urine as a sulfate ester although this has not been helpful in following worker exposure to dust.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, natural rubber, and Viton are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended for this chemical by NIOSH. See NIOSH Criteria Document #78-155.

Respirator Selection: *Up to 50 mg/m^3:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed at 50 and 100 mg/m^3.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Hydroquinone must be stored to avoid contact with sodium hydroxide since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing materials. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hydroquinone may burn but does not readily ignite. For small fires use dry chemical, carbon dioxide, water spray, or foam. Move container from fire area if you can do so without risk. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum), then scrub to remove harmful combustion products.[22]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Hydroquinone*, NIOSH Document No. 78-155

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 35−37 (1982) and 8, No. 1, 51−60 (1988)

New Jersey Department of Health and Senior Services. (August 2000). *Hazardous Substances Fact Sheet: Hydroquinone*. Trenton, NJ

Hydroxylamine (& salts) H:0500

Molecular Formula: H_3NO

Common Formula: $HONH_2$

Synonyms: Oxammonium

CAS Registry Number: 7803-49-8

Salts of hydroxylamine: 5470-11-1 (chloride); 13465-08-2 (nitrate); 10039-54-0 (sulfate)

RTECS® Number: NC2975000

UN/NA & ERG Number: UN3290 (Toxic solid, corrosive, inorganic, n.o.s.)/154

EC Number: 232-259-2 [*Annex I Index No.:* 612-122-00-7]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: Cell transform.-RLV F344 rat embryo; 1988, Positive: *N. crassa*—forward mutation; *S. pombe*—forward mutation; 1988, Negative: *In vitro* cytogenetics—human lymphocyte; 1988, Negative: *D. melanogaster*—whole sex chrom. loss; 1988, Inconclusive:

Carcinogenicity—mouse/rat; 1988, Inconclusive: *D. melanogaster*—nondisjunction; 1988, Inconclusive: *D. melanogaster* sex-linked lethal.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, Xn, N; Risk phrases: R2; R21/22; R37/38; R40; R41; R43; R48/22; Safety phrases: S2; S26; S36/37/39; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Hydroxylamine is a white crystalline substance. Molecular weight = 33.04; Specific gravity (H_2O:1) = 1.23; Boiling point = 70°C (decomposes below BP); Freezing/Melting point = 32°C; it is very hygroscopic and unstable; Flash point = 129°C (explosive); Autoignition temperature = 265°C. NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3. Soluble in water.

Potential Exposure: Compound Description: Mutagen. Those involved in chemical synthesis or use of hydroxylamine. Used as a reducing agent.

Incompatibilities: Self-reactive. Contaminants, temperatures above 129.4°C, or open flame can cause explosive decomposition, especially in the presence of moisture and carbon dioxide. Incompatible with strong acids, organic anhydrides, isocyanates, aldehydes, sodium, finely divided zinc, some metal oxides. Aqueous solution is a weak base. Contact with strong oxidizers may cause a fire and explosion hazard. Attacks some metals. Contact with calcium or zinc forms a heat-sensitive explosive [bis(hydroxylamide)] (Sax).

Permissible Exposure Limits in Air

7803-49-8

Protective Action Criteria (PAC)

TEEL-0: 0.25 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK: Danger of skin sensitization.

Routes of Entry: Inhalation and ingestion of dust.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to skin, eyes, and mucous membranes. May cause methemoglobinemia. The effects may be delayed. Exposure can cause headache; vertigo (dizziness); tinnitus (ringing of ear); dyspnea (difficult breathing); nausea and vomiting, cyanosis, proteinuria and hematuria, jaundice, restlessness, and convulsion; yellowish brown deposit on conjunctiva and cornea; astigmatism; reddening of hair and exposed skin.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and eczema. May affect the nervous system. May cause anemia and liver damage.

Points of Attack: Skin, blood, liver, nervous system.

Medical Surveillance: Annual physical examinations including renal and hepatic. Examination by a qualified allergist. Complete blood count (CBC). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Note to physician: Treat for methemoglobinemia. Test urine for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Protect against physical damage. Store in cool, noncombustible buildings and separate from oxidizing materials. Open airtight containers occasionally to relieve pressure from decomposition products.

Shipping: Toxic solid, corrosive, inorganic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in DOT/UN Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Cover spill with sodium bisulfite and sprinkle with water. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extreme caution in approaching a fire because the material may explode when exposed to heat or flame. No attempt should be made to fight fires except for remotely activated fire extinguishing equipment. Evacuate the surrounding area. Water or foam may cause frothing. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add sodium bisulfite solution and flush to sewer or incinerate.

Reference

Sax, N. I. (E.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 37–39 (1982) and 8, No. 4, 34–39 (1988)

2-Hydroxypropyl acrylate H:0510

Molecular Formula: $C_6H_{10}O_3$

Common Formula: $CH_2{=}CHCOOCH_2CHOHCH_3$

Synonyms: Acrylic acid 2-hydroxypropyl ester; HPA; Hydroxypropyl acrylate; β-Hydroxypropyl acrylate; 1,2-Propanediol 1-acrylate; Propylene glycol monoacrylate

CAS Registry Number: 999-61-1

RTECS® Number: AT1925000

UN/NA & ERG Number: UN1760 (Corrosive liquids, n.o.s.)/154

EC Number: 213-663-8 [*Annex I Index No.:* 607-108-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; R34; R43; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Hydroxypropyl acrylate is a clear to light-yellow liquid with a sweetish, solvent odor. Molecular weight = 130.16; Specific gravity (H_2O:1) = 1.05; Boiling point = 191°C also listed at 205°C; Relative vapor density (air = 1) = 4.5; Flash point = 65°C. Explosive limits: LEL = 1.8%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: 2-Hydroxypropyl acrylate is used as a bifunctional monomer for acrylic resins; it is used as a binder in nonwoven fabrics and may be used in the production of detergent lube oil additives.

Incompatibilities: 2-Hydroxypropyl acrylate can polymerize due to heating, initiators, UV light. Can become unstable at high temperatures and pressures or may react with water with some release of energy but not violently. Reacts with oxidizers, strong acids, nitrates.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.33 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.5 ppm/3 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 ppm/2.8 mg/m^3 TWA [skin] danger of skin sensitization.

No TEEL available.

DFG MAK: danger of skin sensitization.

Australia: TWA 0.5 ppm (3 mg/m^3), [skin], 1993; Belgium: TWA 0.5 ppm (2.8 mg/m^3), [skin], 1993; Denmark: TWA 0.5 ppm (3 mg/m^3), [skin], 1999; France: VME 0.5 ppm (3 mg/m^3), [skin], 1999; Norway: TWA 0.5 ppm (2.9 mg/m^3), 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.5 ppm (2.7 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 3 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm [skin], skin sentitzer. Several states have set guidelines or standards for hydroxypropyl acrylate in ambient air[60] ranging from 30 μg/m^3 (North Dakota) to 50 μg/m^3 (Virginia) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 250 gm/kg (moderately toxic).

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis and eczema; sensitization.

Points of Attack: Skin, lungs.

Medical Surveillance: Lung function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where 2-Hydroxypropyl acrylate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Corrosive liquids, n.o.s. require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous and acid fumes, including acrylic acid, acrolein, are produced in fire. Water may be ineffective. Use dry chemical, alcohol foam, or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

I

Incapacitating agents

Incapacitating agents are chemical warfare agents that produce temporary disabilities and/or render individuals incapable of performing tasks or assigned duties because of physical or mental impairment. Unlike lethal agents, which are primarily designed to kill, incapacitating agents are often meant to be nonlethal, but, under certain conditions or when a victim receives a potent enough dose, they can also kill. The major chemical warfare agent in this category and its code name is listed below along with its record number for quick access.
Quinuclidinyl benzilate, agent BZ see Q:0120.

Indene I:0100

Molecular Formula: C_9H_8
Common Formula: $CH{=}CHCH{=}CHC{=}CCH{=}CHCH_2$
Synonyms: IH-Indene; Indonaphthene
CAS Registry Number: 95-13-6
RTECS® Number: NK8225000
UN/NA & ERG Number: UN1993 (Combustible liquid, n.o.s.)/128. Only regulated when shipped in bulk.
EC Number: 202-393-6
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Indene is a colorless liquid from coal tars. The odor threshold is 0.015 ppm. Molecular weight = 116.17; Specific gravity (H_2O:1) = 0.997; Boiling point = 181.6°C; Freezing/Melting point = −1.7°C; Vapor pressure = 1.1 mmHg at 25°C; Flash point = 78.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water.
Potential Exposure: Indene is used in the preparation of synthetic resins, such as coumarone indene resins. It is also used as an organic intermediate. It is an asphalt and naphtha constituent; from petroleum refining and coke processing.
Incompatibilities: Contact with strong oxidizers and strong acids may cause fire and explosion hazard. Polymerizes and oxidizes on standing. Sunlight can cause polymerization. It has exploded during nitration with sulfuric acid + nitric acid.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.75 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 10 ppm/45 mg/m^3 TWA.
ACGIH TLV®[1]: 5 ppm/24 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 5 ppm
PAC-2: 5 ppm
PAC-3: 300 ppm
Australia: TWA 10 ppm (45 mg/m^3), 1993; Belgium: TWA 10 ppm (48 mg/m^3), 1993; Denmark: TWA 10 ppm (45 mg/m^3), 1999; Finland: TWA 10 ppm (47 mg/m^3); STEL 20 ppm (95 mg/m^3), 1999; France: VME 10 ppm (45 mg/m^3), 1999; the Netherlands: MAC-TGG 45 mg/m^3, 2003; Norway: TWA 10 ppm (45 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (45 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm. Several states have set guidelines or standards for indene in ambient air[60] ranging from 450−700 μg/m^3 (North Dakota) to 750 μg/m^3 (Virginia) to 900 μg/m^3 (Connecticut) to 1071 μg/m^3 (Nevada).
Determination in Air: No method listed. The following are used for coal tar products: OSHA Analytical Method 58. See also NIOSH Analytical Method #5506 by HPLC; #5515 by GC.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 621 μg/L based on health effects.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: May cause eye, skin, and respiratory irritation. Animal studies have shown that liver damage and, occasionally, spleen and kidney injury result from exposure to high (800−900 ppm) vapor concentrations. Liquid indene defatted the skin but did not cause dermatitis. Aspiration of liquid into the lung caused pneumonitis, pulmonary edema, and hemorrhage in laboratory animals.
Long Term Exposure: May cause skin sensitization and allergy. Has caused liver, kidney, and spleen injury in laboratory animals.
Points of Attack: Eyes, skin, respiratory system, liver, kidneys, spleen.
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination by a qualified allergist to diagnose skin allergy. Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products. *Preplacement Medical Examinations:* These examinations shall include: Comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin, respiratory tract, liver, and kidneys. A physical examination giving particular attention to the

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00009-6

oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 cm × 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at 1 s (FEV 1.0); and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive pressure respirators. *Periodic Examinations:* These examinations shall be made available at least annually and shall include: Interim medical and work histories. A physical examination as outlined above. *Initial Medical Examinations:* These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations. *Pertinent Medical Records:* These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer, or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green (*small quantities*): General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sunlight, air, strong acids; oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where indene is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Only regulated when shipped in bulk as a Class 3 combustible liquid, Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Indene is a combustible liquid. Indene may burn, but does not readily ignite. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Indene*. Trenton, NJ

Indeno(1,2,3-cd)pyrene I:0110

Molecular Formula: $C_{22}H_{12}$
Synonyms: Indenopyrene; IP; *o*-Phenylenepyrene; 1,10-(*o*-Phenylene)pyrene; 1,10-(1,2-Phenylene)pyrene; 2,3-*o*-Phenylenepyrene; 2,3-Phenylenepyrene
CAS Registry Number: 193-39-5
RTECS® Number: NK9300000
UN/NA & ERG Number: UN3077/171 (bulk only)
EC Number: 205-893-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as polynuclear aromatic hydrocarbons (PAHs).

US EPA Hazardous Waste Number (RCRA No.): U139.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0055; Nonwastewater (mg/kg), 3.4.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Indeno(1,2,3-c,d)pyrene is a yellow crystalline solid. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings. Molecular weight = 276.34; Boiling point = 536°C; Freezing/Melting point = 162.5−164°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen. Found in internal combustion engine exhausts; cigarette smoke condensate; soot, coal tar pitch.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene-soluble aerosol); Confirmed Human Carcinogen.

NIOSH IDLH: 80 mg/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.15 mg/m^3
PAC-1: 0.5 mg/m^3
PAC-2: 3.5 mg/m^3
PAC-3: 15 mg/m^3

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2.

Austria: carcinogen, 1999; France: carcinogen, 1993.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: A drinking water standard for PAH as a class has been developed. The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 μg/L. This recommended standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo(a)pyrene, benzo(ghi)perylene, benzo (b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)-pyrene. The US EPA addressed PAHs as one of the 65 priority toxic pollutants.[6] They found that there was insufficient data to propose a criterion for the protections of freshwater or of saltwater aquatic life. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.028 μg/L. Kansas[61] has set a guideline of 0.029 μg/L for drinking water.

Determination in Water: Methylene chloride extraction followed by high-performance liquid chromatography (HPLC); with fluorescence or UV detection; or gas chromatography (EPA Method 610; by gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 6.6.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Long Term Exposure: May be carcinogenic in humans. Repeated exposure may cause dermatitis, bronchitis. Indeno (1, 2, 3-cd)pyrene is a complete carcinogen and an initiator for skin carcinogenesis in the mouse. Subcutaneous injections in mice produce local sarcomas.

Points of Attack: Respiratory system, skin, bladder, kidneys. Cancer site for coal tar pitch volatiles is lung, kidney, and skin.

Medical Surveillance: Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products. *Preplacement Medical Examinations:* These examinations shall include: Comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin, respiratory tract, liver, and kidneys.

A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 cm × 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at 1 s (FEV 1.0); and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive-pressure respirators. *Periodic Examinations:* These examinations shall be made available at least annually and shall include: Interim medical and work histories. A physical examination as outlined above. *Initial Medical Examinations:* These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations. *Pertinent Medical Records:* These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer, or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with IP you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, bulk quantities, may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. Label required: "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. IP itself burns only with difficulty. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Indeno(1,2,3-cd)pyrene may be destroyed by permanganate oxidation, by high-temperature incineration with scrubbing equipment, or by microwave plasma treatment. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Eller, P. M., & Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. Publication No. 98-119. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH)

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Indeno (1,2,3-cd)pyrene*. Trenton, NJ

Indium and compounds I:0120

Molecular Formula: In

Synonyms: Elemental indium; Indium metal

CAS Registry Number: 7440-74-6 (elemental); 13464-82-9 (sulfate); 13770-61-1 (nitrate); 1312-43-2 (oxide); 10025-82-8 (trichloride)

RTECS® Number: NL1050000 (elemental); NL1925000 (sulfate); NL1400000 (trichloride)

UN/NA & ERG Number: Not regulated

EC Number: 231-180-0 (elemental); 236-689-1 (sulfate); 237-393-5 (nitrate); 10025-82-8 (trichloride)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (all indium compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned (all above CAS numbers).

Description: Indium metal, In, is malleable, ductile, shiny, and softer than lead. May be found as a white or gray powder. The two most important indium compounds are the oxide and sulfate. Indium, elemental unless otherwise specified: Specific gravity = 7.31; Molecular weight = 114.82; 221.17 (chloride); Boiling point = 2075°C; Freezing/Melting point = 157°C. Insoluble in water. Finely divided indium forms hydroxide on contact with water. Indium sulfate is a grayish-white, hygroscopic powder. Soluble in water.

Trichloride

Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1.

Potential Exposure: Compound Description: (chloride) Mutagen; Reproductive Effector. Indium and its compounds are used as a dental alloy; used to make high-quality solders and braze-bonded connectors; in automotive bearings (Europe only); in low-pressure sodium lamps (Europe). Also used in nuclear reactor control rod alloys; catalysts; indium oxide fuel cells; cryogenic gasket material. Indium oxide is used in coloring glass: a light to dark brown can be obtained, depending on the amount used. Indium sulfate is used in electroplating to prepare sulfate electrolytes. Radioisotopes of indium and indium compounds are also used for medical treatment of cancer and diagnostic organ scanning.

Incompatibilities: Not flammable in bulk; however, dust or powdered form may ignite when dispersed in air. Violent reaction with acetonitrile, dinitrogen tetroxide, mercury(II) bromide (at 350°C), sulfur (mixtures ignite when heated). Oxidizes readily at higher temperatures. Keep away from oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 mg/m^3 TWA; also applies to other indium compounds [as In].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA.

Protective Action Criteria (PAC)

Elemental

TEEL-0: 0.1 mg/m^3

PAC-1: 0.1 mg/m^3

PAC-2: 0.6 mg/m^3

PAC-3: 3.5 mg/m^3

Sulfate

TEEL-0: 0.225 mg/m^3

PAC-1: 0.676 mg/m^3

PAC-2: 1.13 mg/m^3

PAC-3: 4 mg/m^3

Trichloride

TEEL-0: 0.193 mg/m^3

PAC-1: 0.578 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

Oxide

TEEL-0: 0.121 mg/m^3

PAC-1: 0.363 mg/m^3

PAC-2: 0.605 mg/m^3

PAC-3: 500 mg/m^3

Oxide vapor

TEEL-0: 0.107 mg/m^3

PAC-1: 0.321 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg[In]/m^3, 1999; Finland: TWA 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, 1999; United Kingdom: TWA 0.1 mg[In]/m^3; STEL 0.3 mg[In]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3. Several states have set guidelines or standards for indium in ambient air[60] ranging from zero (Connecticut) to 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Nevada).

Indium chloride

United Kingdom: TWA 0.1 mg [In]/m^3; STEL 0.3 mg [In]/m^3, 2000; the Netherlands: MAC-TGG 0.1 mg [In]/m^3, 2003.

Determination in Air: NIOSH II(5) Method #7303, P&CAM #173; OSHA Analytical Method ID-121.

Determination in Water: Neutron activation has been used to analyze indium in seawater. The detection limit is 0.006 ng/L. Polarography has also been used to determine indium in water with a detection limit of 1.0 μg/L.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Indium can affect you when breathed in. Contact can irritate the skin and eyes. Exposure to high levels may damage the kidneys and liver. Indium can irritate the lungs and may cause permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Possible liver, kidney, heart, blood effects (NIOSH). Indium may damage the developing fetus. May damage the lungs.

Points of Attack: Irritation of eyes, skin, respiratory system; possible liver, kidney, heart, blood effects.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests, complete blood count. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *0.1 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green (metal): General storage may be used. Bulk quantities of indium *powder* are pyrophoric and require a Red Code. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where powder or dust may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from mineral acids and sulfur. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources and nonsparking tools when cleaning up powder and dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Indium itself does not burn, but indium powder and dust is flammable and may ignite when exposed to heat or flame. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Indium and its compounds are rated moderately toxic. Recovered indium has a recycled value, so a minimum quantity is discarded. Closed containers are required for the disposal of indium and its compounds. The environmental hazard from indium appears to result from the use and disposal of radioactive isotopes and not chemical toxicity.

References

US Environmental Protection Agency. (August 1975). *Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Vol. II: Indium*, Report EPA-460/2-75-005b. Washington, DC: Office of Toxic Substances

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Indium*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 234−241

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Indium.* Trenton, NJ

Indomethacin I:0130

Molecular Formula: $C_{19}H_{16}ClNO_4$

Synonyms: Amuno; Artracin; Artrinovo; Artrivia; *N*,*p*-Chlorbenzoyl-5-methoxy-2-methylindole-3-acetic acid; 1-(*p*-Chlorobenzoyl)-5-methoxy-2-methylindole-3-acetic acid; 1-(*p*-Chlorobenzoyl)-2-methyl-5-methoxy-3-indole-acetic acid; 1-(*p*-Chlorobenzoyl)-2-methyl-5-methoxyindole-3-acetic acid; α-[1-(*p*-Chlorobenzoyl)-2-methyl-5-methoxy-3-indolyl]acetic acid; 1-*p*-Cloro-benzoil-5-metoxi-2-metilindol-3-acido acetico (Spanish); Confortid; Dolovin; Idomethine; Imbrilon; Inacid; Indocid; Indomecol; Indomed; Indomethazine; Indometicina (Spanish); Indoptic; Indo-rectolmin; Indo-tablinen; Inflazon; Inteban SP; Lausit; Metacen; Metartril; Methazine; Metindol; Mezolin; Mikametan; Mobilan; NCI-C56144; Reumacide; Sadoreum; Tannex

CAS Registry Number: 53-86-1

RTECS® Number: NL3500000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-186-5

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Indomethacin is a pale yellow to tan crystalline powder. Molecular weight = 357.81; Freezing/Melting point = 155−162°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: This material is used as an anti-inflammatory, antipyretic, analgesic medication.

Incompatibilities: Strong alkalis.

Permissible Exposure Limits in Air

No standards or TEEL available. Material is poisonous.

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is classified as very toxic. Probable oral lethal dose in humans is 50−500 mg/kg or between one teaspoon and one ounce for a 70-kg (150-lb) person. Symptoms of exposure include gastrointestinal complaints (loss of appetite; nausea, abdominal pain; ulcers, diarrhea); dizziness, lightheadedness, mental confusion; severe depression; psychosis, hypersensitivity reactions (e.g., rashes, asthma, urticaria, and so on); ringing in the ears; coma and convulsions. Acute pancreatitis, neutropenia, and thrombocytopenia have also been reported. Persons with renal disease or ulcerative lesions of stomach or intestines are at risk. Pregnant women and nursing mothers should be removed from any possible exposure to this material. Use cautiously for elderly patients.

Long Term Exposure: May cause liver and kidney effects.

Points of Attack: Kidney, liver.

Medical Surveillance: Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis.

Shipping: This may be classified as a medicine, poisons, solid n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire (material itself burns with difficulty). Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide, or dry chemical. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Indomethacin*. Washington, DC: Chemical Emergency Preparedness Program

Iodine I:0140

Molecular Formula: I_2

Synonyms: Iodine crystals; Molecular iodine

CAS Registry Number: 7553-56-2

RTECS® Number: NN1575000

UN/NA & ERG Number: UN1759 (corrosive solids, n.o.s.)/154

EC Number: 231-442-4 [*Annex I Index No.:* 053-001-00-3]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; Class E.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/21; R50; Safety phrases: S2; S23; S25; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (CAS: 7553-56-2) 3/8/06.

Description: Iodine is a blue-black or violet solid with a sharp, characteristic odor. Molecular weight = 253.80; Specific gravity (H_2O:1) = 4.93; Boiling point = 185°C; Freezing/Melting point = 113.3°C; Vapor pressure = 0.3 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Iodine is used as a drinking water disinfectant; in the manufacture of organic chemicals, especially pharmaceuticals; as a catalyst in organic reactions. It is used in the manufacture of silver iodide for use in photography.

Incompatibilities: Contact with ammonia forms a shock-sensitive compound which will explode, causing fires. A powerful oxidizer. Violent reaction with reducing agents, combustibles, acetylene, acetaldehyde, antimony, cesium, francium, lithium, potassium, powdered metals, rubidium, phosphorous, sodium, sulfur.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.38 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/1 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.1 ppm/1 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA; 0.1 ppm/1 mg/m^3 STEL.

NIOSH IDLH: 2 ppm.

Protective Action Criteria (PAC)*

Iodine and iodine-125

TEEL-0: 0.01 ppm

PAC-1: **0.1** ppm

PAC-2: **0.5** ppm

PAC-3: **5** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Arab Republic of Egypt: TWA 0.1 ppm (0.1 mg/m^3), 1993; Australia: TWA 0.1 ppm (1 mg/m^3), 1993; Austria: MAK 0.1 ppm (1 mg/m^3), 1999; Belgium: STEL 0.1 ppm (1 mg/m^3), 1993; Denmark: TWA 0.1 ppm (1 mg/m^3), 1999; Finland: STEL 0.1 ppm (1 mg/m^3), [skin], 1999; France: VLE 0.1 ppm (1 mg/m^3), 1999; Japan: 0.1 ppm (1 mg/m^3), 1999; Norway: TWA 0.1 ppm (1 mg/m^3), 1999; the Netherlands: MAC 1 mg/m^3, 2003; the Philippines: TWA 0.1 ppm (1 mg/m^3), 1993; Poland: MAC (TWA) 1 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 1 mg/m^3, [skin], 1993; Sweden: ceiling 0.1 ppm (1 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (1 mg/m^3), KZG-W 0.2 ppm, 1999; Thailand: TWA 0.1 ppm (1 mg/m^3), 1993; Turkey: TWA 0.1 ppm (1 mg/m^3), 1993; United Kingdom: STEL 0.1 ppm (1.1 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for iodine in ambient air[60] ranging from 8 μg/m^3 (Virginia) to 10 μg/m^3 (North Dakota) to 20 μg/m^3 (New York) to 24 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6005; OSHA Analytical Method ID-212. See also OSHA Analytical Method ID-177.

Permissible Concentration in Water: Maine[61] has set a guideline of 340 μg/L for iodine in drinking water.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.5$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Iodine irritates the eyes, skin, and respiratory tract. *Note:* Individuals with thyroid, lung, and kidney disease should consult a physician before working with iodine. *Inhalation:* May cause some irritation at a concentration of 0.1 ppm. However, work is difficult at 0.15−0.2 ppm, and impossible at 0.3 ppm. Concentrations of 1 ppm are highly irritating. Iodine vapor can severely irritate eyes, nose, and throat; action of iodine is similar to that of chlorine, but is more irritating to lungs. Leads to tearing, tightness in the chest, sore throat, and headache. Painful cough and difficult breathing may continue for several weeks following severe exposure. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Solid, vapor, or iodine solution can stain, irritate, damage, and penetrate the skin. May produce symptoms similar to those under inhalation. *Eyes:* A concentration of 0.57 ppm for 5 min was reported to cause eye irritation. Irritation was experienced within 2 min at 1.63 ppm. Contact with saturated vapor for 3−4 min caused brown staining and subsequent loss of outer layer of the cornea, followed by complete healing in 2−3 days. *Ingestion:* Small doses of iodine preparations produce salivation, excessive tearing, swelling of eyelids, soreness and swelling of salivary glands, metallic taste, skin rash, fever, and enlarged lymph glands. Larger doses cause severe vomiting, diarrhea, abdominal pain; thirst, shock, fever, total suppression of urine; delirium, stupor, and death. Ingestion of one milliliter (1/30 fluid ounce) of tincture of iodine or 1 g (1/30 ounce) of iodine crystals results in similar symptoms including giddiness, faintness, pallor, rapid and feeble pulse; excitement and convulsions; collapse and unconsciousness. Fatal dose for an adult is about 1/15 ounce. Some individuals may be more susceptible than others.

Long Term Exposure: Prolonged exposure to iodine or compounds leads to iodism and deficiency of thyroid hormone. Since iodine or iodine compounds are potent sensitizers, repeated contact may be followed by rash, swelling of the vocal cords, severe generalized allergic reaction, and joint pain and swelling.

Points of Attack: Eyes, skin, respiratory system; central nervous system; cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). If symptoms develop or overexposure is suspected, the following may be useful: thyroid function tests, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: *Solid:* Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** Saranex™ coated suits. **4 h:** polyethylene gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Liquid:* Avoid skin contact with liquids of >7% content or repeated or prolonged contact with liquids of <7% content. Wear eye protection to prevent any possibility of eye contact with liquids of >7% iodine content. Employees should wash immediately with soap when skin is wet or contaminated with liquids of >7% content. Remove nonimpervious clothing immediately if wet or contaminated with liquids containing >7% and promptly remove if liquid contains <7% iodine. Provide emergency showers and eyewash if liquids containing >7% contaminants are involved.

Respirator Selection: *Up to 1 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Iodine must be stored to avoid contact with aqueous ammonia, acetylene, acetaldehyde, powdered aluminum, or chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above.

Shipping: Shipping: This material requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.[20,21]

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Extinguish fire using an agent suitable for type of surrounding fire. Iodine itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with large volumes of reducing agent (hypo- or bisulfites or ferrous salts) solution, neutralize and flush to sewer with water. Alternatively, iodine may be recovered from various process waste streams.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 65−68

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Iodine*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Iodine*. Trenton, NJ

Iodine monochloride I:0150

Molecular Formula: ClI

Common Formula: ICl

Synonyms: Iodine chloride; Iodochlorine; Protochlorure diode (French); Wijs' chloride

CAS Registry Number: 7790-99-0

RTECS® Number: NN1650000

UN/NA & ERG Number: UN1792/157

EC Number: 232-236-7

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Iodine monochloride is a black crystalline solid or reddish-brown liquid. Molecular weight = 162.38; Boiling point = 97.4°C and decomposes at 100°C; Freezing/Melting point = 27°C (α-form); 14°C (β-form). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3₩. Soluble in water.

Potential Exposure: This material is used as a chemical reagent.

Incompatibilities: A strong oxidizer. Reacts with air, forming iodine pentoxide; heat may cause explosions. Violent reaction with water, steam, and other forms of moisture (forming toxic and corrosive fumes); organic matter; aluminum foil; cadmium sulfide, hydrides, lead sulfide; metal powders, phosphorus, phosphorus trichloride; potassium, reducing agents, rubber, silver sulfide; sodium, zinc sulfide, and other metals. Handle and store under nitrogen.

Permissible Exposure Limits in Air

No TEEL available.

No occupational exposure limits have been established for this iodine compound. This does not mean that this substance is not harmful. Safe work practices should always be followed. However, because this chemical can release iodides and iodine gas, the OSHA permissible exposure limit (PEL) of 0.1 ppm for iodine should not be exceeded at any time.

Determination in Air: Use NIOSH Analytical Method (IV) #6005.

Harmful Effects and Symptoms

Short Term Exposure: Iodine monochloride is a corrosive chemical and exposure can severely irritate, and may burn, the eyes, skin, nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Irritates the lungs. Repeated exposure may cause bronchitis.

Points of Attack: Lungs.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as iodine): *Up to 1 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow Stripe (strong oxidizer): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Should be handled and stored under nitrogen. Iodine monochloride must be stored to avoid contact with aluminum foil, cadmium sulfide, lead sulfide, organic matter, phosphorus, phosphorus trichloride, potassium, rubber, silver sulfide, sodium, zinc sulfide, and other metals, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where iodine monochloride is used, handled, or stored a manner that could create a potential fire or explosion hazard. It also reacts with water or steam, producing toxic and corrosive fumes. If iodine monochloride is heated to decomposition (100°C), it gives off poisonous chlorine and iodine gases, and may explode.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Iodine monochloride may burn, but does not readily ignite. *Do not use water* as poisonous gases are produced. Use dry chemical, CO_2, or foam extinguishers. If iodine monochloride is heated to decomposition (100°C), it gives off poisonous chlorine, hydrogen iodide, and may explode. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substance Fact Sheet: Iodine Monochloride*. Trenton, NJ

Iodine pentafluoride I:0160

Molecular Formula: F_5I
Common Formula: IF_5
Synonyms: Iodine fluoride; Pentafluoriodine
CAS Registry Number: 7783-66-6
RTECS® Number: NN1770000
UN/NA & ERG Number: UN2495/144
EC Number: 232-019-7

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Iodine pentafluoride is a colorless to yellow liquid. The material gives off pungent, irritating, and toxic fumes when exposed to the air. Molecular weight = 221.90; Boiling point = 104.5°C; Freezing point = 9.4°C. Decomposes violently in water.

Potential Exposure: This material is used as a fluorinating agent and in explosives.

Incompatibilities: A powerful oxidizer. Reacts with almost all organic materials. Violent reaction with benzene, dimethylaminotrimethyl silane, dimethyl sulfoxide; limoline + tetrafluoroethylene; potassium, molten sodium; tetraiodoethylene, potassium hydroxide; calcium carbide; metals, nonmetals (such as boron, silicon, red phosphorus, sulfur, arsenic, antimony, bismuth, molybdenum, and tungsten). Attacks glass. Violent reaction with water or steam.

Permissible Exposure Limits in Air

No TEEL available.

No occupational exposure limits have been established for this iodine compound. This does not mean that this substance is not harmful. Safe work practices should always be followed. However, because this chemical can release iodides and iodine gas, the OSHA permissible exposure limit (PEL) of 0.1 ppm for iodine should not be exceeded at any time.

Determination in Air: Use NIOSH Analytical Method (IV) #6005.

Routes of Entry: Inhalation, skin, and/or eyes.

Harmful Effects and Symptoms

Short Term Exposure: Iodine pentafluoride can affect you when breathed in. Exposure can severely irritate the skin, eyes, nose, throat, bronchial tubes, and lungs. Contact can burn the eyes and skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposures can cause skin rash to develop. Can irritate the lungs; may cause bronchitis.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: To bind the active fluorides in an insoluble form, to relieve pain and limit burn extension, consider the use of calcium gluconate gel, or a slurry calcium gluconate gel in either water or glycerine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as iodine): *Up to 1 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Iodine pentafluoride must be stored to avoid contact with water, steam, acids, organic materials (such as paper, wood, and oil); sulfur, phosphorus, silicon, bismuth, tungsten, arsenic, and other metals; benzene and calcium carbide, since violent reactions occur. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 5.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Small spills (from a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.5

Large spills (from a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 2.6/4.2

Fire Extinguishing: Iodine pentafluoride gives off highly toxic fluorine and iodine gases when heated, or on contact with acids. It also reacts violently with water or steam and gives off poisonous gases. *Do not use water*. Use dry chemical or soda ash to extinguish fire. Iodine pentafluoride can explode on contact with organic materials such as wood, paper, and oil. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Iodine Pentafluoride*. Trenton, NJ

Iodobutane I:0170

Molecular Formula: C_4H_9I

Synonyms: *sec*-Butyl iodide; Butyl iodide; 2-Iodobutane; 2-Jodbutan (German)

CAS Registry Number: 513-48-4

RTECS® Number: EK4410000

UN/NA & ERG Number: UN2390/129

EC Number: 208-163-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); no evidence: mouse, rat.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Iodobutane is a clear to amber liquid. Molecular weight = 184.03; Boiling point = 130.5°C (1-isomer); 117−118°C (2-iodo isomer); Freezing/Melting point = −103.8°C; Flash point = 23°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Drug, Tumorigen, Mutagen. This material is used as an antiseptic, disinfectant on superficial wounds; and in the female reproductive tract; as a laboratory research chemical.

Incompatibilities: Violent reaction with oxidizers. Light sensitive.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

No TEEL available.

Safe work practices should always be followed. However, because iodobutane can release iodides and iodine gas, the OSHA permissible exposure limit (PEL) of 0.1 ppm (Ceiling Concentration) for iodine should not be exceeded at any time.

Determination in Air: Use NIOSH Analytical Method (IV) #6005.

Routes of Entry: Inhalation, skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, skin, and respiratory tract. High exposure may cause running nose, headache, and irritation of mucous membranes.

Long Term Exposure: There is limited evidence that iodobutane causes cancer in animals; it may cause lung cancer. Prolonged or repeated contact can cause skin rash with the development of pimples, boils, redness, blisters, and black-and-blue spots in severe cases. Repeated exposure to iodides can cause weakness, loss of weight, general depression, and anemia.

Points of Attack: Skin, blood.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as iodine): *Up to 1 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 2 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Protect iodobutane from the light. Sources of ignition, such as smoking and open flames, are prohibited where iodobutane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of iodobutane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of iodobutane. Wherever iodobutane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Iodobutane is a flammable liquid. Use dry chemical, CO_2, water spray; or foam extinguishers. Poisonous gases, including iodine and iodides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Iodobutane*. Trenton, NJ

Iodoform I:0180

Molecular Formula: CHI_3

Synonyms: Methane, triiodo-; NCI-C04568; Triiodomethane

CAS Registry Number: 75-47-8

RTECS® Number: PB7000000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-874-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Iodoform is a bright yellow or greenish-yellow crystalline solid with a disagreeable, pungent odor. The odor threshold is 0.005−1.1 ppm; 0.4 ppb.[NTP] Molecular weight = 393.72; Specific gravity (H_2O:1) = 4.01; Boiling point = (decomposes) 210°C; Freezing/Melting point = 119°C. It is nonflammable. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Practically insoluble in water; solubility 0.1%.

Potential Exposure: Iodoform has been used as a topical anti-infective and in veterinary medicine as an antiseptic and disinfectant for superficial lesions.

Incompatibilities: Reacts violently with strong oxidizers, strong bases, lithium, acetone, balsam, metallic salts (e.g., mercuric oxide, silver nitrate), calomel, tannin. Violent reaction with steam.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 16.10 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.6 ppm/10 mg/m^3 TWA.

ACGIH TLV®[1]: 0.6 ppm/10 mg/m^3 TWA.

No TEEL available.

Australia: TWA 0.6 ppm (10 mg/m^3), 1993; Belgium: TWA 0.6 ppm (10 mg/m^3), 1993; Denmark: TWA 0.2 ppm (3 mg/m^3), 1999; France: VME 0.6 ppm (10 mg/m^3), 1999;

Norway: TWA 0.2 ppm (3 mg/m^3), 1999; Switzerland: MAK-W 0.6 ppm (10 mg/m^3), 1999; United Kingdom: TWA 0.6 ppm (9.8 mg/m^3); STEL 1 ppm, 2000; the Netherlands: MAC-TGG 3 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.6 ppm. Several states have set guidelines or standards for iodoform in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Iodoform can affect you when breathed in and by passing through your skin. Irritates the eyes. A generalized allergic reaction, with fever and rash, sometimes occurs. Exposure to very high levels may cause nervous system effects, such as confusion, irritability, and/or poor muscle coordination. Iodoform may cause a skin allergy. If allergy develops, very low future exposures can cause itching and a skin rash. High exposures may damage the liver and kidneys.

Long Term Exposure: Repeated or prolonged contact with skin may cause allergy. May cause liver, kidney, heart damage, visual disturbance.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, heart.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). If symptoms develop or overexposure is suspected, the following may be useful: skin testing with dilute iodoform may help diagnose allergy, if done by a qualified allergist. Liver and kidney function tests. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.6 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Iodoform must be stored to avoid contact with lithium and steam, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from mercuric oxide, calomel, silver nitrate, tannin, balsam, and acetone.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including iodine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be

trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Iodoform.* Trenton, NJ

Iron I:0190

Molecular Formula: Fe

Synonyms: 3ZhP; Ancor EN 80/150; Armco iron; Carbonyl iron; EFV 250/400; Elemental iron; EO 5A; Ferrovac E; GS 6; Iron carbonyl (FCC); Iron, electrolytic; Iron, elemental; Iron, reduced (FCC); Loha; Iron, soluble salts; NC100; PZh2M; PzhO; Remko; SUY-B 2

CAS Registry Number: 7439-89-6

RTECS® Number: NO4565500

UN/NA & ERG Number: UN1376 (iron oxide, spent)/135; UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-096-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Iron is a malleable, silver-gray metal or a gray powder. Molecular weight = 55.85; Boiling point = 3000°C; Freezing/Melting point = 1535°C. Ignition temperature of dust cloud = 420°C; Minimum Explosive concentration = 0.10 oz/ft^3.[USBM] Hazard Identification (based on NFPA-704 M Rating System): (*powder*) Health 1, Flammability 3, Reactivity 1. Insoluble in water. Relative explosion hazard of dust: Strong.

Potential Exposure: Iron is alloyed with carbon to produce steel. The addition of other elements (e.g., manganese, silicon, chromium, vanadium, tungsten, molybdenum, titanium, niobium, phosphorus, zirconium, aluminum, copper, cobalt, and nickel) imparts special characteristics to the steel. Occupational exposures occur during mining, transporting, and preparing of ores; and during the production and refining of the metal and alloys. In addition, certain workers may be exposed while using certain iron-containing materials—welders, grinders, polishers, silver finishers, metal workers, and boiler scalers.

Incompatibilities: Dust forms an explosive mixture with air. Ultrafine iron powder is pyrophoric and may be potentially explosive. Violent reaction with strong oxidizers, acetaldehyde (HEAT plus any of the following: ammonium nitrate, bromine pentafluoride, nitryl fluoride, sodium peroxide). Violent reaction with ammonium peroxodisulfate, chloric acid, chlorine trifluoride, chloroform amidinium nitrate, chlorine, dinitrogen tetroxide, hydrogen peroxide, liquid fluorine, peroxyformic acid, potassium perchlorate, potassium dichromate, sodium acetylide.

Permissible Exposure Limits in Air

OSHA PEL: 10 mg[Fe]/m^3 TWA (dust and fume).

ACGIH TLV®[1]: 5 mg[Fe]/m^3 (vapor, dust) TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 75 mg/m^3

NIOSH IDLH: 2500 mg[Fe]/m^3.

DFG MAK: 1.5 mg[Fe]/m^3 respirable fraction.

Arab Republic of Egypt: TWA 3 ppm (5 mg/m^3) (fume), 1993; Australia: TWA 5 mg/m^3 (fume), 1993; Austria: MAK 6 mg/m^3 (*dust*), 1999; Denmark: TWA 3.5 mg[Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 mg/m^3 (fume), 1999; the Netherlands: MAC-TGG 5 mg [Fe]/m^3, 2003; MAC-TGG 10 mg/m^3, 2003; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 10 mg/m^3 (fume), 1993; Poland: MAC (TWA) (fume) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Sweden: NGV 3.5 mg/m^3 (fume), 1999; Switzerland: MAK-W 6 mg/m^3 (fume), 1999; Thailand: TWA 10 mg/m^3 (fume), 1993; Turkey: TWA 10 mg/m^3 (fume), 1993; United Kingdom: TWA 5 mg[Fe]/m^3; STEL 10 mg[Fe]/m^3, 2000; TWA 10 mg/m^3, rouge, total inhalable dust, 2000; TWA 4 mg/m^3, rouge, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

As iron, soluble salts [as Fe]

NIOSH REL: 1 [Fe]mg/m^3 TWA.

ACGIH TLV®[1]: 1 [Fe]mg/m^3 TWA.

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes and 0.05 mg/L in seawater used for fishery purposes. A standard of 1000 μg/L has been set by Illinois[61] for drinking water; Kansas has set a guideline of 300 μg/L.

Routes of Entry: Inhalation, ingestion, eyes.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Iron dust and fresh iron oxide fumes may cause respiratory irritation and metal fume fever, characterized by metallic taste, dry irritated throat, coughing, shortness of breath, weakness, fatigue, fever, chills, sweating, and pain in the muscles and joints. *Skin:* Hot metal may cause burns and irritation. *Eyes:* Dust may cause irritation and inflammation. *Ingestion:* May cause drowsiness, sluggishness, paleness, increased heart and respiration rates, shock, bloody vomiting, and diarrhea.

Long Term Exposure: Excessive intake of iron compounds may result in increased accumulation of iron in body, especially the liver, spleen, and lymphatic system. Inhalation of dusts may cause mottling of the lung. Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis). There is limited evidence of an increase in lung cancer among iron ore miners. Iron oxide's role in this increase is unclear at this time. Prolonged or repeated contact can discolor the eyes, causing permanent iron staining.

Points of Attack: Respiratory system, skin.

Medical Surveillance: NIOSH lists the following tests (iron oxide fume): chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give eggs or milk. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: Gastric lavage is only beneficial if done within 1 h of ingestion. Deferoxamine may be beneficial in reducing systemic levels. Serum iron levels may be useful in determining severity of exposure if measured during acute phase of intoxication. In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing (leather gauntlets, welding masks, steel-toed shoes as needed) to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: To prevent exposure to dusts, wear a dust mask.

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe (*iron powder and chips*): Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials (see above). Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Iron oxide, spent, or iron sponge, spent or obtained from coal gas purification must be labeled "SPONTANEOUSLY COMBUSTIBLE," Hazard Class 4.2, and Packing Group III. For Metal powders, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall into Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Fine iron powder is pyrophoric and potentially explosive. Use special mixtures of dry chemical for metal fires. For large fires use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfilling. Remove metal with an electromagnet and salvage.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Iron and Its Compounds*, Report No. PB 276−678. Rockville, MD, pp. 143−156

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 73−74

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Iron*. Albany, NY: Bureau of Toxic Substance Assessment

Iron dextran I:0200

Molecular Formula: $[C_6H_{10}O_3]_n[Fe(OH)_3]_n$

Synonyms: B 75; Chinofer; Dextran ion complex; Dextrofer 75®; Eisendextran (German); Fe-Dextran; Fenate®; Ferdex 100®; Ferric dextran; Ferridextran; Ferrodextran; Ferroflukin 75; Ferroglucin; Ferroglukin 75; Imferon®; Imposil; Iro-Jex; Iron dextran; Iron dextran injection; Iron hydrogenated dextran; Ironorm injection; Myofer 100®; Polyfer; Prolongal®; Ursoferran®

CAS Registry Number: 9004-66-4; 9061-47-6 (powder)

RTECS® Number: NI2200000

UN/NA & ERG Number: Not regulated.

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; California Proposition 65 Chemical: Cancer 1/1/88.

Note: Iron dextrin complex (*CAS: 9004-51-7*) IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Iron-dextran complex is a sterile, dark-brown colloidal solvent. It is soluble in water. Iron dextran is a complex of ferric hydroxide with dextran. Dextrans are polysaccharides produced by bacterial action on sucrose. Compounds in this group are pharmaceuticals containing some form of iron associated with carbohydrates of varying complexity.

Incompatibilities: Strong oxidizers. Excessive heat; store between 15°C and 20°C.

Potential Exposure: Iron-dextran complex is a parenteral form of medication used in iron-deficiency anemia in humans and baby pigs. The product for human use is a sterile, dark-brown colloidal solution in saline. The products designed for animal use are more concentrated.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Long Term Exposure: Iron dextran is carcinogenic in mice and rats after subcutaneous or intramuscular injection, producing local tumors. There have been case reports of sarcomas associated with injections of iron dextran. The tumors appeared at the probable site of the injections, and the similarity of the local effect in humans and animals was noted. Intramuscular injections of iron dextran can cause severe anaphylactic reactions.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Iron oxide I:0210

Molecular Formula: Fe_2O_3

Synonyms: Anchred standard; Anhydrous iron oxide; Armenian bole; Bauxite residue; Black oxide of iron; Blended red oxides of iron; Burnt island red; Burnt sienna; Burnt umber; Calcotone red; Caput mortuum; C.I.77491; C. I. Pigment red 101 Mortuum; Colloidal ferric oxide; Deanox; English red; Ferric oxide; Ferrugo; Indian red; Iron (III) oxide; Iron oxide red; Iron sesquioxide; Jeweler's rouge; Levanox red 130A; Light red; Manufactured iron oxides; Mars brown; Mars red; Natural iron oxides; Natural red oxide; Ochre; Prussian brown; Raddle; Red iron oxide; Rouge; Rubigo; Sienna; Specular iron; Stone red; Supra; Synthetic iron oxide; Venetian red; Vitrol red; Vogel's iron red; Yellow ferric oxide; Yellow oxide of iron

CAS Registry Number: 1345-25-1; 1309-37-1 *(ferric oxide; diiron trioxide)*; *(alt.)* 8011-97-0; 1317-61-9 *[iron(II,III) oxide; ferrosoferric oxide]*; 1317-60-8 (*hematite*)

RTECS® Number: NO7400000 (III); NO7525000 (fume)

UN/NA & ERG Number: UN1376 (spent); UN3178 (flammable solid, inorganic, n.o.s.)/133

EC Number: 215-721-8 (iron oxide); 215-168-2 (diiron trioxide); 215-275-4 (hematite)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; No Human Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987 (III, dust).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Iron oxide is a reddish-brown powder; Iron(II) oxide is a black solid material. Molecular weight = 159.70 (III and fume); 71.85 (II); Specific gravity (H_2O:1) = 5.24; Freezing/Melting point = 1462°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Iron oxide fumes are produced when iron containing materials are heated very hot, as in arc welding, and are composed of particles too small to see. Used in metallurgy, paint pigments; coloring rubber; polishing compounds; gas purification; in electronic components: permanent magnets, computer memory cores; magnetic tapes. Used as a mordant, laboratory reagent; as a catalyst, feed additive.

Incompatibilities: Keep away from calcium hypochlorite. Contact with hydrogen peroxide, ethylene oxide, and calcium hypochlorite will cause explosions. Reacts violently with powdered aluminum, hydrazine, and hydrogen trisulfide.

Permissible Exposure Limits in Air

Fe_2O_3

OSHA PEL: 10 mg[Fe]/m^3 TWA (fume); Rouge: TWA; 15 mg[Fe]/m^3, total dust: 5 mg[Fe]/m^3, respirable fraction.

ACGIH TLV®[1]: 5 mg[Fe]/m^3 respirable fraction TWA; Rouge: same as F_2O_2; not classifiable as a human carcinogen.

Nuisance particulates; (fume) 10 mg[Fe]/m^3 TWA.

NIOSH IDLH: 2500 mg[Fe]/m^3.

Protective Action Criteria (PAC)

1345-25-1

TEEL-0: 1.5 mg/m^3
PAC-1: 4.5 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 500 mg/m^3

1309-37-1

TEEL-0: 10 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 400 mg/m^3
PAC-3: 500 mg/m^3

DFG MAK (*Fe_2O_3 and FeO*): 1.5 mg[Fe]/m^3, respirable fraction; 4 mg[Fe]/m^3 (fume; inhalable fraction).

Arab Republic of Egypt: TWA 3 ppm (5 mg/m^3) (fume), 1993; Australia: TWA 5 mg/m^3 (fume), 1993; Austria: MAK 6 mg/m^3 (*dust*), 1999; Denmark: TWA 3.5 mg[Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 mg/m^3 (fume), 1999; the Netherlands: MAC-TGG 5 mg[Fe]/m^3, 2003; MAC-TGG 10 mg/m^3, 2003; Norway: TWA 3 mg/m^3, 1999; the Philippines: TWA 10 mg/m^3 (fume), 1993; Poland: MAC (TWA) (fume) 5 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Sweden: NGV 3.5 mg/m^3 (fume), 1999; Switzerland: MAK-W 6 mg/m^3) (fume), 1999; Thailand: TWA 10 mg/m^3 (fume), 1993; Turkey: TWA 10 mg/m^3 (fume), 1993; United

Kingdom: TWA 5 mg[Fe]/m^3; STEL 10 mg[Fe]/m^3, 2000; TWA 10 mg/m^3, rouge, total inhalable dust, 2000; TWA 4 mg/m^3, rouge, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for iron oxide fume in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μm g/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Filter; Acid; Inductively coupled plasma (ICP); NIOSH Analytical Method (IV) #7300, Elements. See also OSHA Analytical Methods ID-121 and ID-125G.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Iron oxide fume can affect you when breathed in. Exposure can cause metal fume fever. This is a flu-like illness with symptoms of metallic taste, fever and chills, aches, chest tightness, and cough.

Long Term Exposure: Prolonged or repeated contact can cause permanent iron staining of the eyes. Repeated exposure to iron oxide fume can cause changes on the chest X-ray. Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis).

Points of Attack: Respiratory system.

Medical Surveillance: NIOSH lists the following tests (iron oxide fume): chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); urine (chemical/metabolite). Sometimes, iron-containing metals also contain metals which scar or damage the lungs, such as cobalt, nickel, cadmium, or chromium. See also NIOSH #8310, Metals in Urine; NIOSH Profile (Welding and Brazing).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 mg/m^3*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *125 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *2500 mg/m^3*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe (*iron powder and chips*): Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Iron oxide fume must be stored to avoid contact with calcium hypochlorite, aluminum, ethylene oxide, and hydrazine, since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Iron oxide requires a shipping label of "FLAMMABLE SOLID." Based on this description, it would fall in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered

material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a noncombustible solid. Use extinguishing agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Iron Oxide (Dust and Fume)*. Trenton, NJ

Iron pentacarbonyl I:0220

Molecular Formula: C_5FeO_5

Common Formula: $Fe(CO)_5$

Synonyms: FER pentacarbonyle (French); Hierro pentacarbonilo (Spanish); Iron carbonyl; Iron carbonyl [$Fe(CO)_5$], (TB-5-11)-; Pentacarbonyliron

CAS Registry Number: 13463-40-6; *(alt.)* 37220-42-1

RTECS® Number: NO4900000

UN/NA & ERG Number: UN1994/131

EC Number: 236-670-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Iron pentacarbonyl is a highly flammable colorless to yellow to dark-red viscous liquid. Molecular weight = 195.90; Specific gravity (H_2O:1) = 1.46−1.52; Boiling point = 102.8°C at 749 mmHg; Freezing/Melting point = −25°C; Freezing/Melting point = −21°C; Vapor pressure = 40 mmHg at 30°C; Flash point = −15°C (cc); Autoignition temperature = 50°C; Explosive limits: LEL = 3.7%; UEL = 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Organometallic. Iron carbonyl is used as a catalyst in organic reactions; to make carbonyl iron, which is used in high-frequency coils for the radio and television industry; and as an antiknock agent in motor fuels; to make finely divided iron.

Incompatibilities: May explode on heating. Pyrophoric; ignites spontaneously on contact with air. Iron pentacarbonyl is decomposed by heat, light, producing toxic gases, including iron oxides and carbon monoxide. The substance is a strong reducing agent and reacts violently with oxidizers, nitrogen oxide, acetic acid, strong bases, water, amines, halogens, hydrogen, carbon tetrachloride, phosgene, mercaptans, transition metal halides (zinc + cobalt halides). Store under nitrogen.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 ppm[Fe]/0.23 mg/m^3 TWA; 0.2 ppm/0.45 mg/m^3 [Fe] STEL.

ACGIH TLV®[1]: 0.1 ppm/0.23 mg/m^3 TWA; 0.2 ppm/0.45 mg/m^3 STEL.

Protective Action Criteria (PAC)*

TEEL-0: 0.06 ppm

PAC-1: 0.06 ppm

PAC-2: **0.060** ppm

PAC-3: **0.18** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.1 ppm/0.81 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Australia: TWA 0.1 ppm (0.8 mg/m^3); STEL 0.2 ppm, 1993; Austria: MAK 0.1 ppm (0.8 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.23 mg/m^3); STEL 0.2 ppm, 1993; Denmark: TWA 0.1 ppm (0.8 mg/m^3), 1999; Finland: STEL 0.01 ppm (0.08 mg/m^3), 1999; France: VME 0.1 ppm (0.8 mg/m^3), 1999; the Netherlands: MAC-TGG 0.08 mg/m^3, 2003; Russia: STEL 0.1 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.1 ppm (0.8 mg/m^3), KZG-W 0.2 ppm, 1999; United Kingdom: TWA 0.01 ppm (0.08 mg [Fe]/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.2 [Fe]ppm. Several states have set guidelines or standards for iron pentacarbonyl in ambient air[60] ranging from 8−16 μg/m^3 (North Dakota) to 13 μg/m^3 (Virginia) to 16 μg/m^3 (Connecticut) to 19 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Iron pentacarbonyl can irritate the respiratory tract causing cough and/or shortness of breath. Inhalation may result in dizziness, nausea, and vomiting; if exposure continues, unconsciousness will follow. Twelve to twenty-four hours later, fever, cough, and shortness of breath may follow. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact can cause irritation of the skin. Toxicity of this compound is high via all routes of entry. Cyanosis (bluish discoloration of skin) and circulatory collapse may occur after exposure. Death may result. Pneumonitis and injury to the kidneys, liver, and central nervous system may also occur.

Long Term Exposure: Iron pentacarbonyl can cause lung irritation and bronchitis may develop. Repeated exposures can damage the liver, lungs, and brain.

Points of Attack: Eyes, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Consider chest X-ray after acute overexposure. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 0.1 ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where iron pentacarbonyl may be present, check to make sure that an explosive concentration does not exist. Store under nitrogen. Iron pentacarbonyl must be stored to avoid contact with water, since violent reactions occur. Store away from contact with light and air, oxidizers, and other incompatible materials listed above. Iron pentacarbonyl should be handled in an automatic mechanized fashion at all times. Containers should be flushed with nitrogen before opening. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Do not breathe vapors. Shut off or remove ignition sources in hazard area. Do not touch spilled material. Stop leak if this can be done without risk. Use water spray to reduce vapors. Take up *small spills* with sand or other noncombustible absorbent material and place into containers for later disposal. Dike far ahead of *large spills* for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (*from a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.9/3.1

Large spills (*from a large package or from many small packages*)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 3.5/5.5
Night 5.5/8.9

Fire Extinguishing: This chemical is a flammable liquid and can ignite in air. Poisonous gases, including carbon monoxide, are produced in fire. This material is incompatible with water. Use dry chemical, carbon dioxide, water spray, or foam for small fires. Specially trained personnel operating from a safe distance can fight large fires using dry chemical or foam. Move material from fire area if this can be done without risk. Dike fire control water for later disposal. Isolate hazard area and deny entry. Stay upwind and keep out of low areas. Isolate area in all directions if tank car or truck is involved in fire. See isolation distances above. Wear positive pressure breathing apparatus and special protective clothing. Cool containers exposed to flames with water until fire is out. This material presents a vapor explosion and poison hazard indoors, outdoors, or in sewers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987) *Chemical Hazard Information Profile: Iron, Pentacarbonyl*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Iron Pentacarbonyl*. Trenton, NJ

Isoamyl acetate I:0230

Molecular Formula: $C_7H_{14}O_2$

Synonyms: Acetate d'isoamyle (French); Acetato de isoamilo (Spanish); Acetic acid, isopentyl ester; *iso*-Amyl acetate; *sec*-Amyl acetate; Amyl acetate; Amylacetic ester; Banana oil; 1-Butanol, 3-methyl-, acetate; Isoamyl ethanoate; Isopentyl acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl ester of acetic acid; 3-Methylbutyl ethanoate; Methylbutyl ethanoate; Pear oil

CAS Registry Number: 123-92-2

RTECS® Number: NS9800000

UN/NA & ERG Number: UN1104/129

EC Number: 204-662-3 [*Annex I Index No.*: 607-130-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

TSCA: 40CFR712.(e)10; 40CFR716.120(d)10.

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

European/International Regulations: Hazard Symbol: None listed; Risk phrases: R10; R66; Safety phrases: S2; S23; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isoamyl acetate is a clear, colorless liquid with a banana-like odor. Odor threshold = 0.22 ppm. Molecular weight = 130.21; Specific gravity (H_2O:1) = 0.87; Boiling point = 142.2°C; Freezing/Melting point = −78.3°C; Vapor pressure = 4 mmHg at 20°C; Flash point = 25°C; Autoignition temperature = 360°C. Flammability limits: LEL = 1.0% at 100°C; UEL = 9.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a solvent in making lacquers, paints, perfumes, artificial fruit flavorings, smokeless powder, airplane "dopes," dry cleaning compounds.

Incompatibilities: Forms explosive mixture with air. Strong alkalis, strong acids, nitrates, oxidizers. Violent reaction with reducing agents. Attacks asbestos; softens and dissolves many plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/525 mg/m^3 TWA.

NIOSH REL: 100 ppm/525 mg/m^3 TWA.

ACGIH TLV®[1]: (*all isomers of amyl acetates*) 50 ppm/266 mg/m^3 TWA; 100 ppm/532 mg/m^3 STEL.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 200 ppm

PAC-3: 1000 ppm

DFG MAK: 50 ppm/270 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Australia: TWA 100 ppm (525 mg/m^3), 1993; Belgium: TWA 100 ppm (532 mg/m^3), 1993; Denmark: TWA 100 ppm (525 mg/m^3), 1999; France: VME 100 ppm (525 mg/m^3), 1999; Japan: 100 ppm (530 mg/m^3), 1999; Norway: TWA 50 ppm (260 mg/m^3), 1999; the Philippines: TWA 100 ppm (525 mg/m^3), 1993; Russia: TWA 100 ppm, 1993; Switzerland: MAK-W 50 ppm (270 mg/m^3), [skin], 1999; United Kingdom: LTEL 100 ppm (525 mg/m^3); STEL 125 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm.

Determination in Air: Use NIOSH Analytical Method (IV) #1450, Esters I; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure to high concentrations of vapors can cause headache, drowsiness, dizziness, lightheadedness, fatigue, and unconsciousness.

Long Term Exposure: Prolonged contact can cause skin drying and cracking. Can irritate the lungs with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Lung function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Move to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1000 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Amyl acetates must be labeled "FLAMMABLE LIQUID." They fall in Hazard Class 3 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Isoamyl Acetate*. Trenton, NJ

Isoamyl alcohols I:0240

Molecular Formula: $C_5H_{12}O$

Common Formula: $(CH_3)_2CHCH_2CH_2OH$

Synonyms: *primary:* Alcool isoamylique (French); Fermentation amyl alcohol; Fusel oil; Isoamyl alcohol (primary); Isoamyol; Isobutyl carbinol; Isopentyl alcohol; 3-Methyl-1-butanol; 3-Methyl-1-butanol; Potato spirit oil; Primary isoamyl alcohol

secondary: Isoamyl alcohol (*sec-*); 2-Methyl-3-butanol; Secondary isoamyl alcohol

CAS Registry Number: 123-51-3 (*primary-*); 6032-29-7 (*secondary-*); 137-32-6 (*active primary-*); 8013-75-0 (mixture of isoamyl alcohols)

RTECS® Number: EL5425000

UN/NA & ERG Number: UN1105/129

EC Number: 232-395-2 (CAS: 8013-75-0); 204-633-5 (3-methylbutan-1-ol); 227-907-6 (pentan-2-ol); 205-289-9 [*Annex I Index No.:* 603-006-00-7] (2-methylbutan-1-ol)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*primary*).

Description: Isoamyl alcohol is a colorless liquid. It has a disagreeable odor which causes coughing. Molecular weight = 88.17 (*primary- and secondary-*); Specific gravity (H_2O:1) = 0.81 at 13.9°C; Boiling point = 132°C (primary); 112.2°C (secondary); Freezing/Melting point = −117.2°C (*primary-*); Vapor pressure = 28 mmHg (*primary-*); 1 mmHg (*secondary-*); Flash point = 43°C (cc); 55°C (oc) (*primary-*); 35°C (*secondary-*); Autoignition temperature = 350°C. Explosive limits: LEL (*primary-*) = 1.2% at 100°C; UEL (*primary-*) = 9.0% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2% at 13.9°C.

Potential Exposure: Compound Description: (*primary-*) Tumorigen, Human Data; Primary Irritant; (*secondary-* and *active primary-*) Primary Irritant. Amyl alcohols are used in the manufacture of lacquers, paints, varnishes, paint removers; shoe cements; perfumes, pharmaceuticals, chemicals, rubber, plastics, fruit essences; explosives, hydraulic fluids; ore flotation agents; in the preparation of other amyl derivatives; in the extraction of fats; and in the textile and petroleum refining industries.

Incompatibilities: Isoamyl alcohol forms explosive mixture with air. Violent reaction with strong oxidizers, reducing agents, hydrogen trisulfide, causing explosion hazard. Not compatible with acid anhydrides, acid chlorides. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

primary- and secondary-

Conversion factor: 1 ppm = 3.61 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/360 mg/m^3.

NIOSH REL: 100 ppm/360 mg/m^3 TWA; 125 ppm/450 mg/m^3 STEL.

ACGIH TLV®[1] (*primary-*): 100 ppm/361 mg/m^3 TWA; 125 ppm/452 mg/m^3 STEL.

NIOSH IDLH: 500 ppm (*primary- and secondary-*).

Protective Action Criteria (PAC)

primary-

TEEL-0: 100 ppm

PAC-1: 125 ppm

PAC-2: 125 ppm

PAC-3: 500 ppm

secondary-6032-29-7

TEEL-0: 20 ppm

PAC-1: 20 ppm

PAC-2: 100 ppm
PAC-3: 500 ppm
DFG MAK (primary): 20 ppm/73 mg/m^3 TWA; Peak Limitation Category II(4); Pregnancy Risk Group C.

Australia: TWA 100 ppm (360 mg/m^3); STEL 125 ppm, 1993; Austria: MAK 100 ppm (360 mg/m^3), 1999; Belgium: TWA 100 ppm (361 mg/m^3); STEL 125 ppm (452 mg/m^3), 1993; Denmark: TWA 100 ppm (360 mg/m^3), 1999; France: VME 100 ppm (360 mg/m^3), 1999; Japan: 100 ppm (360 mg/m^3), 1999; the Netherlands: MAC-TGG 360 mg/m^3, 2003; the Philippines: TWA 100 ppm (360 mg/m^3), 1993; Russia: TWA 100 ppm; STEL 5 mg/m^3, 1993; Switzerland: MAK-W 100 ppm (360 mg/m^3), KZG-W 200 ppm (720 mg/m^3), 1999; Turkey: TWA 100 ppm (360 mg/m^3), 1993; United Kingdom: TWA 100 ppm (366 mg/m^3); STEL 125 ppm (458 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 125 ppm. Several states have set guidelines or standards for isoamyl alcohol in ambient air[60] ranging from 3.6–4.5 mg/m^3 (North Dakota) to 7.2 mg/m^3 (Connecticut, Florida and New York) to 8.571 mg/m^3 (Nevada).

secondary-

Denmark: TWA 100 ppm (360 mg/m^3), 1999; Norway: TWA 50 ppm (180 mg/m^3), 1999; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 450 mg/m^3, 1993.

Determination in Air: Use NIOSH Analytical Method (IV) s (*primary- and secondary-*) #1402, for Alcohols III; (*primary-*) #1405 for Alcohols Combined.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient level goal for all primary pentanols of 5000 μg/L, based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.42 (*primary-*).

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. If ingested, may affect the central nervous system. Isoamyl alcohol can affect you when breathed in and by passing through your skin. Contact can cause severe burns of the eyes, leading to permanent damage. It can irritate the nose and throat. Higher levels may irritate the lungs, causing coughing and/or shortness of breath. Higher exposure can cause dizziness, lightheadedness, headache, cough, dyspnea (breathing difficulty), nausea, vomiting, diarrhea, narcosis, unconsciousness, and death.

Long Term Exposure: Repeated or prolonged exposure to isoamyl alcohol can cause drying and cracking of the skin. May cause liver damage. Isoamyl alcohol can irritate the lungs and may cause bronchitis.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, liver function tests.

First Aid: If isoamyl alcohol gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** butyl rubber gloves, suits, boots; Neoprene™ rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where Isoamyl alcohol may be present, check to make sure that an explosive concentration does not exist. Isoamyl alcohol must be stored to avoid contact with strong oxidizers, such as chlorine and bromine, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where isoamyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Amyl alcohols require a shipping label of "FLAMMABLE LIQUID." They fall in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is flammable. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (April 1999). *Hazardous Substances Fact Sheet: Isoamyl Alcohol*. Trenton, NJ

Isobenzan I:0250

Molecular Formula: $C_9H_4Cl_8O$

Synonyms: CP14,957; ENT 25,545; ENT25,545-X; Isobenzano (Spanish); 1,3,4,5,6,7,10,10-Octochloro-4,7-endo-methylene-4,7,8,9-tetrahydrophthalan; 1,3,4,5,6,8,8-Octochloro-1,3,3a, 4,7,7a-hexahydro-4,7-methanoisobenzofuran; Octochlorohexahydromethanoisobenzofuran; 1,3,4,5, 6,7,8,8-Octochloro-2-oxa-3a,4,7,7a-tetrahydro-4,7-methanoi ndene; Omtan; R 6700; SD 440; Shell 4402; Shell WL 1650; Telodrin; WL 1650

CAS Registry Number: 297-78-9

RTECS® Number: PC1225000

UN/NA & ERG Number: UN2761/151

EC Number: 206-045-4 [*Annex I Index No.:* 602-053-00-0]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Very Toxic Substance (World Bank).[15]

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isobenzan is a white to light brown crystalline powder. Molecular weight = 411.73; Freezing/Melting point = 121.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, or application of this insecticide.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 2 mg/m^3

Routes of Entry: Inhalation, ingestion, through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This material is highly toxic. It is absorbed by the skin as well as by the respiratory and gastrointestinal tracts. Symptoms may last for a long time because the material is eliminated slowly; its half-life in human blood is 2.77 years. Symptoms of exposure include headache, dizziness, drowsiness, irritability, and numbness of the legs. Convulsions may occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand, full face-piece self-contained breathing apparatus or pressure-demand supplied-air respirator with escape SCBA and fully encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This material falls under organochlorine pesticides, solid, toxic, n.o.s. This class of compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep upwind. Avoid bodily contact with the material. Keep unnecessary people away; isolate hazard area and deny entry. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use agent suitable for type of surrounding fire. Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide, or dry chemical. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Wear full protective clothing including boots, protective gloves, goggles; and wear self-contained breathing apparatus. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isobenzan.* Washington, DC: Chemical Emergency Preparedness Program

Isobutane I:0260

Molecular Formula: C_4H_{10}
Common Formula: $(CH_3)_3CH$
Synonyms: 1,1-Dimethylethane; Isobutano (Spanish); LPG; 2-Methylpropane; Propane, 2-methyl; Trimethylmethane
CAS Registry Number: 75-28-5
RTECS® Number: TZ4300000

UN/NA & ERG Number: UN1969/115; UN1075 (Petroleum gases, liquefied or Liquefied petroleum gas)/115

EC Number: 200-857-2 [*Annex I Index No.:* 601-004-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16.

Description: Isobutane is a colorless gas with a gasoline-like or natural gas odor. Shipped as a liquefied compressed gas. Molecular weight = 58.14; Specific gravity (H_2O:1) = 0.6 (liquid); Boiling point = −12°C; Freezing/Melting point = 159.4°C; Relative vapor density (air = 1) = 2.06; Vapor pressure = 3.1 atm; Flash point = Flammable gas (−60°C); Autoignition temperature = 460°C. Explosive limits: LEL = 1.8%; UEL = 8.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Practically insoluble in water.

Potential Exposure: It is used as a refrigerant, fuel, and aerosol propellant.

Incompatibilities: Forms explosive gas mixture with air. Strong oxidizers (e.g., nitrates, perchlorates, chlorine, fluorine) and nickel carbonyl + oxygen may cause fire and explosions. Reacts with acetylene, halogens, and nitrous oxides. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.38 mg/m^3 at 25°C & 1 atm.

Large amounts of isobutane will decrease the amount of available oxygen. Before entering a confined space, oxygen content should be tested to ensure that it is at least 19% by volume.

OSHA PEL: None.

NIOSH REL: 800 ppm/1900 mg/m^3 TWA.

ACGIH TLV®[1]: 800 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 800 ppm

PAC-1: 2400 ppm

PAC-2: 4000 ppm

PAC-3: 15,000 ppm

DFG MAK: 1000 ppm (2400 mg/m^3) (isobutane and butane isomers).

Austria: MAK 800 ppm (1900 mg/m^3), 1999; Switzerland: MAK-W 800 ppm (1900 mg/m^3), 1999; United Kingdom: LTEL 600 ppm (1430 mg/m^3); STEL 750 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 800 ppm.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.78.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Isobutane can affect you when breathed in. Isobutane vapor may irritate and burn the eyes. Contact with the liquid can cause frostbite. Exposure to very high amounts can cause dizziness, lightheadedness, irregular heartbeat, and unconsciousness. With extremely high levels, death can occur from lack of oxygen.

Long Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Central nervous system, skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Prevent possible skin freezing from direct liquid contact. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to isobutane is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where isobutane may be present, check to make sure that an explosive concentration does not exist. Isobutane cylinders should be stored in a cool, well-ventilated dry area of noncombustible construction. Protect containers against physical damage. Store away from sources of heat or ignition and from oxygen, chlorine, and other oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where isobutane is handled, used, or stored. Ground and bond all lines and equipment used with isobutane. Wherever isobutane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep isobutane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Isobutane is a flammable gas or liquid. Stop the flow of gas if it can be done safely. Use dry chemical or CO_2 extinguishers. Use water to keep fire-exposed containers cool. Poisonous gases, including carbon monoxide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Isobutane*. Trenton, NJ

Isobutyl acrylate I:0270

Molecular Formula: $C_7H_{12}O_2$

Common Formula: $CH_2{=}CHCOOCH_2CH(CH_3)_2$

Synonyms: Acrylic acid isobutyl ester; Isobutyl 2-propenoate; Isobutyl propenoate; 2-Methylpropyl acrylate; 2-Propenoic acid 2-methylpropyl ester

CAS Registry Number: 106-63-8

RTECS® Number: AT2100000

UN/NA & ERG Number: UN2527/129

EC Number: 203-417-8 [*Annex I Index No.:* 607-115-00-0]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20/21; R38; R43; Safety phrases: S2; S9; S24; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Isobutyl acrylate is a clear, colorless liquid. Molecular weight = 128.19; Boiling point = 138°C (61−63°C at 15 mm); Flash point = 30°C; Autoignition temperature = 427°C. Explosive limits: LEL = 1.9%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 4, Reactivity 1. Slightly soluble in water.

Potential Exposure: This material is used as a monomer for acrylate resins.

Incompatibilities: Forms explosive mixture with air. Heat and contamination may cause polymerization. Reacts with strong acids, aliphatic amines, alkanolamines.

Permissible Exposure Limits in Air

No standards or TEEL available for isobutyl acrylate. See *n*-butyl acrylate 141-32-2.

Harmful Effects and Symptoms

Short Term Exposure: Irritating to skin, eyes, nose, and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Moderately toxic when swallowed. LD_{50} = (oral-rat) 7070 mg/kg (insignificantly toxic). Contact with the eyes causes minor irritation no worse than that produced by hand soap.

Long Term Exposure: Can irritate the lungs. May cause bronchitis to develop.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where isobutyl acrylate may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof cool area. Protect from air and light for long-term storage. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorbent may be used to consolidate spills on land (such as sorbent polyurethane foams). Oil skimming equipment may be used for spills on water. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray into incinerator. Flammable solvent may be added.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 43−44 (1982) and 7, No. 6, 68−71 (1987)

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Isobutyl Acrylate*. Trenton, NJ

Isobutylene I:0280

Molecular Formula: C_4H_8

Synonyms: γ-Butylene; 1,1-Dimethylethylene; Isobutene; Isobutylene; Liquefied petroleum gas; 2-Methylpropylene; 2-Metilpropeno (Spanish); 1-Propene, 2-methyl-

CAS Registry Number: 115-11-7

RTECS® Number: UD0890000

UN/NA & ERG Number: UN1055/115

EC Number: 204-066-3 [*Annex I Index No.:* 601-012-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq 1.00\%$ concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); equivocal evidence: rat; no evidence: mouse.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): D001.

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S19; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Isobutylene, an aliphatic hydrocarbon, is a colorless gas, or liquid under pressure, with a sweet, gasoline odor. Molecular weight = 56.12; Specific gravity (H_2O:1) = 0.588; Boiling point = −7°C. Freezing point = −140°C; Relative vapor density (air = 1) = 1.94; Vapor pressure = 3278 mmHg at 37.7°C; Flash point = −76°C (cc); Autoignition temperature = 465°C. Explosive Limits: LEL = 1.8%; UEL = 9.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 1. Practically insoluble in water.

Potential Exposure: Used in the production of aviation gasoline, butyl rubbers; resins, other intermediates and chemicals; making antioxidants for food, packaging, and plastics.

Incompatibilities: Flammable gas; forms explosive mixture with air. Polymerizes easily. Violent reaction with strong oxidizers, strong acids, hydrogen bromide, nitrogen oxides, and with numerous other materials. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 250 ppm

PAC-1: 750 ppm

PAC-2: 1250 ppm

PAC-3: 100,000 ppm

Russia: STEL 100 mg/m^3, 1993.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Contact with the liquid can cause frostbite. Can cause headache, dizziness, lightheadedness, and fatigue. Higher levels can cause coma and death.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; *do not* rub the affected areas or flush them with water. In order to prevent further tissue damage, *do not* attempt to remove frozen clothing from frostbitten areas. If frostbite has *not* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact-resistant goggles when working with gas. Wear splash-proof chemical goggles and face shield when working with liquids unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with Isobutylene you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Where possible, automatically pump isobutylene from cylinders or from other storage containers to process containers. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Isobutylene requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Isobutylene*. Trenton, NJ

Isobutyl isocyanate I:0290

Molecular Formula: C_5H_9NO
Synonyms: 1-Isocyanato-2-methyl propane
CAS Registry Number: 1873-29-6
RTECS® Number: NQ9208000
UN/NA & ERG Number: UN2486/155
EC Number: 217-495-6

Regulatory Authority and Advisory Bodies

US DOT Inhalation Hazard Chemicals.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isobutyl isocyanate is a highly flammable, colorless liquid with a pungent odor; Flash point = <23°C. Soluble in water; reactive.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Reacts with water. Oxidizers can cause a fire and explosion hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Isocyanate-bearing waste (as CNs, n.o.s.)

TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Isobutyl isocyanate can affect you when breathed in and by passing through your skin. Little is known about the health effects of isobutyl isocyanate. However, similar chemicals can irritate the eyes, skin, nose, throat, and lungs.

Long Term Exposure: Many isocyanates cause an asthma-like lung allergy. It is not known for sure if isobutyl isocyanate does.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/

clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to isobutyl isocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where isobutyl isocyanate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of isobutyl isocyanate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tool and equipment, especially when opening and closing containers of isobutyl isocyanate.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II. A plus symbol (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (*from a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.1/1.8

Large spills (*from a large package or from many small packages*)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 3.0
Night 4.6

Fire Extinguishing: Isobutyl isocyanate is a flammable liquid. Poisonous gas is produced in fire. Containers may explode in fire. Use dry chemical, CO_2, or foam extinguishers. *Do not use water*. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2004). *Hazardous Substances Fact Sheet: Isobutyl Isocyanate*. Trenton, NJ

Isobutyraldehyde I:0300

Molecular Formula: C_4H_8O

Common Formula: $(CH_3)_2CHCHO$

Synonyms: Isobutaldehyde; Isobutanal; Isobutiraldehido (Spanish); Isobutyl aldehyde (DOT); Isobutyral; Isobutyric aldehyde; Isobutyryl aldehyde; Isopropyl aldehyde; Isopropylformaldehyde; 2-Methyl-1-propanal; 2-Methylpropanal; Methylpropanal; α-Methylpropionaldehyde; 2-Methylpropionaldehyde; NCI-C60968; Propanal, 2-methyl-; Valine aldehyde

CAS Registry Number: 78-84-2

RTECS® Number: NQ4025000

UN/NA & ERG Number: UN2045/130

EC Number: 201-149-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isobutyraldehyde is a colorless liquid with a pungent odor. The odor threshold is 0.05 ppm. Molecular weight = 72./12; Specific gravity (H_2O:1) = 0.8; Boiling point = 61°C; Freezing/Melting point = − 65°C; Flash point = −18°C; Autoignition temperature = 196°C. Explosive limits: LEL = 1.6%; UEL = 10.6%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water; solubility = 7% at 20°C.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Primary Irritant. Isobutyraldehyde is used in the organic synthesis of pantothenic acid, valine, leucine, and cellulose ester; in making gasoline additives, perfumes, flavors, and plasticizers.

Incompatibilities: Forms explosive gas mixture with air. Incompatible with strong acids, caustics, reducing agents, aliphatic amines, alkanolamines, aromatic amines, strong oxidizers.

Permissible Exposure Limits in Air

AIHA WEEL: 25 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 25 ppm

PAC-1: 300 ppm

PAC-2: 1500 ppm

PAC-3: 1500 ppm

Poland: MAC (TWA) 100 mg/m^3, 1999; Russia: STEL 5 mg/m^3, [skin], 1993.

Determination in Air: Use NIOSH Analytical Method #2539, aldehydes, screening.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.2.

Routes of Entry: Skin absorption, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Isobutyraldehyde can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. High levels can irritate the lungs. High levels can cause you to feel dizzy, lightheaded, and to pass out. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Corrosive on ingestion. Exposure may result in death.

Long Term Exposure: Can irritate the lungs and may cause bronchitis to develop. Repeated exposure can cause skin dryness, itching, and rash.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to isobutyraldehyde, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where isobutyraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of isobutyraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isobutyraldehyde. Wherever isobutyraldehyde is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 46−48

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Isobutyraldehyde*. Trenton, NJ

Isobutyric acid I:0310

Molecular Formula: $C_4H_8O_2$

Synonyms: Acetic acid, dimethyl-; Acido isobutirico (Spanish); Dimethylacetic acid; Isobutanoic acid; Isobutyric acid; Isopropylformic acid; α-Methylpropanoic acid; 2-Methylpropanoic acid; α-Methylpropionic acid; Propane-2-carboxylic acid; Propionic acid, 2-methyl-

CAS Registry Number: 79-31-2

RTECS® Number: NQ4375000

UN/NA & ERG Number: UN2529/132

EC Number: 201-195-7 [*Annex I Index No.:* 607-063-00-9]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below), as isomer of butyric acid.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isobutyric acid is a colorless liquid with a sharp odor of rancid butter fat; Freezing/Melting point = −47°C. Molecular weight = 88.12; Boiling point = 152°C; Flash point = 56°C (oc); Autoignition temperature = 481.6°C. Flammability limits: LEL = 2.0%; UEL = 9.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Isobutyric acid is used to make solvents, flavors, perfumes, varnishes, disinfectants; in tanning; in nonalcoholic beverages and processed foods.

Incompatibilities: Forms explosive mixture with air. Aqueous solution forms a medium strong acid. Incompatible with oxidizers, sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides, epichlorohydrin. Attacks aluminum and other metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.3 ppm

PAC-1: 1 ppm

PAC-2: 6 ppm

PAC-3: 35 ppm

This chemical can be absorbed through the skin, thereby increasing exposure. For butyric acid the former USSR-UNEP/IRPTC joint project MAC value is 2.5 ppm (10 mg/m^3)[43] for work-place air. They also cite a momentary MAC value of 0.015 mg/m^3 and an allowable average daily MAC of 0.01 mg/m^3 in ambient air of residential areas.

Determination in Air: No method available.

Permissible Concentration in Water: Designated a hazardous substance and regulated under section 311 of the Federal Water Pollution Control Act and the Clean Water Act Amendments. See reportable quantity above, for discharges of this substance.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Can cause severe eye and skin irritation and burns leading to permanent damage. Inhalation can cause respiratory tract irritation, coughing, wheezing, and/or shortness of breath. Ingestion is poisonous and causes irritation of mouth and stomach; between 1 teaspoonful and 1 ounce may be fatal. The LD_{50} is 280 mg/kg (oral, rat).

Long Term Exposure: May affect the blood. Repeated exposures may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. May cause kidney damage.

Points of Attack: Kidneys, lungs, blood.

Medical Surveillance: Kidney function tests, complete blood count (CBC), lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, heat, food, and water. Where possible, automatically pump liquid from drums or other storage containers to process containers. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored.

Shipping: Isobutyric acid requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Isobutyric Acid*. Trenton, NJ

Isobutyronitrile I:0320

Molecular Formula: C_4H_7N

Common Formula: $(CH_3)_2CHCN$

Synonyms: 2-Cyanopropane; Dimethylacetonitrile; Isobutironitrilo (Spanish); Isopropyl cyanide; Isopropylkyanid; Isopropylnitrile; α-Methylpropanenitrile; 2-Methylpropanenitrile; α-Methylpropionitrile; 2-Methylpropionitrile; Propanenitrile, 2-methyl-

CAS Registry Number: 78-82-0

RTECS® Number: TZ4900000

UN/NA & ERG Number: UN2284/131

EC Number: 201-147-5

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Isobutyronitrile is a colorless liquid. Molecular weight = 69.12; Boiling point = 101°C; Freezing/Melting point = −65°C; Flash point = 8°C; Autoignition temperature = 482°C. Explosive limits: LEL = 1.6%; UEL = 10.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Isobutyronitrile is used in organic synthesis, as an intermediate for insecticides, and as a gasoline additive.

Incompatibilities: Reacts with oxidants, strong reductants, and strong bases.

Permissible Exposure Limits in Air

NIOSH REL: 8 ppm/22 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 8 ppm

PAC-1: **10** ppm

PAC-2: **18** mg/m^3

PAC-3: **68** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.

Harmful Effects and Symptoms

Short Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Lacrimation (tearing) and burning sensation of the mouth and throat are common. Signs and symptoms of acute exposure to isobutyronitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red (and potentially bloody) mucous membranes, cardiac arrhythmias, and other cardiac abnormalities are common. Cyanosis (blue tint to skin and mucous membranes) may also be found. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage may occur. Headache, vertigo (dizziness), agitation, giddiness, salivation, nausea, and vomiting may be followed by combative behavior, convulsions, and coma. *Warning:* Heart palpitation may occur within minutes after exposure. High doses can stop breathing. Vital signs should be monitored closely. Caution is advised.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, immediately begin administering 100% oxygen to all victims. Monitor victims for respiratory distress and remove from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, evaluate vital signs and proceed as earlier in this section. Rush to a health-care facility. Do not induce vomiting or attempt to neutralize. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **4 h:** Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Isobutyronitrile requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Keep sparks, flames, and other sources of ignition away. Establish forced ventilation to keep levels below explosive limit. Build dikes to control flow as necessary. Attempt to stop leak if this can be done without hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Avoid breathing vapors. Keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear positive pressure breathing apparatus and special protective clothing. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish with dry chemical, carbon dioxide, water spray, foam, or fog. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Isolate for 1/2 mile in all directions if tank car or truck is involved in fire. Move container from fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. Toxic oxides of nitrogen are produced during combustion. It is a flammable/combustible material and may be ignited by heat, sparks, or flames. Vapor explosion and poison hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isobutyronitrile*. Washington, DC: Chemical Emergency Preparedness Program

Isocyanatobenzotrifluoride I:0330

Molecular Formula: $C_8H_4F_3NO$

Common Formula: $C_6H_4(CF_3)NCO$

Synonyms: Benzene, isocyanato(trifluoromethyl)-; Isocyanato trifluoromethyl benzene; Trifluoromethylphenyl isocyanate

CAS Registry Number: 71121-36-3

RTECS® Number: NR0200500

UN/NA & ERG Number: UN2285/156 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isocyanatobenzotrifluoride is a highly flammable liquid. May react with water.

Incompatibilities: Reacts with oxidants, strong reductants, and strong bases. Contact with acids and bases may initiate explosive polymerization. Contact with water may release carbon dioxide and amines.

Potential Exposure: Used as an intermediate in pesticide manufacture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Isocyanate-bearing waste (as CNs, n.o.s.)

TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: The health effects are not known at this time, but similar chemicals can severely irritate the eyes, skin, nose, throat, air passages, and lungs.

Long Term Exposure: Very irritating substances, such as this one, can cause lung irritation and may cause bronchitis to develop.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to isocyanatobenzotrifluoride, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete.

Fire Extinguishing: Isocyanatobenzotrifluoride may burn, but does not readily ignite. Do not use water or regular foam as toxic gases may be released. Poisonous gases, including nitrogen oxides and fluorides, are produced in fire. Use dry chemical, dry sand, alcohol-resistant foams, carbon dioxide extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health (NIOSH). (October 1977). *Information Profiles on Potential Occupational Hazard: Organoisocyanates*, Report PB-276, 678. Rockville, MD, pp. 265–275

New Jersey Department of Health and Senior Services. (February 1987). *Hazardous Substances Fact Sheet: Isocyanatobenzotrifluoride*. Trenton, NJ

Isoeugenol (*cis-, trans*-mixture) I:0335

Molecular Formula: $C_{10}H_{12}O_2$

Synonyms: 1-Hydroxy-2-methoxy-4-propenyl-(*cis*)benzene; 4-Hydroxy-3-methoxy-1-propenylbenzene; 1-(3-Methoxy-4-hydroxyphenyl)-1-propene; 2-Methoxy-4-propenylphenol; 2-Methoxy-4-propenylphenol; 2-Methoxy-4-(1-propenyl) phenol; Phenol, 2-methoxy-4-propenyl-; 4-Propenylguaiacol

CAS Registry Number: 97-54-1

RTECS®Number: SL7875000

EC Number: 202-590-7

Regulatory Authority and Advisory Bodies

Listed in the TSCA inventory.

Canada: WHMIS category D2B; on DSL List.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36/37/38; R43; Safety phrases: S24/25; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: A viscous, pale yellow oily liquid. Odor is spicy carnation clove. This chemical is combustible. Molecular Weight = 164.204; Density = 1.082 g/cm^3; Specific Gravity = 1.08 at 25°C; Boiling Point: 266°C at 760 mmHg; Freezing/Melting point = −10°C; Vapor Pressure = 0.2 Pa at 25°C; Flash point = 134°C; 132°C at 981 mbar. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability 0; Reactivity 0. Moderately soluble in water; solubility = 700–805 mg/L.

Potential Exposure: Occurs naturally in ylang-ylang (*Cananga odorata*) oil and other essential oils. Found in cloves, tobacco, other plants and flowers. Used as a fragrance ingredient; in household cleaning, maintenance, and personal products; perfumes, skin-care products; deodorants, soaps, shampoos, detergents; in manufacture of vanillin.

Incompatibilities: Keep away from strong oxidizers, strong acids.

Permissible Exposure Limits in Air:

No OELs or TEEL available.

Determination in Air:

No NIOSH or OSHA method available.

Permissible Concentration in Water: Not found.

Determination in Water: Octanol–water partition coefficient: Log $P_{ow} = 3.04$.

Routes of Entry: Ingestion, eyes, dermal route.

Harmful Effects and Symptoms

Short Term Exposure: This compound is a primary irritant and sensitizer; may be able to cause contact allergy from dermal exposure. LD_{50} = (oral-rat) 1560 mg/kg. Moderately toxic.

Long Term Exposure: This compound may be irritating to the skin and eyes.

Points of Attack: Skin, eyes.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy.

First Aid: *Eyes*: Check the victim for contact lenses and remove. Flush victim's eyes with water or normal saline solution for 20–30 min, lifting lower and upper eyelids occasionally. Remove contaminated clothing and shoes. Get medical attention immediately. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water and wash for at least 15 min. Remove and isolate all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician. Transport the victim to a hospital for treatment. *Inhalation*: Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. *Ingestion*: *Do not induce vomiting*. If the victim is conscious and not convulsing, give large amount of water to dilute the chemical. Never give anything by mouth to an unconscious person. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician. In all cases get medical attention immediately. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body.

Personal Protective Methods: Wear protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Recommended gloves: Ansell 5.109 (Latex); thickness: 0.18 mm; Breakthrough time: *15 min*; Edmont 29-870 (Neoprene); thickness: 0.51 mm; Breakthrough time: *135 min*; North Model F-091 (Viton); thickness: 0.41 mm; Breakthrough time: *480 min*.

Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA- or European Standard EN 149-approved respirator; or use a billboard November 6, 1948 half-face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas, and SO_2) with a dust/mist filter.

Storage: Color Code—Green: General storage may be used. Store this material in a refrigerator at 0−6°C.

Shipping: Not regulated.

Spill Handling: Remove all sources of ignition. Provide ventilation. Use inert material (e.g., vermiculite, sand, or earth) to pick up all liquid spill material. All contaminated clothing and absorbent material should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section.

Fire Extinguishing: This compound is not very flammable but any fire involving this compound may produce dangerous vapors. You should evacuate the area. All firefighters should wear full-body protective clothing and use self-contained breathing apparatuses. You should extinguish any fires involving this chemical with a dry chemical, carbon dioxide, foam, or halon extinguisher.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

Hazardous Substances Data Bank [HSDB], US National Library of Medicine, TOXNET. *Eugenol.* http://toxnet.nlm.nih.gov

Isodrin I:0340

Molecular Formula: $C_{12}H_8Cl_6$

Synonyms: AI3-19244; Compound 711; 1,4: 5,8-Dimethano naphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1a,4a,4a.b,5b,8b,8ab)-; 1,4: 5,8-Dimethano naphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endo, endo-; ENT19,244; (1a,4a,4ab,5b,8b, 8a.b)-1,2,3,4,10,10-Hexachloro-1,4,4a,-5,8,8a-hexahydro-1,4: 5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4: 5,8-endo, endo-dimethanon aphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo, endo-5,8-dimethanon aphthalene; Isodrina (Spanish)

CAS Registry Number: 465-73-6

RTECS® Number: IO1925000

UN/NA & ERG Number: UN2761/151

EC Number: 207-366-2 [*Annex I Index No.:* 602-050-00-4]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Very Toxic Substance (World Bank).[15]

US EPA Hazardous Waste Number (RCRA No.): P060.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 0.066.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/27/28; R50/53; Safety phrases: S1/2; S13; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isodrin is a crystalline solid. Molecular weight = 364.90; Freezing/Melting point = 241°C. Decomposes above 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. May be dissolved in flammable liquids.

Potential Exposure: Those involved in the manufacture, formulation, and application of this pesticide. An isomer of aldrin. See also "Aldrin" entry.

Incompatibilities: Incompatible with concentrated mineral acids, acid catalysts, acid oxidizing agents, phenols, reactive metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 7 mg/m^3

PAC-3: 7 mg/m^3

Determination in Air: There is no OEL established for Isodrin. However, this chemical is an isomer of aldrin. See Aldrin.

Routes of Entry: Inhalation, ingestion, eyes and/or skin.

Harmful Effects and Symptoms

Short Term Exposure: Isodrin is classified as extremely toxic. Probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 2 teaspoonsful for a 70-kg (150-lb) person. It causes renal damage and hyperactivity of sympathetic nervous system. Symptoms experienced are similar to poisoning by dieldrin and aldrin, including overall discomfort, headache, nausea, vomiting, dizziness, tremors, convulsions, rise in blood pressure; fever, disturbances in sleep and behavior; and rapid heartbeat. Death from respiratory arrest may occur in coma.

Long Term Exposure: May cause dermatitis, skin rash, and acne. May cause liver and/or kidney damage.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Isodrin falls into the category of Organochlorine pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry containers and cover/move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but may not ignite readily. Fire and runoff from fire control water may produce irritating or poisonous gases, including chlorine. Extinguish by using water spray, dry chemical, foam, or carbon dioxide. Use water to keep fire exposed containers cool. Wear full protective clothing including positive pressure breathing apparatus. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1977). *Dangerous Properties of Industrial Materials Report*, 7, No. 6, 72−75

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isodrin*. Washington, DC: Chemical Emergency Preparedness Program

Isofluorophate I:0350

Molecular Formula: $C_6H_{14}FO_3P$

Synonyms: Diflupyl; Diflurophate; Diisopropoxyphosphoryl fluoride; *O*,*O*-Diisopropyl fluorophosphate; Diisopropyl fluorophosphate; Diisopropyl fluorophosphonate; Diisopropylfluorophosphoric acid ester; Diisopropylfluorphosphorsaeureester (German); Diisopropyl phosphofluoridate; Diisopropyl phosphorofluoridate; *O*,*O′*-Diisopropyl phosphoryl fluoride; DPF; Dyflos; Floropryl; Fluophosphoric acid, diisopropyl ester; Fluorodiisopropyl phosphate; Fluoropryl; Fluostigmine; Isofluorphate; Isoflurophate; Isopropyl fluophosphate; Isoproyl phosphorofluoridate; Neoglaucit; PF-3; Phosphorofluoridic acid, diisopropyl ester; T-1703; TL-466

CAS Registry Number: 55-91-4

RTECS® Number: TE5075000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-247-6

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P043.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ) = 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isoflurophate is an oily, colorless to faintly yellow liquid. Molecular weight = 184.17; Boiling point = 62°C at 9 mmHg; Freezing/Melting point = −82°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: An insecticide. This organophosphate compound is used as a research tool in neuroscience for its ability to inhibit cholinesterase (by phosphorylation) on an acute/subacute basis and to produce a delayed neuropathy. Used as a basis for "nerve gases."

Incompatibilities: Forms hydrofluoric acid in the presence of water. In the presence of moisture attacks metals, rubbers, plastics, coatings, and silica-containing materials, such as glass. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.6 mg/m^3

PAC-3: 3.6 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Isoflurophate is extremely toxic: probable oral lethal dose in humans is 5−50 mg/kg, between 7 drops and 1 teaspoonful for 70-kg person. Even traces of the vapor cause pinpoint pupils. High exposures may cause pulmonary edema.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or

authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand, full face-piece self-contained breathing apparatus or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and steam.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. would be the applicable category here. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. Dike far ahead of *large spills* for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but will not ignite readily. Container may explode in heat of fire. Fire and runoff from fire control water may produce irritating or poisonous gases of fluorine and phosphorus oxides. Use dry chemical, carbon dioxide. For large fires, water spray, fog, or foam. Fight fire from maximum distance. Dike fire control water for later disposal. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isofluorophate*. Washington, DC: Chemical Emergency Preparedness Program

Isolan® I:0360

Molecular Formula: $C_{10}H_{17}N_3O_2$

Synonyms: Dimethylcarbamate-d'l-isopropyl-3-methyl-5-pyrazoylle (French); Dimethylcarbamic acid 3-methyl-1-(1-methylethyl)-1H-pyrazol-5-yl ester; Dimetilcarbamato de 1-isopropil-3-metil-5-pirazolilo (Spanish); ENT 19,060; Geigy G-23611; Isolane (French); Isopropylmethylpyrazol dimethylcarbamate; (1-Isopropyl-3-methyl-1H-pyrazol-5-yl)-*N*,*N*-dimethyl-carbamat (German); (1-Isopropyl-3-methyl-1H-pyrazol-5-yl)-*N*,*N*-dimethyl carbamate; 1-Isopropyl-3-methyl-5-pyrazolyl dimethyl carbamate; 1-Isopropyl-3-methylpyrazolyl-(5) dimethylcarbamate; Isopropylmethylpyrazoyl dimethylcarbamate; 5-Methyl-2-isopropyl-3-pyrazolyl dimethylcarbamate; Primin; Saolan

CAS Registry Number: 119-38-0
RTECS® Number: FA2100000
UN/NA & ERG Number: UN2992 (Carbamate pesticides, liquid, toxic)/151
EC Number: 204-318-2 [*Annex I Index No.*: 006-009-00-6]
Regulatory Authority and Advisory Bodies
US EPA Hazardous Waste Number (RCRA No.): P192.
Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 100 lb (45.4 kg).
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
European/International Regulations: Hazard Symbol: T+; Risk phrases: R27/28; Safety phrases: S1/2; S28; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Isolan®, a carbamate pesticide, is a colorless liquid. Molecular weight = 211.30; Boiling point = 103°C at 0.7 mm, and 117−118°C at 2.5 mm.
Potential Exposure: **AMHP** Compound Description: Agricultural Chemical; Mutagen. This material is a systemic aphicide used in Europe. It is not registered as a pesticide in the United States, and is currently of little commercial interest.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 5.6 mg/m^3
PAC-3: 5.6 mg/m^3
Harmful Effects and Symptoms
Short Term Exposure: Isolan® is classified as extremely toxic. Probable oral lethal dose in humans is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. A cholinesterase inhibitor; although it is not an organic phosphate, it resembles that group in action. Can cause death due to respiratory arrest. Symptoms include cool extremities; trembling, fixed pinpoint pupils; nausea; vomiting, slight bluing of skin, lips, and nail beds; tearing, diarrhea, excessive salivation; sweating, slurring of speech; jerky movements; loss of bladder control; convulsions, coma, and death.
Short Term Exposure: A mutagen and may be carcinogenic.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand full face-piece self-contained breathing apparatus or pressure-demand supplied-air respirator with escape SCBA and a fully encapsulating, chemical-resistant suit.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: Carbamate pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid breathing vapors. Treat as a liquid carbamate pesticide. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is

designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use methods for liquid carbamate pesticides. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. As with other liquid carbamate pesticides, keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isopropylmethylpyrazolyl Dimethylcarbamate*. Washington, DC: Chemical Emergency Preparedness Program

Isooctyl alcohol I:0370

Molecular Formula: $C_8H_{18}O$

Common Formula: $C_7H_{15}CH_2OH$

Synonyms: 2-Ethylhexanol; Isodibutol; Isooctanol; Oxooctyl alcohol

CAS Registry Number: 26952-21-6

RTECS® Number: NS7700000

UN/NA & ERG Number: NA1993/128 (A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada).

EC Number: 248-133-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Isooctyl alcohol is a clear, combustible liquid. Molecular weight = 130.26; Specific gravity (H_2O:1) = 0.83; Boiling point = 186°C; Freezing/Melting point = < −76°C; Vapor pressure = 0.4 mmHg at 20°C; Flash point = 82°C (oc); Autoignition temperature = 277°C. Explosive limits: LEL = 0.9%; UEL = 5.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: It is used to form phthalate, maleate, adipate, and sebacate esters with the corresponding acids for use as plasticizers. It is used as a raw material for surfactants and as an antifoaming agent, emulsifier, and solvent.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine) can cause fire and explosion hazard. Incompatible with strong acids, caustics, amines, isocyanates.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 50 ppm/270 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 50 ppm/266 mg/m^3 TWA [skin].

No TEEL available.

Australia: TWA 50 ppm (270 mg/m^3), [skin], 1993; Belgium: TWA 50 ppm (266 mg/m^3), [skin], 1993; Denmark: TWA 50 ppm (270 mg/m^3), [skin], 1999; France: VME 50 ppm (270 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 270 mg/m^3, 2003; Norway: TWA 25 ppm (135 mg/m^3), 1999; Russia: STEL 50 mg/m^3, 1993; Switzerland: MAK-W 50 ppm (270 mg/m^3), [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm [skin]. Russia[43] set a MAC of 0.15 mg/m^3 for ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for *iso*-octyl alcohol in ambient air[60] ranging from 2.7 mg/m^3 (North Dakota) to 4.5 mg/m^3 (Connecticut) to 6.429 mg/m^3 (Nevada).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Isooctyl alcohol can affect you when breathed in and by passing through your skin. Exposure irritates the eyes, nose, and throat, and possibly the lungs. Contact can irritate the skin and prolonged contact may cause skin burns. Contact can irritate and burn the eyes and cause possible permanent damage. Inhalation of the vapor can cause depression of the central nervous system; can cause dizziness, lightheadedness, headache, confusion, and unconsciousness. Exposure can cause nausea, vomiting, diarrhea, and irregular heartbeat.

Long Term Exposure: Defats the skin, causing redness, drying, and rash. May damage the liver and kidneys. Inhalation can cause lung irritation causing coughing and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system, liver, and kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, permanganates, chlorates, nitrates, and peroxides). Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F. A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada. It falls in Hazard Class "COMBUSTIBLE LIQUID," Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably in admixture with a more flammable solvent.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 49−50

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Isooctyl Alcohol*. Trenton, NJ

Isopentane I:0390

Molecular Formula: C_5H_{12}

Synonyms: Butane, 2-methyl-; Ethyl dimethyl methane; Exxsol isopentane; Isoamyl hydride; Isopentano (Spanish); 2-Methylbutane; Phillips 66 isopentane

CAS Registry Number: 78-78-4; *(alt.)* 68923-44-4; *(alt.)* 92046-46-3

RTECS® Number: EK4430000

UN/NA & ERG Number: UN1265/128

EC Number: 201-142-8 [*Annex I Index No.*: 601-006-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List (isopentane not listed) *n*-pentane Concentration 1%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S9; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Isopentane is a volatile, colorless, watery liquid with a gasoline-like odor. Molecular weight = 72.17; Boiling point = 28°C. Freezing point = − 161°C; Flash point ≤ −51°C (cc); Autoignition temperature = 420°C. Flammability limits: LEL = 1.4%; UEL = 7.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.

Potential Exposure: Used as expanding or blowing agent in polystyrene foam beads; as a process solvent, chemical intermediate; in the manufacture of chlorinated derivatives; and as an antiknock additive in gasoline.

Incompatibilities: Highly volatile liquid; mixture with air may explode. Contact with oxidizers may cause fire and explosion hazard. Attacks some paints, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: 1000 ppm/2950 mg/m^3 TWA.

NIOSH REL: 120 ppm/350 mg/m^3 TWA.

ACGIH TLV®[1]: 600 ppm/1770 TWA.

NIOSH IDLH: 1500 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 600 ppm

PAC-1: 600 ppm

PAC-2: 610 ppm

PAC-3: 20.000 ppm

DFG MAK: 1000 ppm/3000 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Austria: MAK 600 ppm (1899 mg/m^3), 1999; Denmark: TWA 500 ppm (1500 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 600 ppm. United Kingdom[33] TWA 600 ppm (1800 mg/m^3); STEL of 750 ppm (2250 mg/m^3) (all isomers of pentane).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for Hydrocarbons.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can irritate the eyes and respiratory tract. Skin contact can cause a rash or burning sensation on contact. Can cause headache, nausea, weakness, dizziness, sleepiness, loss of coordination, and loss of consciousness. Ingestion may cause aspiration into the lungs and chemical pneumonitis. May affect the central nervous system.

Long Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as pentane): *1200 ppm*: Sa (APF = 10) (any supplied-air respirator). *1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Pentanes require a label of "FLAMMABLE LIQUID." They fall in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Isopentane*. Trenton, NJ

Isophorone I:0400

Molecular Formula: $C_9H_{14}O$

Synonyms: 2-Cyclohexen-1-one,3,5,5-trimethyl-; Isoacetophorone; Isoforon; Isoforona (Spanish);

NCI-C55618; 1,1,3- Trimethyl-3-cyclohexene-5-one; 3,5,5-Trimethyl-2-cyclohexene-1-one; 3,5,5-Trimethyl-2-cyclohexen-1-one (German)

CAS Registry Number: 78-59-1

RTECS® Number: GW7700000

UN/NA & ERG Number: NA1993/128 (A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada).

EC Number: 201-126-0 [*Annex I Index No.:* 606-012-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Possible Human Carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; NTP: Carcinogenesis Studies (gavage); some evidence: rat.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (60); 8270 (10).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R21/22; R36/37; R40; Safety phrases: S2; S13; S23; S36/37/39; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isophorone, a cyclic ketone, is a colorless or pale liquid with a peppermint-like odor. The odor threshold is 5.4 ppm in water; 0.2 ppm in air. Molecular weight = 138.23; Specific gravity (H_2O:1) = 0.92; Boiling point = 215°C; Freezing/Melting point = −8°C; Vapor pressure = 0.3 mmHg at 20°C; Flash point = 84°C (cc); Autoignition temperature = 460°C. Explosive limits: LEL = 0.8%; UEL = 3.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 1%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Isophorone is an industrial chemical synthesized from acetone and used commercially as a solvent or cosolvent for polyvinyl and nitrocellulose resins, pesticides, herbicides, fats, oils, and gums. It is used as a solvent and emulsifier; in some printing inks, paints, lacquers, and adhesives. It is also used as a chemical feedstock for the synthesis of 3,5-xylenol, 2,3,5-trimethyl-cyclohexanol, and 3,5-dimethylaniline. Although this is an industrial chemical, it also occurs naturally in cranberries.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with aliphatic amines. Attacks some plastics, resins, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.65 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/140 mg/m^3 TWA.

NIOSH REL: 4 ppm/23 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/28 mg/m^3 TWA Ceiling Concentration; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)

TEEL-0: 4 ppm

PAC-1: 4 ppm

PAC-2: 5 ppm

PAC-3: 200 ppm

DFG MAK: 2 ppm/11 mg/m^3 TWA; Peak Limitation Category I(2); Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 5 ppm (25 mg/m^3), 1993; Austria: MAK 5 ppm (28 mg/m^3), 1999; Belgium: STEL 5 ppm (28 mg/m^3), 1993; Denmark: TWA 5 ppm (25 mg/m^3), 1999; Finland: TWA 5 ppm (28 mg/m^3); STEL 10 ppm (56 mg/m^3), 1999; France: VLE 5 ppm (25 mg/m^3), 1999; the Netherlands: MAC 25 mg/m^3, 2003; the Philippines: TWA 25 ppm (140 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC 25 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: KTV 5 ppm (30 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (28 mg/m^3), 1999; Turkey: TWA 25 ppm (149 mg/m^3), 1993; United Kingdom: STEL 5 ppm (29 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 ppm. Several states have set guidelines or standards for isophorone in ambient air[60] ranging from 83.3 μg/m^3 (New York) to 200.0 μg/m^3 (Virginia) to 250.0 μg/m^3 (North Dakota and South Carolina) to 460.0 μg/m^3 (Connecticut) to 595 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2508; #2556; OSHA Analytical Method 7.

Permissible Concentration in Water: The EPA recommends that levels in lakes and streams should be limited to 8.4 μg/L. *To protect freshwater aquatic life:* 117,000 μg/L, on an acute toxicity basis. *To protect saltwater aquatic life:* 12,900 μg/L, on an acute toxicity basis. *To protect human health:* 5200 μg/L.[6] The state of Kansas has set a guideline of 5200 μg/L for drinking water.[61]

Determination in Water: Methylene chloride extraction followed by exchange to toluene, gas chromatography with flame ionization detection (EPA Method 609) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 1.7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Because of the odor and taste of isophorone, ingestion is not expected unless by accident.

Harmful Effects and Symptoms

Short Term Exposure: Isophorone can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Exposure may cause headaches, nausea, and a drunken feeling. Higher levels can cause you to pass out. Contact can burn the eyes, causing permanent damage. Exposure can irritate the eyes, nose, and throat. Repeated exposure may cause chronic irritation with eye and nasal discharge. Long-term exposure can cause drying and cracking of the skin.

Long Term Exposure: Repeated or prolonged contact will cause dry skin, cracking, dermatitis. May cause chronic irritation of the eyes and nose, with discharge. May cause liver and kidney damage. Many solvents and other similar petroleum-based chemicals have been shown to cause brain or other nerve damage. Some animal studies suggest that isophorone may cause birth defects and slower growth in the offspring of rats and mice that breathed the vapors during pregnancy. These studies found some harmful health effects in adult female animals. High doses fed to male rats caused kidney disease and tumors of the kidney, liver, and lymph and reproductive glands.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the eyes and nose for chronic inflammation, kidney function tests. Liver function tests. Interview for brain effects and refer positive and borderline individuals for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** Responder™ suits. **4 h:** polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 40 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator). *Up to 100 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 200 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isophorone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F. A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada. It falls in Hazard Class "COMBUSTIBLE LIQUID," Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, DHEW (NIOSH) Publication No. 78-173. Washington, DC

US Environmental Protection Agency. (1980). *Isophorone: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 108−110

US Public Health Service. (December 1988). *Toxicological Profile for Isophorone*. Atlanta, GA: Agency for Toxic Substance and Disease Registry

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Isophorone*. Trenton, NJ

Isophorone diisocyanate I:0410

Molecular Formula: $C_{12}H_{18}N_2O_2$

Synonyms: Cyclohexane, 5-isocyanato-1-(isocyanatomethyl)-1,3,3-trimethyl-; Diisocianato de isoforona (Spanish); IPDI; 5-Isocyanato-1-(isocyanatomethyl)-1,3,3-trimethylcyclohexane; 3-Isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate; Isocyanic acid, methylene(3,5,5-trimethyl-3,1-cyclohexylene) ester; Isophorone diamine diisocyanate; Triisocyanatoisocyanurate of isophorone-diisocyanate

CAS Registry Number: 4098-71-9

RTECS® Number: NQ9370000

UN/NA & ERG Number: UN2290/156

EC Number: 223-861-6 [*Annex I Index No.:* 615-008-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23; R36/37/39; R42/43; R51/53; Safety phrases: S1/2; S26; S28; S38; S45; S61.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Isophorone diisocyanate is a colorless to yellowish liquid with a pungent odor. Molecular weight = 222.32; Specific gravity (H_2O:1) = 1.06; Boiling point = 158°C; Freezing/Melting point = −60°C; Vapor pressure = 0.0003 mmHg at 20°C; Flash point = 155°C (cc); Autoignition temperature = 430°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Decomposes in water (soluble).

Potential Exposure: Compound Description: Reproductive Effector. Isophorone diisocyanate is used as a raw material for polyurethane paints, varnishes, and elastomers which are exceptionally stable to atmospheric and chemical attack.

Incompatibilities: Forms explosive mixture with air. Reacts with water, forming carbon dioxide. Reacts with all acids, caustics, ammonia, aliphatic amines, alkanolamines, aromatic amines, amides, alcohols, glycols, caprolactum, oxidizers, phenols, mercaptans, urethanes, ureas. Attacks many metals, plastics, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.09 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.005 ppm/0.045 mg/m^3 TWA; 0.02 ppm/0.18 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.005 ppm/0.045 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.005 ppm

PAC-1: 0.02 ppm

PAC-2: 0.135 ppm

PAC-3: 1.5 ppm

DFG MAK: 0.005 ppm/0.046 mg/m^3 TWA; Peak Limitation Category I(1), a momentary value of 0.01 mL/m^3/0.092 mg/m^3 should not be exceeded; [skin] danger of sensitization of the airways and the skin; Pregnancy Risk Group D.

Austria: MAK 0.01 ppm (0.09 mg/m^3), 1999; Belgium: TWA 0.005 ppm (0.045 mg/m^3), [skin], 1993; Denmark: TWA 0.005 ppm (0.045 mg/m^3), [skin], 1999; France: VME 0.01 ppm (0.09 mg/m^3), VLE 0.02 ppm (0.18 mg/m^3), 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, 2003; Norway: TWA 0.005 ppm (0.045 mg/m^3), 1999; Switzerland: MAK-W 0.01 ppm (0.09 mg/m^3), KZG-W 0.02 ppm (0.18 mg/m3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.005 ppm. Several states have set guidelines or standards for IPDI in ambient air[60] ranging from 0.09 μg/m^3 (Connecticut) to 1.5 μg/m^3 (Virginia) to 9.0 μg/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method #5525; OSHA Analytical Method PV-2034.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the skin and eyes. Permanent eye damage may result. Inhalation can cause coughing, wheezing, shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Isocyanates can cause itching and skin rashes, tearing of the eyes, inflammation of the mucous membrane of the nose, and lung problems. This material is highly toxic by inhalation and moderately toxic through the skin. People with skin or respiratory problems should avoid exposure.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy with itching and skin rash. Isophorone diisocyanate may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Permanent damage to the lungs could also occur. Permanent lung damage may occur, even if no allergic symptoms are noticed.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Viton™ gloves, suits; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.05 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 0.125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.25 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, alcohol, phenols, amines, urethanes, mercaptans, and ureas.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Avoid inhalation. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. *Small fires:* dry chemical, carbon dioxide, water spray, or polymer foam. *Large fires:* water spray, fog, or foam. Poisonous gases, including cyanide, nitrogen oxide, and carbon monoxide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isophorone Diisocyanate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Isophorone Diisocyanate*. Trenton, NJ

Isoprene I:0420

Molecular Formula: C_5H_8

Common Formula: $CH_2{=}C(CH_3)CH{=}CH_2$

Synonyms: 1,3-Butadiene, 2-methyl; Isoprene rubber; Isopreno (Spanish); β-Methylbivinyl; 2-Methyl-1,3-butadiene; 2-Methylbutadiene; (*Z*)-1,4-Polyisoprene rubber; *cis*-1,4-Polyisoprene rubber

CAS Registry Number: 78-79-5; *(alt.)* 78006-92-5

RTECS® Number: NT4037000

UN/NA & ERG Number: UN1218/130

EC Number: 201-143-3 [*Annex I Index No.:* 601-014-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq 1.00\%$ concentration).

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (60); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).
California Proposition 65 Chemical: Cancer 5/1/96.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: F+, T, N; Risk phrases: R45; R12; R68; R50/53; Safety phrases: S53; S45; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*July 27, 2005*).

Description: Isoprene is a colorless liquid with a mild petroleum-like odor. Vapor is heavier than air; will collect in low areas. The odor threshold is 0.005 ppm. Molecular weight = 68.13; Boiling point = 34°C; Freezing/Melting point = −146°C; Flash point = −54°C; Autoignition temperature = 395°C. Explosive limits: LEL = 1.5%; UEL = 8.9%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Isoprene is used in the manufacture of synthetic rubber and in elastomer plastics; in the production of *cis*-1,4-polyisoprene rubber, styrene/isoprene/styrene block polymers.

Incompatibilities: Isoprene is a highly flammable and reactive liquid, and a dangerous fire and explosive hazard. Store under inert atmosphere (preferably nitrogen) with at least 50 ppm *tert*-butylcatechol present as an inhibitor. Forms explosive mixture with air. Air contact forms explosive peroxides; heat, buildup of peroxides; and contact with many materials may cause violent polymerization, with fire or explosion hazard. Violent reaction with oxidizers, strong acids, reducing agents, strong bases, acid chlorides, alcohols, causing fire and explosion hazard. Attacks some paints, rubber, and coatings. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air
AIHA WEEL: 2 ppm TWA.
Protective Action Criteria (PAC)
TEEL-0: 2 ppm
PAC-1: 5 ppm
PAC-2: 1000 ppm
PAC-3: 4000 ppm
DFG MAK: 3 ppm/8.5 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group C; Germ Cell Mutagen Category 5; Carcinogen Category 5.
Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 300 mg/m^3, 1999; Russia: STEL 40 mg/m^3, 1993. Russia has set[35] a MAC of 0.04 mg/m^3 in ambient air in residential areas on a once-daily basis.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.005 mg/L in water bodies used for domestic purposes and 0.01 mg/L in surface water used for fishery purposes.

Routes of Entry: Inhalation, eyes and/or skin.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, skin, and respiratory tract. Contact irritates the eyes and skin. Higher levels can affect the central nervous system and cause dizziness, lightheadedness, confusion, and unconsciousness.

Long Term Exposure: Lungs may be affected by repeated or prolonged exposure; bronchitis may develop. There is limited evidence that isoprene can cause cancer of the testes in animals, in high concentrations. This substance is possibly carcinogenic to humans. High exposures may affect blood cells.

Points of Attack: Lungs, blood cells.

Medical Surveillance: Lung function tests, complete blood count (CBC), consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to isoprene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isoprene must be stored to avoid contact with strong acids (such as chlorosulfonic, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, flame, and oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where isoprene is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of isoprene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment especially when opening and closing containers of isoprene. Wherever isoprene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Isoprene, inhibited, requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable and reactive liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 74–76

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Isoprene.* Trenton, NJ

Isopropanolamine dodecylbenzene sulfonate I:0430

Molecular Formula: $C_{18}H_{30}O_3S \cdot C_3H_9NO$

Synonyms: Benzenesulfonic acid, 4-dodecyl-, compound with 1-amino-2-propanol (1:1); Isopropanolamine salt of dodecylbenzenesulfonate

CAS Registry Number: 42504-46-1

UN/NA & ERG Number: UN3077/171

EC Number: 255-854-9

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isopropanolamine dodecylbenzene sulfonate is a colorless solid. Molecular weight 385.5; 401.61; Vapor pressure = 13–15 mmHg at 20°C; Flash point = >149°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used as a surface active ingredient in soaps and detergents; in the fragrance industry.

Incompatibilities: May act as a base and react with acids. May react with strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Can irritate and burn the eyes and skin on contact. Inhalation can cause irritation of the nose and throat with coughing and wheezing.

Long Term Exposure: Unknown at this time.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Isopropanolamine Dodecylbenzenesulfonate*. Trenton, NJ

2-Isopropoxyethanol I:0440

Molecular Formula: $C_5H_{12}O_2$

Synonyms: Dowanol Eipat; Ethanol, isopropoxy-; Ethylene glycol isopropyl ether; Ethylene glycol, monoisopropyl ether; β-Hydroxyethyl isopropyl ether; IPE; Isopropoxyethanol; Isopropyl cellosolve; Isopropyl glycol; Isopropyloxitol; 2-(1-Methylethoxy)ethanol; Monoisopropyl ether of ethylene glycol

CAS Registry Number: 109-59-1

RTECS® Number: KL5075000

UN/NA & ERG Number: UN1987 (alcohols, n.o.s.)/127

EC Number: 203-685-6 [*Annex I Index No.:* 603-013-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol $R-(OCH_2CH_2)_n-OR'$ where $n = 12$ or 3; $R =$ alkyl or aryl groups; $R' = R$, H, or groups which when removed, yield glycol ethers with the structure: $R-(OCH_2CH)_n-OH$. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. R—$(OCH_2CH_2)_n$—OR′; Where $n = 12$ or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; R′ + H, or alkyl C7 or less; or OR′ consisting of carboxylic ester, sulfate, phosphate, nitrate, or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/21; R36; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isopropoxyethanol is a clear, colorless liquid with an ethereal odor. Molecular weight = 104.14; Specific gravity (H_2O:1) = 0.9; Boiling point = 139.4°C. Vapor pressure = 3 mmHg at 20°C; Flash point = 33°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Used in lacquers and other coatings; and as a solvent for resins, dyes, and textiles.

Incompatibilities: Forms explosive mixture with air. Contact with oxidizers can cause a fire or explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None established; See *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV®[1]: 25 ppm/106 gm/m^3 TWA [skin].

No TEEL available.

DFG MAK: 5 ppm/22 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group C.

Australia: TWA 25 ppm (105 mg/m^3), 1993; Austria: MAK 5 ppm (22 mg/m^3), [skin], 1999; Belgium: TWA 25 ppm (106 mg/m^3), 1993; Denmark: TWA 25 ppm (105 mg/m^3), 1999; France: VME 25 ppm (105 mg/m^3), 1999; Norway: TWA 20 ppm (80 mg/m^3), 1999; the Netherlands: MAC-TGG 44 mg/m^3, 2003; MAC-TGG 44 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm [skin].

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate and burn the eyes and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposure through skin contact or inhalation can cause severe damage to the kidneys, blood, and liver. This can cause bloody urine and death.

Long Term Exposure: Exposure can cause anemia. Prolonged contact can degrease and irritate the skin. Very irritating substances, such as IPE, may affect the lungs.

Points of Attack: Eyes, skin, respiratory system, blood.

Medical Surveillance: Lung function tests. Liver and kidney function tests. Complete blood count (CBC). Urinalysis. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24—48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. The use of alcoholic beverages may enhance the toxic effect.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Alcohols, flammable, toxic, n.o.s. require a label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." This compound falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Isopropoxyethanol*. Trenton, NJ

Isopropyl acetate I:0450

Molecular Formula: $C_5H_{10}O_2$

Common Formula: $CH_3COOCH(CH_3)_2$

Synonyms: Isopropylacetat (German); Isopropyl (acetate d') (French); Isopropyl ester of acetic acid; 1-Methylethyl acetate; 1-Methylethyl ester of acetic acid; *sec*-Propyl acetate; 2-Propyl acetate

CAS Registry Number: 108-21-4

RTECS® Number: AI4930000

UN/NA & ERG Number: UN1220/129

EC Number: 203-561-1 [*Annex I Index No.:* 607-024-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; R36; R66; R67; Safety phrases: S2; S16; S26; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isopropyl acetate is a colorless liquid with a fruity odor. The odor threshold = 4.1 ppm. Molecular weight = 102.15; Specific gravity (H_2O:1) = 0.87; Boiling point = 90°C; Freezing/Melting point = −68.8°C; Vapor pressure = 42 mmHg at 20°C; Flash point = 2.2°C; Autoignition temperature = 460°C. Explosive limits: LEL = 1.8% at 38°C; UEL = 8.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Moderately soluble in water; solubility = 3%.

Potential Exposure: Compound Description: Human Data; Primary Irritant. This material is used as an organic solvent for nitrocellulose and other resins, fats, oils, waxes, and gums. It is used in synthetic perfumes and food flavorings.

Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers may cause fire and explosions. Incompatible with strong acids, caustics, nitrates. Dissolves rubber and many plastic materials. Contact with steel may cause slow decomposition. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 250 ppm/950 mg/m^3 TWA.

NIOSH REL: None established; See Appendix D of the *NIOSH Pocket Guide.*

ACGIH TLV®[1]: 100 ppm/418 mg/m^3 TWA; 200 ppm/950 mg/m^3 STEL (2001).

NIOSH IDLH: 1800 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 200 ppm

PAC-2: 200 ppm

PAC-3: 1800 ppm

DFG MAK: 100 ppm/420 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.
Australia; TWA 200 ppm (950 mg/m^3); STEL 310 ppm, 1993; Austria: MAK 200 ppm (840 mg/m^3), 1999; Belgium: TWA 250 ppm (1040 mg/m^3); STEL 310 ppm (1290 mg/m^3), 1993; Denmark: TWA 150 ppm (625 mg/m^3), 1999; France: VME 250 ppm (950 mg/m^3), VLE 300 ppm (1140 mg/m^3), 1999; Hungary: TWA 400 mg/m^3; STEL 800 mg/m^3, 1993; Norway: TWA 100 ppm (240 mg/m^3), 1999; the Philippines; TWA 250 ppm (950 mg/m^3), 1993; Switzerland: MAK-W 200 ppm (840 mg/m^3), KZG-W 400 ppm (1680 mg/m^3), 1999; United Kingdom: STEL 200 ppm (849 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 310 ppm. Several states have set guidelines or standards for isopropyl acetate in ambient air[60] ranging from 1.4 mg/m^3 (Massachusetts) to 3.3 mg/m^3 (New York) to 9.5−11.85 mg/m^3 (North Dakota) to 16.0 mg/m^3 (Virginia) to 19.0 mg/m^3 (Connecticut) to 22.619 mg/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #1454, #1460; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Health effects can occur below the legal exposure limit. Eye contact can cause severe irritation or burns. The vapors can cause eye, nose, and throat irritation. Coughing and chest tightness can also occur. Higher levels cause headaches, drowsiness, poor coordination, and passing out. Ingestion may cause chemical pneumonitis.

Long Term Exposure: Repeated exposure can cause dry, cracking skin and may damage the liver. Can irritate the lungs and may cause bronchitis to develop. Although this chemical has not been adequately evaluated, many solvents and similar petroleum-based chemicals have been shown to cause brain or other nerve damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests; evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1800 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from nitrates and strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric) and strong alkalis. Sources of ignition, such as smoking and open flames, are prohibited where isopropyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of isopropyl acetate should be grounded and bonded.

Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropyl acetate.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 68−69

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Isopropyl Acetate*. Trenton, NJ

Isopropyl alcohol I:0460

Molecular Formula: C_3H_8O

Common Formula: $CH_3CHOHCH_3$

Synonyms: Alcohol isopropilico (Spanish); Alcojel; Alcool isopropylique (French); Alcosolve 2; Alcowipe; Avantin; Avantine; Combi-Schutz; Dimethylcarbinol; Hartosol; 2-Hydroxypropane; Imsol A; IPA; I.P.S.; Isohol; Isopropanol; Lutosol; Petrohol; PRO; *i*-Propanol; *n*-Propan-2-ol; 2-Propanol; Propan-2-ol; Propol; *sec*-Propyl alcohol; 2-Propyl alcohol; *i*-Propylalkohol (German); *iso*-Propylalkohol (German); Sasetone; Spectrar; Sterisol hand disinfectant; Takineocol

CAS Registry Number: 67-63-0; *(alt.)* 8013-70-5

RTECS® Number: NT8050000

UN/NA & ERG Number: UN1219/129

EC Number: 200-661-7 [*Annex I Index No.:* 603-117-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE; *N. crassa—aneuploidy*.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 (reportable if being manufactured by the strong process only; no supplier notification).

Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36; R67; Safety phrases: S2; S7; S16; S24/25; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isopropyl alcohol is a flammable liquid with a slight odor resembling that of a mixture of ethanol and acetone. The odor threshold is 22 ppm. Molecular weight = 60.11; Specific gravity (H_2O:1) = 0.79; Boiling point = 82.5°C; Freezing/Melting point = − 90°C; Vapor pressure = 33 mmHg at 20°C; Flash point = 12°C; Autoignition temperature = 399°C. Explosive limits: LEL = 2.0%; UEL = 12.7% at 93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Isopropyl alcohol is a chemical widely used as an analytical reagent and to manufacture acetone, glycerol, and isopropyl acetate; in liniments, skin lotions, cosmetics, permanent wave preparations; pharmaceuticals and hair tonics. It is also employed as a solvent in perfumes, in extraction processes; as a preservative; in lacquer formulations; and in many dye solutions. In addition, it has been employed as an ingredient of antifreezes, soaps, and window cleaners. It may also be used as a raw material for the manufacture of various isopropyl derivatives, such as pesticides.

Incompatibilities: Forms explosive mixture with air. Incompatible with alkaline earth and alkali metals, crotonaldehyde, phosgene, strong acids, amines, ammonia, caustics, strong oxidizers. Attacks some plastics, rubber, and coatings. Reacts with metallic aluminum at high temperatures.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.46 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 400 ppm/980 mg/m^3.

NIOSH REL: 400 ppm/980 mg/m^3 TWA: 500 ppm/1225 mg/m^3 STEL.

ACGIH TLV®[1]: 200 ppm TWA; 400 ppm STEL; not classifiable as a human carcinogen (2001).

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 400 ppm

PAC-1: 400 ppm

PAC-2: 400 ppm

PAC-3: 2000 ppm

DFG MAK: 200 ppm/500 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C; BAT 50 mg[acetone]/L blood/end-of-shift; 50 mg[acetone]/L urine/end-of-shift; Pregnancy Risk Group C.

Australia: TWA 400 ppm (980 mg/m^3); STEL 500 ppm, 1993; Austria: MAK 400 ppm (980 mg/m^3), 1999; Belgium: TWA 400 ppm (985 mg/m^3); STEL 500 ppm, 1993; Denmark: TWA 200 ppm (490 mg/m^3), 1999; France: VLE 400 ppm, 1999; Japan: STEL 400 ppm (980 mg/m^3), 1999; the Netherlands: MAC-TGG 650 mg/m^3, 2003; the Philippines: TWA 400 ppm (980 mg/m^3), 1993; Poland; MAC (TWA) 900 mg/m^3, MAC (STEL) 1200 mg/m^3, 1999; Russia: STEL 400 ppm (10 mg/m^3), 1993; Sweden: NGV 150 ppm (350 mg/m^3), KTV 250 ppm (600 mg/m^3), 1999; Switzerland: MAK-W 400 ppm (980 mg/m^3), KZG-W 800 ppm (1960 mg/m^3), 1999; Turkey: TWA 200 ppm (500 mg/m^3), 1993; United Kingdom: TWA 400 ppm (999 mg/m^3); STEL 500 ppm (1250 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 500 ppm. Russia[43] has set a MAC value of 0.6 mg/m^3 in the ambient air of residential areas both on a momentary and on a daily average basis. Several states have set guidelines or standards for isopropanol in ambient air[60] ranging from 3.267 mg/m^3 (New York) to 9.8 mg/m^3 (Florida) to 9.8−12.25 mg/m^3 mg/m^3 (North Dakota) to 16.5 mg/m^3 (Virginia) to 19.6 mg/m^3 (Connecticut and South Dakota) to 23.333 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with 2-butanol in CS$_2$, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1400.[18]

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 13,500 μg/L based on health effects. Russia[43] set a MAC of 0.25 mg/L in water bodies used for domestic purposes. Maryland[61] has set a guideline of 3.0 mg/L for isopropanol in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Isopropyl alcohol irritates the eyes, skin, and respiratory tract. *Inhalation:* Irritation of the nose and throat may occur at 400 ppm and above. *Skin:* 5% solution may cause irritation and dryness. *Eyes:* Vapor levels of 20 ppm or above may result in irritation. Liquid may cause corneal burns and eye damage. *Ingestion:* 22.5 mL (2/3 oz) has caused salivation, reddening of face, stomach pain, depression, dizziness, headache, vomiting, and unconsciousness. Ingestion of 100 mL (3 oz) has caused death.

Long Term Exposure: Repeated or prolonged contact may cause dry, cracking skin. There is an increased incidence of nasal sinus cancer in workers involved in the manufacture of IPA by the strong acid process. Although this chemical has not been adequately evaluated, many solvents and similar petroleum-based chemicals have been shown to cause brain or other nerve damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite). Also, NIOSH recommends that workers subject to isopropyl alcohol exposure have comprehensive preplacement medical examinations. Periodic medical examinations shall be made available on an annual basis. Particular attention will be given in these medical examinations to the skin sinuses, and respiratory system. Isopropyl alcohol and its metabolite, acetone, may be detected in blood, urine, and body tissues. Evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves, CPF3™ suits; Responder™ suits. **4 h:** Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/

clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full-face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isopropyl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where isopropyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of isopropyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropyl alcohol.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Isopropyl Alcohol*, NIOSH Document No. 76-142

US Environmental Protection Agency. (December 29, 1977). *Chemical Hazard Information Profile: Isopropyl Alcohol*. Washington, DC, also revised edition (1979)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Isopropyl Alcohol*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration,*

Reregistration, and Special Review (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Isopropyl Alcohol*. Trenton, NJ

Isopropylamine I:0470

Molecular Formula: C_3H_9N

Common Formula: $(CH_3)_2CHNH_2$

Synonyms: 1-Amino-2-hydroxypropane; 2-Aminopropane; 1-Amino-propanol-2; 2-Amonopropan (German); 2-Hydroxypropylamine; Isopropilamina (Spanish); Isopropyl amine; 1-Methylethylamine; Monoisopropylamine; 2-Propanamine; *sec*-Propylamine

CAS Registry Number: 75-31-0

RTECS® Number: NT8400000

UN/NA & ERG Number: UN1221/132

EC Number: 200-860-9 [*Annex I Index No.:* 612-007-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

NTP: Carcinogenesis studies; selected, October 2000.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xi; Risk phrases: R12; R36/37/38; Safety phrases: S2; S16; S26; S29 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Isopropylamine is a colorless liquid with a pungent ammonia-like odor. A gas above the boiling point. The odor threshold is 0.21 ppm. Molecular weight = 59.13; Specific gravity (H_2O:1) = 0.69; Boiling point = 34.4°C; Freezing/Melting point = −101°C; Vapor pressure = 460 mmHg at 20°C; Flash point = −37°C; Autoignition temperature = 402°C. Explosive limits: LEL = 2.0%; UEL = 10.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Primary Irritant. Isopropyl amine is used to produce rubber accelerators, oil-soluble emulsifiers; in the synthesis of pharmaceuticals, pesticides, dyes, and surface active agents.

Incompatibilities: Forms explosive mixture with air. A strong base. Reacts with alkali metals, alkaline earth, acid anhydrides, acid chlorides. Reacts violently with strong oxidizers (fire and explosions), strong acids (explosive spattering), nitroparaffins, halogenated hydrocarbon, aldehydes, ketones, epoxides, and many other substances. Attacks some plastics, rubber, and coatings. Attacks copper and its compounds, lead, zinc, tin.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.42 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/12 mg/m^3 TWA.

NIOSH REL: None established; See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV®[1]: 5 ppm/12 mg/m^3 TWA; 10 ppm/24 mg/m^3 STEL.

NIOSH IDLH: 750 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 10 ppm

PAC-2: 150 ppm

PAC-3: 750 ppm

DFG MAK: 5 ppm/12 mg/m^3 TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/25 mg/m^3 should not be exceeded; Pregnancy Risk Group C.

Australia: TWA 5 ppm (12 mg/m^3); STEL 10 ppm, 1993; Austria: MAK 5 ppm (12 mg/m^3), 1999; Belgium: TWA 5 ppm (12 mg/m^3); STEL 10 ppm (24 mg/m^3), 1993; Denmark: TWA 5 ppm (12 mg/m^3), 1999; France: VME 5 ppm (12 mg/m^3), 1999; the Netherlands: MAC-TGG 12 mg/m^3, 2003; Norway: TWA 5 ppm (12 mg/m^3), 1999; Poland: MAC (TWA) 12 mg/m^3, MAC (STEL) 24 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: TWA 5 ppm (12 mg/m^3); STEL 10 ppm (25 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (12 mg/m^3), KZG-W 10 ppm (24 mg/m^3), 1999; Turkey: TWA 5 ppm (12 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm. The OSHA PEL is 5 ppm TWA. NIOSH, the DFG MAK[3] and the ACGIH[1] TWA value is 5 ppm (12 mg/m^3) and the STEL is 10 ppm (24 mg/m^3). Russia[43] set a MAC of 1.0 mg/m^3 in work-place air and Russia set a MAC value of 0.01 mg/m^3 for ambient air in residential areas. Several states have set guidelines or standards for monoisopropylamine in ambient air[60] ranging from 40 μg/m^3 (New York) to 120 μg/m^3 (Florida) to 120−240 μg/m^3 (Nevada) to 300 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH II(3), Method #S147.

Permissible Concentration in Water: Russia[35,43] set a MAC of 2.0 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Isopropylamine is corrosive to the eyes, skin, and respiratory tract. Contact with the liquid or vapor can cause severe burns of the eyes and skin; can cause blurred vision or seeing halos around lights, with loss of vision and scarring. Corrosive on ingestion. Swallowing the liquid may cause chemical pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated or prolonged contact can cause thickening and cracking of the skin. Repeated exposure can cause loss of vision and scarring. Can irritate the lungs and may cause bronchitis.

Points of Attack: Lungs, eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, examination of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 h:** Tychem 1000™ suits. **4 h:** Teflon™ gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *250 ppm:* CcrFS (APF = 50) [any air-purifying full-face-piece respirator equipped with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *750 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isopropylamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where isopropylamine is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of isopropylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropylamine. Wherever isopropylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Isopropylamine will attack some forms of plastics, rubber, and coatings.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID, CORROSIVE.” It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and hydrogen cyanide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

Reference

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Isopropylamine*. Trenton, NJ

N-Isopropyl aniline I:0480

Molecular Formula: $C_9H_{13}N$

Common Formula: $C_6H_5NHCH(CH_3)_2$

Synonyms: Aniline, *o*-isopropyl-; Benzenamine, *N*-(1-methylethyl)-; 2-Isopropyl aniline; Isopropylaniline; *N*-(1-Methylethyl)-benzenamine; *N*-IPA; *N*-Phenylisopropylamine

CAS Registry Number: 768-52-5

RTECS® Number: BY4200000

UN/NA & ERG Number: UN2810/Guide 153

EC Number: 212-196-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isopropyl aniline is a yellowish liquid with a sweet, aromatic odor. Molecular weight = 135.23; Specific gravity (H_2O:1) = 0.93 at 15.6°C; Boiling point = 202.6°C; Freezing/Melting point = −50°C; Vapor pressure = 0.03 mmHg at 20°C; Flash point = 87.7°C. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. *N*-isopropyl aniline is used in the dyeing of acrylic fibers and as a chemical intermediate.

Incompatibilities: Strong oxidizers; strong acids.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.53 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 2 ppm/10 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/11 mg/m^3 TWA [skin]; BEI$_M$ issued for Methemoglobin inducers.

No TEEL available.

Australia: TWA 2 ppm (10 mg/m^3), [skin], 1993; Belgium: TWA 2 ppm (11 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (10 mg/m^3), [skin], 1999; France: VME 2 ppm (10 mg/m^3), [skin], 1999; Norway: TWA 2 ppm (11 mg/m^3), 1999; Switzerland: MAK-W 2 ppm (11 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 10 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin]. North Dakota has set a standard for *N*-Isopropyl aniline in ambient air or 100 μg/m^3.[60]

Determination in Air: Use OSHA Analytical Method 78.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *N*-Isopropyl aniline reduces the blood's ability to supply oxygen to the body, resulting in the formation of methemoglobin. Exposure can cause cyanosis (the lips, ears, and other skin areas turn blue). The effects may be delayed. It can also cause headaches and lightheadedness. High exposures can cause trouble breathing, collapse, and even death. Contact may irritate the eyes and skin.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated high exposures may cause headaches, dizziness, poor appetite, and anemia.

Points of Attack: Eyes, skin, respiratory system, blood, cardiovascular system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation recommended.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic, liquids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. *Do not use water.* Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2006). *Hazardous Substances Fact Sheet: N-Isopropylaniline*. Trenton, NJ

Isopropyl chloroformate I:0490

Molecular Formula: $C_4H_7ClO_2$

Common Formula: $(CH_3)_2CHOOCCl$

Synonyms: Carbonochloride acid 1-methyl ester; Carbonochloridic acid, 1-methylethyl ester; Chloroformic acid isopropyl ester; Cloruro de isopropilo (Spanish); Isopropyl chlorocarbonate; Isopropyl chloromethanoate

CAS Registry Number: 108-23-6

RTECS® Number: LQ6475000

UN/NA & ERG Number: UN2407/155

EC Number: 203-563-2

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 ($\geq$ 1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isopropyl chloroformate is a highly flammable, clear, colorless liquid with a pungent odor. Molecular weight = 122.56; Boiling point = 105°C; Flash point = 28°C (oc); Autoignition temperature ≥ 500°C. Explosive limits: LEL = 4%; UEL = 15%. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. Isopropyl chloroformate is used as an intermediate for free-radical polymerization initiators and in organic synthesis.

Incompatibilities: Decomposes slowly in cold water and above 20°C. Store under refrigeration. Contact with iron salts may cause explosive thermal decomposition. Incompatible with oxidizers, metal salts, acids, alkalis, amines, alcohols.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*
TEEL-0: 0.15 ppm
PAC-1: 0.4 ppm
PAC-2: **3.3** ppm
PAC-3: **10** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Netherlands: MAC-TGG 5 mg/m^3, 2003; Russia: STEL 0.1 mg/m^3, 1993; United Kingdom: TWA 1 ppm (5.1 mg/m^3), 2000.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: A phosgene derivative. Inhalation exposures at elevated concentrations cause death by immediate lung damage; lower concentrations cause difficult breathing, collapse, and convulsions. Can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation of material may cause death or permanent injury. Eye irritations, irritation of upper respiratory tract, and surface burns have been observed. Eye irritation may persist after exposure ceases, and skin sensitization may occur. Ingestion can be fatal.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in refrigeration, below 20°C. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, iron salts, acids, alkalis, amines, alcohols. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

In case of spills or leaks, shut off ignition sources and keep away flares, smoke, or flames. Do not touch spilled material. Use water to reduce vapors but do not get water inside containers. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. For *large spills*, dike far ahead of spill for later disposal.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (*from a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.2/0.3

Large spills (*from a large package or from many small packages*)

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day	0.5/0.8
Night	0.9/1.5

Fire Extinguishing: This chemical is a flammable liquid. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind and keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Vapor explosion hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. *See above for isolation distances.* Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers exposed to flame with water until well after fire is out. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (June 2002). *Chemical Hazard Information Profile: Isopropyl Chloroformate*. Washington, DC: Chemical Emergency Preparedness Program

Isopropyl formate I:0500

Molecular Formula: $C_4H_8O_2$

Common Formula: $HCOOCH(CH_3)_2$

Synonyms: Formic acid, isopropyl ester; Isopropyl methanoate

CAS Registry Number: 625-55-8

RTECS® Number: LQ8750000

UN/NA & ERG Number: UN1281/129

EC Number: 210-901-2 [*Annex I Index No.:* 607-016-00-2]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36/37; R67; Safety phrases: S2; S9; S16; S24; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Isopropyl formate is a clear liquid with a pleasant odor. Molecular weight = 88.11; Boiling point = 67°C; Flash point = − 6°C (cc); Autoignition temperature = 485°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1.

Potential Exposure: Used as a fumigant and in organic synthesis.

Incompatibilities: Oxidizing materials.

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation of vapor can cause irritation of eyes and nose. High concentrations can cause unconsciousness in a few minutes, with death within a few hours. Contact with liquid formic acid, isopropyl ester can cause irritation of eyes and skin. Ingestion can result in irritation of the mouth and stomach, with loss of consciousness and death occurring if untreated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Propyl formates require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Isopropyl Formate*. Washington, DC: Chemical Emergency Preparedness Program

Isopropyl glycidyl ether I:0510

Molecular Formula: $C_6H_{12}O_2$

Common Formula: $CH_2-(O)-CH-CH_2-O-CH(CH_3)_2$

Synonyms: 1,2-Epoxy-3-isopropoxypropane; Glycidyl isopropyl ether; IGE; Isopropil glicidil eter (Spanish); Isopropyl epoxypropyl ether; (Isoproxymethyl)oxirane; NCI-C56439; Oxyde de 2,3-epoxypropyle et d'isopropyle (French)

CAS Registry Number: 4016-14-2

RTECS® Number: TZ3500000

UN/NA & ERG Number: UN1993/128

EC Number: 223-672-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: DFG Carcinogen Category 3 (suspected).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as glycol ethers.

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% as glycol ethers.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: IGE is a colorless liquid. Molecular weight = 116.18; Specific gravity (H_2O:1) = 0.92; Boiling point = 137.2°C; Vapor pressure = 9 mmHg at 25°C; Flash point = 33.3°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 1. Soluble in water; solubility = 19%.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. IGE is used as a reactive diluent for epoxy resins; as a stabilizer for organic compounds; and as an intermediate for the synthesis of ethers and esters.

Incompatibilities: Forms explosive mixture with air. Contact with moist air and light can form explosive polymerization. Contact with caustics can cause explosive polymerization. Oxidizers can cause fire and explosion hazard. Attacks some rubbers and plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.75 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/240 mg/m^3 TWA.

NIOSH REL: 50 ppm/240 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 50 ppm/238 mg/m^3 TWA; 75 ppm/356 mg/m^3 STEL.

NIOSH IDLH: 400 ppm.

No TEEL available.

DFG MAK: Carcinogen Category 3B.

Australia: TWA 50 ppm (240 mg/m^3); STEL 75 ppm, 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (238 mg/m^3); STEL 75 ppm (356 mg/m^3), 1993; Denmark: TWA 50 ppm (240 mg/m^3), 1999; Finland: STEL 50 ppm (240 mg/m^3), 1999; France: VME 50 ppm (240 mg/m^3), 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Switzerland: MAK-W 50 ppm (240 mg/m^3), KZG-W 100 ppm (480 mg/m^3), 1999; Turkey: TWA 30 ppm (240 mg/m^3), 1993; United Kingdom: TWA 50 ppm (241 mg/m^3); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 75 ppm. Several states have set guidelines or standards for IGE in ambient air[60] ranging from 2.4 mg/m^3 (Connecticut) to 2.4−3.6 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 5.714 mg/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #1620, Isopropyl glycidyl ether; OSHA Analytical Method 7.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.48.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system, causing headache, dizziness, and loss of consciousness.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization. Lungs may be affected by inhalation of high concentrations of the vapor, and may cause bronchitis. Possible hematopoietic effects.

Points of Attack: Eyes, skin, respiratory system, blood, reproductive system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood count. Pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in an explosion-proof refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: Flammable liquid n.o.s. require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Glycidyl Ethers*, Report PB-276, 678. Rockville, MD, pp. 116–123

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers*, NIOSH Document No. 78-166. Washington, DC

Isopropyl isocyanate I:0520

Molecular Formula: C_4H_7NO
Common Formula: $(CH_3)_2CHNCO$
Synonyms: 2-Isocyanatopropane; Propane, 2-isocyanato
CAS Registry Number: 1795-48-8
RTECS® Number: NQ9230000
UN/NA & ERG Number: UN2483/155
EC Number: 217-276-5
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Isopropyl isocyanate is a colorless liquid with a strong odor. Molecular weight = 85.10; Boiling point = 73°C; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Flash point = − 10°C. Insoluble in water.
Potential Exposure: Isopropyl isocyanate is used in making other chemicals and pesticides.
Incompatibilities: Forms explosive mixture with air. Reacts with acetaldehyde, alcohols, oxidizers.
Permissible Exposure Limits in Air
Isocyanate-bearing waste (as CNs, n.o.s.)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3
Routes of Entry: Inhalation, passing through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Although little is known about the health effects of isopropyl isocyanate, similar chemicals can cause severe irritation of the eyes, skin, nose, throat, and lungs; and cause lung allergy to develop. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.
Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this

chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where isopropyl isocyanate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropyl isocyanate.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

UN 2483 (Isopropyl isocyanate) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water*: Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Isopropyl Isocyanate*. Trenton, NJ

K

Kerosene K:0100

Synonyms: Coal Oil; Deobase; Fuel oil No. 1; Illuminating oil; Jet fuel JP-1; Lamp oil; Light petroleum; Range oil; Straight run kerosene

CAS Registry Number: 8008-20-6

RTECS® Number: OA5500000

UN/NA & ERG Number: UN1223/128

EC Number: 232-366-4 [*Annex I Index No.*: 650-001-02-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (as jet fuel): Animal Limited Evidence, Group 3, 1989.

FDA—over-the-counter drug (8008-20-6).

US EPA, FIFRA 1998 Status of Pesticides: Canceled (8008-20-6).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R65; Safety phrases: S2; S23; S24; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Kerosene is a pale yellow or clear, mobile liquid, composed of a mixture of petroleum distillates, having a characteristic odor. The odor threshold is 0.6 mg/m^3. The taste threshold is 0.1 mg/L in water.[59] A refined petroleum solvent (predominantly C9–C16), which typically is 25% normal paraffins, 11% branched paraffins, 30% monocycloparaffins, 12% dicycloparaffins, 1% tricycloparaffins, 16% mononuclear aromatics, and 5% dinuclear aromatics. Molecular weight = 170 (approx.); Specific gravity (H_2O:1) = 0.81; Boiling point = 175–325°C; Freezing/Melting point = −23°C; Vapor pressure = 5 mmHg at 37.8°C; Flash point = 35–72°C; Autoignition temperature = 210–220°C. Explosive limits: LEL = 0.7%; UEL = 5.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant; (petroleum, hydrotreated) Tumorigen. Kerosene is used as a fuel for lamps, stoves, jets, and rockets. It is also used for degreasing and cleaning metals and as a vehicle for insecticides. Jet fuels JP-5 and JP-8 are used as aircraft fuels by the military. JP-8 is the primary jet fuel used by the US Navy and Air Force. Kerosene is the primary component of both JP-5 and JP-8.

Incompatibilities: Explosive mixture in air. Oxidizers may cause fire and explosion hazard. Incompatible with nitric acid. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: None, but both OSHA and the Air Force Office of Safety and Health have set an exposure limit of 400 mg/m^3 of petroleum product for an 8-h workday, 40-h workweek.

NIOSH REL: 100 mg/m^3 TWA.

ACGIH TLV®[1]: 200 mg/m^3 TWA [skin] avoid prolonged and repeated skin contact; may be associated with an increase in skin cancer.

Protective Action Criteria (PAC)*

TEEL-0: 200 mg/m^3

PAC-1: **290** mg/m^3

PAC-2: **1100** mg/m^3

PAC-3: 1100 mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 300 mg/m^3, 1999; Russia[43] set a MAC of 300 mg/m^3 in work-place air.

Determination in Air: Use NIOSH Analytical Method (IV) #1550, Naphthas.

Permissible Concentration in Water: MAC concentrations in water bodies used for domestic purposes ranging from 0.10 mg/L have been set by Russia.[43] New Jersey[59] has declined to set a maximum contaminant level for kerosene in water because of its variable composition.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) > 500 mg/kg. Slightly irritates the skin and respiratory tract. *Inhalation:* Does not evaporate fast enough to cause health effects except when heated or in enclosed spaces. Headache, tiredness, stupor, dizziness, nausea, coma, and death may occur with increasing exposure. *Skin:* If not promptly removed, may cause reddening, blisters, itching, and an increased risk of infection. *Eyes:* Irritation may occur. *Ingestion:* Accidental ingestion of unknown amounts has caused irritation of mouth, throat, and stomach, nausea, vomiting, rapid breathing, blue skin coloration, and convulsions. Death may result from as little as 1-fluid ounce. Inhalation into lungs following ingestion may result in bronchitis, chemical pneumonia, accumulation of fluid and blood in lungs, and death. As little as 1/30 oz may be fatal in this way.

Long Term Exposure: Repeated or prolonged skin contact may cause defatting, itching, and rash. Absorption through skin is slow but repeated skin contact over many years has caused muscular weakness, anemia, changes in white blood cells, fever, and death. Can irritate the lungs; bronchitis may develop. May cause kidney damage. A study on the use of kerosene stoves found an increase in oral cancer in humans who used kerosene stoves. Skin tumors were seen in mice when their skin was exposed to jet fuel JP-5 for 60 weeks.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00010-2

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h:** nitrile rubber gloves, suits, boots; polyethylene gloves, suits, boots; Viton™ gloves, suits. **4 h:** Neoprene™ rubber gloves, suits, boots; polyvinyl alcohol gloves; polyvinyl chloride gloves, suits, boots; Barricade™ coated suits; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol, nitrile, and nitrile + PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1000 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *2500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *5000 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Kerosene requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Spray into furnace after mixing with a more flammable solvent.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Refined Petroleum*, NIOSH Document No. 77-192. Washington, DC

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Kerosene*. Albany, NY: Bureau of Toxic Substance Assessment

US Department of Health and Human Services. (August 1999). *ATSDR ToxFAQs, Jet Fuels JP-5 and JP-8*. Atlanta, GA

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Kerosene*. Trenton, NJ

Ketene K:0110

Molecular Formula: C_2H_2O

Common Formula: $H_2C{=}C{=}O$

Synonyms: Carbomethene; Ethenone; Keto-ethylene

CAS Registry Number: 463-51-4

RTECS® Number: OA7700000

EC Number: 207-336-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Ketene is a flammable, colorless gas with a sharp, disagreeable odor. Molecular weight = 42.04; Boiling point = −54.4°C; Freezing/Melting point = −148.3°C; Relative vapor density (air = 1): 1.45; Vapor pressure = <1 atm. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 3. Reacts with water.

Potential Exposure: Ketene is used as an acetylating agent in cellulose acetate and aspirin manufacture; it is used in the conversion of higher acids to their anhydrides; in the production of spices, acetic anhydride, diethylamino gestrinone; ethyl acetate; ethyl acetoacetate; sorbic acid; vitamin A.

Incompatibilities: Forms an explosive mixture with air. Ketene readily polymerizes. Decomposes in water, alcohol, and ammonia. Reacts with water to form acetic acid. Contact with hydrogen peroxide forms explosive diacetyl peroxide. Reacts violently with reducing agents, oxidizers, and many organic compounds. Can dimerize to diketene even at low temperatures. Diketene forms an explosive mixture with air.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.72 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.5 ppm/0.9 mg/m^3 TWA.

NIOSH REL: 0.5 ppm/0.9 mg/m^3 TWA; 1.5 ppm/3 mg/m^3 STEL.

ACGIH TLV®[1]: 0.5 ppm/0.86 mg/m^3 TWA; 1.5 ppm/2.6 mg/m^3 STEL.

NIOSH IDLH: 5 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.19 ppm

PAC-1: 0.19 ppm

PAC-2: 0.66 ppm

PAC-3: 2 ppm

Arab Republic of Egypt: TWA 0.5 ppm (0.9 mg/m^3), 1993; Australia: TWA 0.5 ppm (0.9 mg/m^3); STEL 1.5 ppm, 1993; Austria: MAK 0.5 ppm (0.9 mg/m^3), 1999; Belgium: TWA 0.5 ppm (0.89 mg/m^3); STEL 1.5 ppm, 1993; Denmark: TWA 0.5 ppm (0.9 mg/m^3), 1999; Finland: STEL 0.5 ppm (0.9 mg/m^3), 1999; France: VME 0.5 ppm (0.9 mg/m^3), 1999; the Netherlands: MAC-TGG 0.9 mg/m^3, 2003; Norway: TWA 0.5 ppm, 1999; the Philippines: TWA 0.5 ppm (0.9 mg/m^3), 1999; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Switzerland: MAK-W 0.5 ppm (0.9 mg/m^3), KZG-W 1 ppm (1.8 mg/m^3), 1999; Turkey: TWA 0.5 ppm (0.9 mg/m^3), 1993; United Kingdom: TWA 0.5 ppm (0.87 mg/m^3); STEL 0.5 ppm (2.6 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1.5 ppm; Several states have set guidelines or standards for ketene in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 4.5 μ/m^3 (South Carolina) to 9.0 μ/m^3 (Florida) to 9.0−30.0 μ/m^3 (North Dakota) to 18.0 μ/m^3 (Connecticut) to 21.0 μ/m^3 (Nevada) to 25.0 μ/m^3 (Virginia).

Determination in Air: Use NIOSH (II-2),[2] Method #S92.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Ketene can affect you when breathed in. Breathing the vapor can irritate the lungs, causing coughing, chest pain, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Repeated or high exposure may cause permanent lung damage. Exposure can irritate the eyes, nose, and throat.

Long Term Exposure: Repeated or prolonged exposure may cause permanent lung damage, resulting in emphysema and fibrosis. Prolonged skin contact may cause skin rash.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, or to rule out scarring in persons with a history of suspected repeated overexposures.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 ppm:* Sa* (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Ketene cannot be stored. Ketene must be kept away from water and a wide variety of organic compounds, since violent reactions occur. Ketene must be kept in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Ketene is not shipped as a rule, but is generated at the point of use in a chemical process by acetone pyrolysis. It polymerizes readily and hence immediate use is preferred.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. *Do not use water* because it reacts violently with ketene. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not use water*. This chemical is a flammable gas. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Ketene*. Trenton, NJ

L

Lactonitrile L:0050

Molecular Formula: C_3H_5NO
Common Formula: $CH_3CHOHCN$
Synonyms: Acetaldehyde cyanohydrin; 2-Hydroxypropionitrile; Lactonitrilo (Spanish); NSC-7764; Propionitrile, 2-hydroxy-
CAS Registry Number: 78-97-7
RTECS® Number: OD8225000
UN/NA & ERG Number: UN3276 (Nitriles, toxic, liquid, n.o.s.)/151
EC Number: 201-163-2
Regulatory Authority and Advisory Bodies
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Lactonitrile is a colorless to straw-colored liquid. Molecular weight = 71.09; Boiling point = 183°C (slight decomposition); Freezing/Melting point = −40°C; Flash point = 77°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.
Potential Exposure: This material is used as a solvent and as an intermediate in the production of ethyl lactate and lactic acid.
Incompatibilities: Alkalis form hydrogen cyanide. Violent reaction with strong oxidizers.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 3.5 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 18 mg/m^3
PAC-3: 150 mg/m^3
Determination in Air:
NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-min work period.
Permissible Concentration in Water: See NIOSH Criteria Document 212 *Nitriles*.
Routes of Entry: Inhalation, ingestion, skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Signs and symptoms of acute exposure to lactonitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood, cardiac arrhythmias; other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) may be present, following exposure to lactonitrile. Salivation, nausea, and vomiting may also occur. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may occur. Headache, vertigo (dizziness), agitation, and giddiness may be followed by combative behavior, convulsions, paralysis, protruding eyeballs, dilated and unreactive pupils, and coma. Lactonitrile is irritating to the skin and mucous membranes. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. *Warning:* Heart palpitations may occur within minutes after exposure. Caution is advised. Vital signs should be monitored closely. Symptoms may be delayed.
Long Term Exposure: May cause liver and kidney damage.
Points of Attack: Respiratory system, central nervous system, cardiovascular system, liver, kidneys.
Medical Surveillance: Liver function tests. Kidney function tests. See also NIOSH Criteria Document 212 *Nitriles*.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The NIOSH REL for nitriles is a Ceiling Concentration of 6 mg/m^3, not to be exceeded in any 15-min work period.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00011-4

chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and alkalis. Store in a refrigerator under an inert atmosphere and protect from light for prolonged storage. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Nitriles, toxic, n.o.s. must be labeled "POISONOUS/TOXIC MATERIALS." This chemical falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.1
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including cyanide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Lactonitrile*. Washington, DC: Chemical Emergency Preparedness Program

Lead & inorganic compounds L:0100

Molecular Formula: Pb

Synonyms: C.I. 77575; C.I. Pigment metal 4; Glover; Haro mix CE-701; Haro mix CK-711; Haro mix MH-204; JMI Sloop; KS-4; Lead-S2; Lead element; Lead flake; Litharge; Omaha; PB-S 100; Plomo (Spanish); Plumbum

CAS Registry Number: 7439-92-1 (metallic lead)

RTECS® Number: OF7520000

UN/NA & ERG Number: UN3077 (Environmentally hazardous substances, solid, n.o.s.)/171; UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-100-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (inorganic): Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; (organic) Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: Sperm morphology—human; Negative: *In vivo* cytogenetics—nonhuman bone marrow; Negative: *In vitro* cytogenetics—human lymphocyte; Inconclusive: Carcinogenicity—mouse/rat; Inconclusive: *In vivo* cytogenetics—human lymphocyte.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Banned or Severely Restricted (Many countries, especially in food) (UN)[35], (Maine, Minnesota).[61]

Lead, metallic:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

US EPA Hazardous Waste Number (RCRA No.): D008.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 5.0 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as lead compounds, n.o.s., waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.69; Nonwastewater (mg/L), 0.37 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (40); 7420 (1000); 7421 (10).

Safe Drinking Water Act: MCL, zero; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer; 10/1/92; Developmental/Reproductive toxin (male, female) 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Lead compounds:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

California Proposition 65 Chemical: Cancer; 10/1/92; Developmental/Reproductive toxin (male, female) 2/27/87

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as inorganic compounds, n.o.s.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Inorganic lead includes lead oxides, metallic lead, lead salts, and organic salts, such as lead soaps, but excludes lead arsenate and organic lead compounds. Lead is a blue−gray metal which is very soft and malleable. Lustrous when freshly cut; tarnishes in moist air. Specific gravity (H_2O:1) = 11.34; Molecular weight = 207.19; Boiling point = 1750°C; Freezing/Melting point = 327°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Organometallic; Reproductive Effector; Human Data. Metallic lead is used for lining tanks, piping, and other equipment where pliability and corrosion resistance are required, such as in the chemical industry in handling corrosive gases and liquids used in the manufacture of sulfuric acid; in petroleum refining; and in halogenation, sulfonation, extraction, and condensation processes; and in building industry. It is also used as an ingredient in solder, a body filler in the automobile industry, and a shielding material for X-rays and atomic radiation, in manufacture of tetraethyl lead and organic and inorganic lead compounds, pigments for paints and varnishes, storage batteries, fling glass, vitreous enameling, ceramics as a glaze, litharge rubber, plastics, and electronic devices. Lead is utilized in metallurgy and may be added to bronze, brass, steel, and other alloys to improve their characteristics. It forms alloys with antimony, tin, copper, etc. It is also used in metallizing to provide protective coatings and as a heat treatment bath in wire drawing. Exposures to lead dust may occur during mining, smelting, refining, and to fume, during high temperature (>500°C) operations, such as welding or spray coating of metals with molten lead. There are numerous applications for lead compounds, some of the more common being in the plates of electric batteries and accumulators; as compounding agents in rubber manufacture; as ingredients in paints, glazes, enamels, glass, pigments; and in the chemical industry. In addition, to these usual levels of exposure from environmental media, there exist miscellaneous sources which are hazardous. The level of exposure resulting from contact is highly variable. Children with pica for paint chips or for soil may experience elevation in blood lead, ranging from marginal to sufficiently great to cause clinical illness. Certain adults may also be exposed to hazardous concentrations of lead in the workplace, notably in lead smelters and storage battery manufacturing plants. Again, the range of exposure is highly variable. Women in the workplace are more likely to experience adverse effects from lead exposure than men due to the fact that their hematopoietic system is more lead-sensitive than men. Because of health concerns, lead from gasoline, paints, and ceramic products, caulking, and pipe solder, has been dramatically reduced in recent years.

Incompatibilities: Lead dust is flammable in air and may explode when exposed to heat or flame. Reacts with sulfuric acid, hot concentrated nitric acid, boiling concentrated hydrochloric acid. Powdered lead can react (possibly violently) with strong oxidizers, ammonium nitrate, chlorine trifluoride, chemically active metals, concentrated hydrogen peroxide, sodium acetylide. Incompatible with sodium azide, disodium acetylide, hydrogen peroxide, active metals—sodium, potassium, zirconium. Lead is attacked by pure water and weak organic acids in the presence of oxygen. Attacked at room temperature by chlorine, fluorine.

Permissible Exposure Limits in Air

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other inorganic lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers “lead” to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called “soaps;” all other lead compounds are excluded from this definition.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers “lead” to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead “soaps” but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

NIOSH IDLH: 100 mg [Pb]/m^3

Metallic lead

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.25 mg/m^3

PAC-3: 100 mg/m^3

European OEL: 0.15 mg[Pb]/m^3 TWA (2002)

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Austria: MAK 0.1 mg/m^3, 1999; Denmark: TWA 0.1 mg/m^3, 1999; Japan 0.1 mg/m^3, 1999; Norway: TWA 0.05 mg/m^3, 1999; Poland: MAC (TWA) 0.05 mg/m^3, 1999; Sweden: TWA 0.05 mg/m^3 (resp. dust), 1999; Sweden: TWA 0.1 mg/m^3 (total dust), 1999; the Netherlands: MAC-TGG 0.15 mg/m^3, 2003. The EPA requires lead in air not to exceed 1.5 μg/m^3 averaged over 3 months; the Czech Republic at 0.7 μg/m^3 on a daily average basis *and* at 2.0 μg/m^3 on a momentary basis. Several states have set guidelines or standards for lead in ambient air[60] ranging from 0.068 μg/m^3 (Massachusetts) to 0.357−1.5 μg/m^3 (North Dakota and Pennsylvania) to 2.5 μg/m^3 (New York) to 3.0 μg/m^3 (Connecticut) to 4.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Ingestion of dust, inhalation of dust or fume, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The effects of exposure to fumes and dusts of inorganic lead may be slow to develop. Extremely high exposures can lead to seizures, coma, and death, but symptoms occur after weeks to months of exposure. The earliest symptoms may include tiredness, decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains and decreased appetite, moodiness (mostly irritability and depression). Skin contact may cause irritation. Eyes contact may cause irritation. Ingestion of large amounts of lead may lead to seizures, coma, and death.

Long Term Exposure: Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include high blood pressure, anemia, pale skin, a blue line at the gum margin, paralysis of forearm, wrist joint, and fingers, causing decreased hand-grip strength, abdominal pain, severe constipation, nausea, vomiting. Prolonged exposure to high enough levels may result in serious, permanent kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, mood and personality changes, retarded mental development, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead is a probable teratogen in humans. Continuous exposure can result in decreased fertility in males and females. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects. May cause retarded development of the newborn.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs. The effects may be delayed. Medical observation is recommended. The biological half-life (PB) in the bones of humans = 10 years.

Points of Attack: Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue.

Medical Surveillance: OSHA mandated medical tests: whole blood (chemical/metabolite), blood lead level, hemoglobin, hematocrit, zinc protoporphyrin, blood urea nitrogen, serum creatinine, urinalysis (routine), microscopic examination. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

NIOSH lists the following tests: whole blood (chemical/metabolite); blood lead level; biologic tissue/biopsy; complete blood count; nerve conduction studies; neurologic examination/electromyography; red blood cells/count; red blood cells/count: zinc protoporphyrin; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), 24-h collection; Zinc Protoporphyrin; Zinc Protoporphyrin, after 1-month exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention.

Antidotes and special procedures: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Prevent skin contact: Any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Vacuum clothing with HEPA. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH 78-158 *Lead, inorganic dusts, and fumes*.

Respirator Selection: OSHA: *0.5 mg/m³:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *1.25 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m³:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Lead is regulated by OSHA Standard 1910. 1025. All requirements of the standard must be followed.

Shipping: For Metal powder, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall into Hazard Class 4.2 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Get all workers out of spill area. Put on necessary protective equipment including respirators. If spill is a solution, cover with absorbent and shovel into suitable container. If spill is in powder form, vacuum (HEPA) whenever possible to avoid raising dust by sweeping or blowing. Place in suitable container. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead powder is flammable when exposed to heat or flame. *Do not use water*. Use dry chemicals appropriate for extinguishing metal fires. Generally the problem is to fight a fire based on the surrounding combustible material since metallic lead is not combustible. Poisonous fumes, including lead, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle wherever possible. May be treated with HNO_3 to give lead nitrate; the lead may be precipitated as sulfide, which is then sent to a lead recovery plant.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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National Academy of Sciences. (1972). *Medical and Biologic Effects of Environmental Pollutants: Lead, Airborne Lead in Perspective*. Washington, DC

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World Health Organization. (1977). *Lead: Environmental Health Criteria No. 3*. Geneva, Switzerland

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New York State Department of Health. (June 1982). *Chemical Fact Sheet: Lead (Metallic and Inorganic Compounds)*. Version 3. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Lead*. Trenton, NJ

Lead acetate L:0110

Molecular Formula: $C_4H_6O_4Pb$

Common Formula: $Pb(OCOCH_3)_2$

Synonyms: Acetate de plomb (French); Acetato de plomo (Spanish); Acetic acid, lead(2 +) salt; Acetic acid, lead(II) salt; Arseniato de plomo (Spanish); Black marking ink, 105E; Bleiacetat (German); Dibasic lead acetate; Leadac; Lead(2+) acetate; Lead(II) acetate; Lead acetate trihydrate; Lead acetate(II), trihydrate; Lead diacetate; Multilayer dielectric ink HD; Neutral lead acetate; Normal lead acetate; Plumbous acetate; Salt of saturn; Sugar of lead

CAS Registry Number: 301-04-2; 15347-57-6; 6080-56-4 [Lead(II) acetate]

RTECS® Number: AI5250000

UN/NA & ERG Number: UN1616/151

EC Number: 206-104-4 [*Annex I Index No.:* 082-007-00-9]; 215-630-3 [*Annex I Index No.:* 082-007-00-9] (basic)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*as organic lead compounds*): Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

FDA—over-the-counter drug.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

US EPA Hazardous Waste Number (RCRA No.): U144.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Chemical: Cancer 1/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations (*301-04-2; 15347-57-6*): Hazard Symbol: T, N; Risk phrases: R61; R33; R48/22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Lead acetate is a white, flaky crystalline substance with a slight odor of acetic acid. Commercial grades may be powdered granules, or brown or gray lumps. Molecular weight = 325.29; Boiling point = 280°C; Freezing/Melting point = 75°C (decomposes above 200°C). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water, but absorbs carbon dioxide upon exposure to air, and may become insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Organometallic, Mutagen; Reproductive Effector; Human Data. Lead acetate is used as a color additive in hair dyes, as a mordant in cotton dyes, in the lead coating of metals, as a drier in paints, varnishes and pigment inks, and in medicines such as astringents.

Incompatibilities: Reacts violently with strong oxidizers, bromates, strong acids, chemically active metals, phosphates, carbonates, phenols. Contact with strong acids forms acetic acid. Incompatible with strong bases, ammonia, amines, cresols, isocyanates, alkylene oxides, epichlorohydrin, sulfites, resorcinol, salicylic acid, chloral hydrate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
301-04-2
TEEL-0: 4 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 500 mg/m^3
Lead acetate(II) 6080-56-4
TEEL-0: 40 mg/m^3
PAC-1: 125 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
As organic lead
ACGIH TLV®[1]: No listing for organic lead compounds.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This material is poisonous. It emits toxic fumes of lead when heated to decomposition. Symptoms of exposure include irritation on the eyes, respiratory tract, and alimentary tract; headache, nausea, vomiting, colic, constipation, leg cramps; muscle weakness; paralysis, paresthesias, depression, dizziness, loss of consciousness; coma; and death. High levels of exposure to lead acetate may affect the central nervous system and blood, causing anemia, nervous disorders, kidney impairment.

Long Term Exposure: Repeated exposure may cause lead to accumulate in the body and may cause lead poisoning. See above for symptoms. May affect the blood, bone marrow, cardiovascular system, kidneys, nervous system including weakness and poor coordination in the arms and legs, hemolytic anemia, increase in blood pressure, paralysis, brain damage, behavioral effects including irritability, reduced memory, and disturbed sleep. Has been shown to cause kidney cancer in animals; possibly carcinogenic to humans. A probable teratogen. May cause reduced growth of offspring after birth while also decreasing fertility in males.

Points of Attack: Kidneys, brain, nervous system, blood.

Medical Surveillance: OSHA mandated medical tests: whole blood (chemical/metabolite), blood lead level, hemoglobin, hematocrit, zinc protoporphyrin, blood urea nitrogen, serum creatinine, urinalysis (routine), microscopic examination. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines “exposure” for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

NIOSH lists the following tests: whole blood (chemical/metabolite); Blood Lead Level; biologic tissue/biopsy; Complete blood count; Nerve Conduction Studies; Neurologic Examination/Electromyography; red blood cells/count; red blood cells/count: Zinc Protoporphyrin; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), 24-h collection; Zinc Protoporphyrin; Zinc Protoporphyrin, after 1-month exposure.

First Aid: ***Skin Contact***[52]***:*** Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Avoid dust inhalation; wear NIOSH and US Bureau of Mines approved dust mask. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH 78-158 *Lead, inorganic dusts and fumes.*

Respirator Selection: OSHA: *0.5 mg/m^3:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place and keep tightly covered and avoid contact with oxidizers, strong acids, chemically active metals. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust then transfer material to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead acetate may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous fumes of lead are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Convert to nitrate using nitric acid, evaporate, then saturate with H_2S, wash and dry the sulfide and ship to the supplier.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 79−82 (1981) and 6, No. 2, 73−79 (1986)

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Lead Acetate*. Trenton, NJ

Lead arsenate L:0120

Molecular Formula: $AsHO_4Pb$; $As_2O_8Pb_3$

Common Formula: $PbHAsO_4$; $Pb_3(AsO_4)_2$

Synonyms: *3687-31-8*: Arseniate de plomb (French); Arseniato de plomo (Spanish); Arsenic acid, lead salt; Lead acetate acid; Plumbous arsenate

7784-40-9: Acid lead arsenate; Acid lead arsenite; Acid lead orthoarsenate; Arsenate of lead; Arseniato de plomo (Spanish); Arsenic acid, lead(2+); Arsenic acid, lead(II); Arsenic acid, lead salt; Arsinette; Dibasic lead arsenate; Gypsine; Lead acid arsenate; Ortho L10 dust; Ortho L40 dust; Plumbous arsenate; Salt arsenate of lead; Schultenite; Security; Soprabel; Standard lead arsenate; Talbot

10102-48-4: Acid lead arsenate; Acid lead orthoarsenate; Arsenate of lead; Arseniato de plomo (Spanish); Arsenic acid, lead(2+) salt; Arsinette; Dibasic lead arsenate; Gypsine; Ortho L10 dust; Ortho L40 dust; Schultenite; Security; Soprabel; Standard lead arsenate; Talbot

CAS Registry Number: 3687-31-8; 7784-40-9 (dibasic lead arsenate); 7645-25-2 (PbH_3AsO_4)

RTECS® Number: CG0980000 ($PbHAsO_4$); CG0990000 [$Pb_3(AsO_4)_2$]; CG1000000 ($Pb_xH_3AsO_4$)

UN/NA & ERG Number: UN1617/151

EC Number: 232-064-2 [*Annex I Index No.:* 082-011-00-0] (lead hydrogen arsenate); 222-979-5 (trilead diarsenate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (In Agriculture in India, Japan) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025 and 1910. 1018).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 2/27/87; 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R23/25; Safety phrases: S1/2; S20/21; S28; S45 as arsenic compounds.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Lead arsenate is an odorless, heavy, white powder, or crystals. Molecular weight = 347.12; Freezing/Melting point = (decomposes) approximately 280°C. Also listed at 1042°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in cold water; soluble in hot water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen. Used as an insecticide, herbicide, and in manufacture of drugs and veterinary tapeworm medicine.

Incompatibilities: Violent reactions occur from contact with oxidizers, chemically active metals, strong acids. Acids and acid mists cause the release of arsine, a deadly gas. Decomposes above 270°C forming toxic fumes including arsenic and lead compounds.

Permissible Exposure Limits in Air

As arsenic

OSHA PEL: 0.01 mg[As]/m^3 TWA; cancer hazard that can be inhaled, see 29CFR1910.1018.

NIOSH REL: 0.002 mg[As]/m^3 [15 min] Ceiling Concentration. Limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: TLV® [withdrawn].

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category; Germ Cell Mutagen Group 3A.

NIOSH IDLH: 5 mg[As]/m^3.

Protective Action Criteria (PAC)

3687-31-8

TEEL-0: 0.06 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 30 mg/m^3

Dibasic, *7784-40-9*

TEEL-0: 0.0463 mg/m^3

PAC-1: 23.2 mg/m^3

PAC-2: 23.2 mg/m^3

PAC-3: 23.2 mg/m^3

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Lead:

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Argentina[35] has set 0.15 mg/m^3 as a TWA ambient air[60] ranging from 0.5 μg/m^3 (New York) to 0.75 μg/m^3 (South Carolina) to 0.5 μg/m^3 (Florida and North Dakota) to 2.5 μg/m^3 (Virginia) to 3.0 μg/m^3 (Connecticut) to 4.0 μg/m^3 (Nevada).

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Lead arsenate irritates the eyes, skin, and respiratory tract. Skin contact can cause burning sensation, itching, and rash. High exposure can cause poor appetite; nausea, vomiting, and muscle cramps. May affect the heart, with abnormal EKG, gastrointestinal tract, and nervous system. Arsenic intoxication: nausea, diarrhea, inflammation of skin and mucous membranes; lead intoxication: abdominal pain, appetite loss, constipation, tiredness, weakness, nervousness, paresthesia. A rebuttable presumption against registration for pesticide uses was issued on October 18, 1978 by EPA on the basis of oncogenicity, teratogenicity, and mutagenicity.

Long Term Exposure: Lead arsenate is a carcinogen and has been shown to cause skin, lung, and liver cancer. Lead arsenate may also affect the gastrointestinal tract, nervous system, kidneys, and blood. Lead and certain lead compounds may be teratogens and cause reproductive damage in humans. See entry on "lead" for additional information on lead poisoning.

Points of Attack: Kidneys, blood, gingival tissue, lymphatic, skin, gastrointestinal system, central nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

Also seek prompt medical evaluation if health effects are noticed. With each visit, careful attention should be given to the inner nose, skin, nails, and nervous system. A test for serum arsenic is recommended. NIOSH recommends urine arsenic should not be greater than 50−100 μg/L of urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic and may be of SOME value in the case of lead poisoning. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Persons with significant lead poisoning can be treated with Ca EDTA while hospitalized. Since this drug causes a rush of lead from body organs into the blood and kidneys, and thus has its own hazards, it must be done by experienced medical persons under careful observation. It or other "chelating" drugs should never be used to prevent poisoning while exposure continues, as severe kidney damage can result.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document *#78-158, Lead, inorganic dusts and fumes.*

Respirator Selection:

As inorganic arsenic

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

As lead

OSHA (lead): OSHA: *0.5 mg/m^3:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead arsenate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Avoid the presence of acids since arsine, a very deadly gas, is released in the presence of acid or acid mist. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Lead arsenates require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Protect against exposure to dust or fumes. Poisonous gases of lead and arsenic are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Long-term storage in large, weatherproof, and sift-proof storage bins or silos; may be disposed of by conversion to soluble salt, such as chloride, precipitation as sulfide, and return to supplier.[22]

References

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Lead Arsenate*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Lead chloride L:0130

Molecular Formula: Cl_2Pb

Synonyms: Cloruro de plomo (Spanish); Lead(2 +) chloride; Lead(II) chloride; Lead dichloride; Plumbous chloride

CAS Registry Number: 7758-95-4

RTECS® Number: OF9450000

UN/NA & ERG Number: UN2291/151

EC Number: 231-845-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to* *humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead chloride is a white crystalline powder. Molecular weight = 278.00; Boiling point = 950°C; Freezing/Melting point = 501°C; Vapor pressure = 1 mmHg at 547°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in cold water; more soluble in hot water.

Potential Exposure: Used to make lead salts, lead chromate pigments, as an analytical reagent for making other chemicals, making printed circuit boards, as a solder and flux.

Incompatibilities: Violent reaction with oxidizers, chemically active metals, and explosive with calcium + warming.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0671 mg/m^3

PAC-1: 0.201 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 134 mg/m^3

Lead

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

The National primary and secondary ambient air quality standards for lead and its compounds (measured as elemental Pb) = 1 mg[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter. In addition, Russia[43] set a MAC of 0.0017 mg/m^3 in the ambient air of residential areas (on a daily average basis; about 6 times the same limits for lead compounds in general).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: 0.1 mg/L Pb in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short Term Exposure: Lead chloride can irritate the eyes on contact. Inhalation can irritate the nose and throat. Skin contact can cause burning, itching, rash, and pigment changes. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains, and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: Lead chloride causes mutations. Such chemicals have a cancer risk. May damage the developing fetus. High levels can cause lead poisoning with symptoms of headache, irritability, disturbed sleep, tiredness, reduced memory, and personality changes. Higher levels can cause muscle or joint pains, weakness, and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, papaverine). Consider morphine sulfate for severe pain. Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *0.5 mg/m^3:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, chemically active metals, calcium, and heat. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: Lead compounds, soluble, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." Lead chloride falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous fumes, including lead and chlorine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Lead Chloride*. Trenton, NJ

Lead chromate L:0140

Molecular Formula: CrO_4Pb

Common Formula: $PbCrO_4$

Synonyms: Canary chrome yellow 40-2250; Chrome green; Chrome yellow; Chromic acid, lead(2 +) salt (1:1); C.I. 77600; Cologne yellow; Crocoite; King's yellow; Lead chromate(VI); Leipzig yellow; Lemon yellow; Paris yellow; Plumbous chromate

CAS Registry Number: 7758-97-6; *(alt.)* 8049-64-7; *(alt.)* 11119-70-3; 18454-12-1 (lead chromate oxide)

RTECS$^®$ Number: GB2975000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-846-0 [*Annex I Index No.:* 082-004-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (inorganic): Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA [as Cr(VI)] *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE; Positive: *S. cerevisiae*—homozygosis.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08; (lead and compounds) Cancer 10/1/92.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R61; R62; R33; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead chromate is an orange or orange-yellow crystalline solid or powder. Molecular weight = 323.19; 546.38 (lead chromate oxide); Boiling point = (decomposes); Freezing/Melting point = 844°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. Lead chromate is used to make paint pigments for wood and metal.

Incompatibilities: Oxidizers, active metals; hydrazine, sodium and potassium; organics at elevated temperature. Reacts with aluminum dinitronaphthalene, iron(III) hexacyanoferrate (IV).

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen.

ACGIH TLV®[1] (*as lead*): 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

DFG MAK (lead chromate & lead chromate oxide): Carcinogen Category 3B.

Protective Action Criteria (PAC)

7758-97-6

TEEL-0: 0.0311 mg/m^3

PAC-1: 0.186 mg/m^3

PAC-2: 93.2 mg/m^3

PAC-3: 93.2 mg/m^3

As chromium(VI), inorganic insoluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen.

DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

As lead:

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: Carcinogen Category 3B.

Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA 0.05 mg/m^3, carcinogen, 1993; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; TWA 0.1 mg[Pb]/m^3, 1999; Finland: carcinogen, 1999; France: VME 0.05 mg[Cr]/m^3, VME 0.15 mg[Pb]/m^3, 1999; Japan 0.01 mg[Cr]/m^3, 1999; 0.1 mg[Pb]/m^3, 1999; Norway: TWA 0.1 mg[CrO_3]/m^3, 1999; Norway: TWA 0.05 mg[Pb]/m^3, 1999; Poland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, 1999; Poland: MAC (TWA) 0.05 mg[Pb]/m^3, 1999; Sweden: TWA 0.02 mg[Cr]/m^3, carcinogen, 1999; Switzerland: MAK-W 0.05 mg[Cr]/m^3, carcinogen, 1999; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for lead chromate in ambient air[60] ranging from 0.5 μg/m^3 (Connecticut and Virginia) to 1.0 μg/m^3 (Nevada).

Determination in Air: For lead use NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206; #7024 for chromium, hexavalent.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the respiratory tract. Lead chromate is a carcinogen—handle with extreme caution. Lead poisoning symptoms may include poor appetite, colic, upset stomach, headache, irritability, muscle or joint pains, and weakness. Permanent kidney damage can result from long term or high exposure. Breathing lead chromate can cause a hole in the inner nose. Irritation of nose, throat, or bronchial tubes can also occur, with cough and/or wheezing. Skin contact with concentrated lead chromate can cause burns, deep ulcers, or an allergic skin rash.

Long Term Exposure: Lead chromate has been shown to cause kidney cancer. Repeated or prolonged contact may cause skin sensitization; dermatitis, irritation, chronic ulcers, eczema. Repeated or prolonged inhalation exposure may cause asthma. Lead chromate may affect the kidneys. May cause increased blood pressure. May cause reproductive toxicity and genetic damage in humans. May cause lead poisoning with symptoms of poor appetite, upset stomach, colic, headache, irritability, muscle or joint pains and weakness, constipation, disturbed sleep, and reduced memory. See also "Lead" entry.

Points of Attack: Kidneys, skin, lungs.

Medical Surveillance: NIOSH lists the following tests for chromates: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires employers to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: (*as chromic acid and chromates*) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129 *Chromium(VI)* and NIOSH 78-158 *Lead, inorganic dusts and fumes.*

Respirator Selection:

As lead

OSHA: *0.5 mg/m^3:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators]. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

As chromates:

NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead chromate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, zinc and ferric ferrocyanide), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." Lead chromate falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead chromate may burn but does not easily ignite. NFPA recommends the use of water on fire. Poisonous gases, including lead and chromium, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 65−66

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Lead Chromate*. Trenton, NJ

Lead dioxide L:0145

Molecular Formula: O_2Pb
Common Formula: PbO_2
Synonyms: Lead, brown; Lead(IV) oxide; Lead oxide, brown; Lead peroxide; Lead superoxide; Peroxyde de plomb (French)
CAS Registry Number: 1309-60-0
RTECS® Number: OG0700000
UN/NA & ERG Number: UN1872/141
EC Number: 215-174-5
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Banned or Severely Restricted (various countries; in Pharmaceuticals) (UN).[13]
OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.
EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.
California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as lead inorganic compounds, n.o.s.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Lead Dioxide is a dark brown crystalline solid or powder. Molecular weight = 239.19; Freezing/Melting point = (decomposes) 290°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 3 (Oxidizer). Insoluble in water.
Potential Exposure: This material is used in electrodes for lead-acid batteries, in matches, explosives, and as a curing agent for polysulfide elastomers.
Incompatibilities: A powerful oxidizer. Violent reaction with many compounds, including reducing agents, chemically active metals, combustible materials.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
1309-60-0
TEEL-0: 0.0577 mg/m^3
PAC-1: 0.173 mg/m^3
PAC-2: 0.3 mg/m^3
PAC-3: 115 mg/m^3
As inorganic lead
OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition. See 29CFR1910.1025.
NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.
ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.
European OEL: 0.15 mg[Pb]/m^3 TWA (2002).
NIOSH IDLH: 100 mg [Pb]/m^3.
DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.
Determination in Air: Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.
Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.
Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Lead dioxide can affect you when breathed in. Irritates eyes, skin, and respiratory tract. Lead

dioxide should be handled as a teratogen with extreme caution. Lead poisoning can cause poor appetite, colic, upset stomach, headaches, irritability, muscle or joint pains and weakness. Permanent kidney damage can result from high exposures.

Long Term Exposure: Repeated, prolonged, or high exposures may cause kidney damage. May cause lead poisoning with symptoms of poor appetite, upset stomach, colic, headache, irritability, muscle or joint pains and weakness, constipation, disturbed sleep, and reduced memory. See also "Lead" entry.

Points of Attack: Kidneys.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes.*

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Lead dioxide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood, paper, and oil. Lead dioxide is regulated by OSHA Standard 1910.1025. All requirements of the standard must be followed. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Lead dioxide requires a shipping label of “OXIDIZER.” It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep combustibles (wood, paper, oil) away from spilled material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead dioxide does not burn but it will increase the intensity of a fire. Use extinguisher suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Conversion to soluble salt, precipitation as sulfide, and return to supplier.

Reference

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Lead Dioxide*. Trenton, NJ

Lead fluoborate L:0150

Molecular Formula: B_2F_8Pb

Common Formula: $Pb(BF_4)_2$

Synonyms: Borate(1-), tetrafluoro-, lead(2 +); Fluoborato de plomo (Spanish); Lead tetrafluoroborate; Tetrafluoro borate; Tetrafluoro borate(1-), lead(2 +)

CAS Registry Number: 13814-96-5

RTECS$^{®}$ Number: ED2700000

UN/NA & ERG Number: UN2291/151

EC Number: 237-486-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard set. See below, “Permissible Exposure Limits in Air” section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Hazardous Substance (EPA) (RQ = 5000/2270).[4]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as lead inorganic compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead fluoborate is a nonflammable colorless liquid or crystalline powder with a faint odor. Specific gravity (H_2O:1) = 1.75 at 20°C; Molecular weight = 380.81. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water (decomposes).

Potential Exposure: This material is used in material finishing operations.

Incompatibilities: Aqueous solution is acidic. Incompatible with oxidizers, bases, active metals. Decomposes in water or alcohol. Attacks most metals, especially aluminum.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) *13814-96-5*

TEEL-0: 0.0919 mg/m^3

PAC-1: 0.276 mg/m^3

PAC-2: 0.459 mg/m^3

PAC-3: 184 mg/m^3

As inorganic lead

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition. See 29CFR1910.1025.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

European OEL: 0.15 mg[Pb]/m^3 TWA (2002).

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Lead fluoborate can affect you when breathed in and if swallowed from food, drinks, or cigarettes. Contact can cause skin and eye irritation and burns. Irritates the respiratory tract. Can cause headache, irritability, mood changes, reduced memory, and disturbed sleep.

Long Term Exposure: Repeated exposure causes lead fluoborate build up in the body and lead to lead or fluoride poisoning. Low levels may cause tiredness, mood changes, headaches, stomach problems, and trouble sleeping. Higher levels may cause aching, weakness, and concentration or memory problems. May damage the nervous system causing numbness, "pins and needles" weakness in the hands and feet. Lead fluoborate can also cause serious permanent kidney, brain damage, and damage the blood cells, causing anemia. Lead fluoborate exposure increases risk of high blood pressure. Lead compounds have been determined to be teratogens and may also cause reproductive damage, such as reduced fertility and interference with menstrual cycles. Lead fluoborate should be handled as a teratogen with extreme caution.

Points of Attack: Kidneys, nervous system, brain, blood.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

NIOSH lists the following tests for fluorides: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes*.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead fluoborate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: Lead compounds, soluble, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate and wash area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead fluoborate itself does not burn. Use any agent suitable for type of surrounding fire.

Poisonous fumes including lead and fluorine are in fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 79−80

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Lead Fluoborate*. Trenton, NJ

Lead fluoride L:0160

Molecular Formula: F_2Pb

Synonyms: Fluoruro de plomo (Spanish); Hydrofluoric acid, lead(2 +) salt; Hydrofluoric acid, lead(II) salt; Lead difluoride; Lead(2 +) fluoride; Lead(II) fluoride; Plomb fluorure (French); Plumbous fluoride

CAS Registry Number: 7783-46-2

RTECS® Number: OG1225000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-998-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead fluoride is a white to colorless, odorless crystalline (rhombic, orthorhombic) solid. Molecular weight = 245.19; Boiling point = 1292°C; Freezing/Melting point = 825°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used to make other chemicals, underwater paints, electronic and optical parts (for growing single-crystal, solid-state lasers), in high-temperature dry-film lubricants, and for making special grades of glass.

Incompatibilities: Violent reaction with oxidizers, chemically active metals, calcium carbide. May ignite combustibles, such as wood, paper, oil, etc.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

7783-46-2

TEEL-0: 0.0592 mg/m^3

PAC-1: 0.178 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 118 mg/m^3

As inorganic lead

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in “nonferrous foundries with less than 20 employees” is 0.075 mg/m^3. OSHA considers “lead” to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called “soaps;” all other lead compounds are excluded from this definition. See CFR1910.1025.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers “lead” to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead “soaps” but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

As inorganic fluorides
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15-min Ceiling Concentration.
ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.
NIOSH IDLH: 250 mg[F]/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: 0.1 mg/L Pb in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause skin and eye irritation and burns. Inhalation can irritate the nose and throat. Lead fluoride can cause headache, irritability, mood changes, reduced memory, and disturbed sleep. The fluoride ion can cause protoplasmic poisoning at higher concentrations. See also entry on "Fluorides."

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: While lead fluoride has not been identified as a teratogen, or a reproductive hazard, lead and certain lead compounds have been determined to be teratogens and may also cause reproductive damage, such as reduced fertility and interfere with menstrual cycles. Handle with extreme caution. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

As fluorides

NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: Toxic solid, inorganic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." Lead fluoride falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn. Use any extinguishing agent suitable for surrounding fire. Poisonous gases, including hydrogen fluoride, lead oxide, and lead fumes, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November, 1999). *Hazardous Substances Fact Sheet: Lead Fluoride*. Trenton, NJ

Lead iodide L:0170

Molecular Formula: I_2Pb

Common Formula: PbI_2

Synonyms: Lead(2 +) iodide; Lead(II) iodide; Yoduro de plomo (Spanish)

CAS Registry Number: 10101-63-0

RTECS® Number: OG1515000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 233-256-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Hazardous Substance (EPA) (RQ = 5000/2270).[4]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as lead, inorganic compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead Iodide is a heavy, bright-yellow, odorless powder. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Lead iodide is used in bronzing, gold pencils, mosaic gold, printing, and photography.

Incompatibilities: Contact with oxidizers or active metals may cause violent reaction.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) *10101-63-0*

TEEL-0: 0.111 mg/m^3

PAC-1: 0.334 mg/m^3

PAC-2: 0.556 mg/m^3

PAC-3: 222 mg/m^3

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

As inorganic lead

OSHA PEL: 0.050 $mg[Pb]/m^3$ TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition. See CFR1910.1025.

NIOSH REL: 0.050 $mg[Pb]/m^3$ TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than

0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 μm filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Can cause headache, irritability, reduced memory, and disturbed sleep. Lead poisoning can cause poor appetite, colic, upset stomach, headaches, irritability, muscle or joint pains, and weakness.

Long Term Exposure: Permanent kidney damage can result from long-term or high exposures. Repeated exposure may cause brain damage, and damage to the blood cells, leading to anemia. Higher levels can cause muscle and joint pains, weakness, and fatigue. May cause nerve damage. Lead exposure increases the risk of high blood pressure. Lead iodide should be handled as a teratogen, with extreme caution. Repeated exposure may cause lead poisoning and/or iodism. Symptoms of iodism can include running nose, headache, mucous membrane irritation, and skin rash.

Points of Attack: Kidneys, brain, nervous system, blood.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes*.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead iodide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Lead iodide is regulated by an OSHA Standard, 1910.1025. All requirements of the standard must be followed.

Shipping: Toxic solid, inorganic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." Lead fluoride falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous fumes of lead and iodine are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Lead Iodide*. Trenton, NJ

Lead phosphate L:0180

Molecular Formula: $O_8P_2Pb_3$

Common Formula: $Pb_3(PO_4)_2$

Synonyms: Bleiphosphat (German); C.I. 77622; Fasfato de plomo (Spanish); Lead orthophosphate; Lead phosphate (3:2); Lead(2 +) phosphate; Lead(II) phosphate; Normal lead orthophosphate; Perlex paste; Phosphoric acid, lead salt; Phosphoric acid, lead(2 +) salt (2:3); Plumbous phosphate; Trilead phosphate; Trilead bis(orthophosphate)

CAS Registry Number: 7446-27-7

RTECS® Number: OG3675000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-205-5 [*Annex I Index No.:* 082-006-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.
US EPA Hazardous Waste Number (RCRA No.): U145.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
Form R Toxic Chemical Category Code: N420.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Chemical: Cancer 4/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R61; R33; R48/22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead phosphate is a white powder or colorless crystals. Molecular weight = 811.51; Freezing/Melting point = 1012°C. Hazard Identification (based on NFPA-704 M Rating System) (estimated): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Lead phosphate is used as a stabilizer in styrene and casein plastics.

Incompatibilities: Oxidizers, active metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
7446-27-7
TEEL-0: 0.0653 mg/m^3
PAC-1: 0.196 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 131 mg/m^3
As inorganic lead

OSHA PEL: 0.05 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition. See 29CFR-1910.1025.

NIOSH REL: 0.05 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: 100 mg [Pb]/m^3.
DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Lead phosphate can cause headache, irritability, reduced memory, and disturbed sleeping patterns. Lead enters the body by breathing and from contaminated food, beverages, or cigarettes. Lead poisoning can cause poor appetite, colic, upset stomach, headaches, irritability, muscle or joint cramps, and weakness.

Long Term Exposure: Lead phosphate is a carcinogen, handle with extreme caution. Lead phosphate should be handled as a teratogen, with extreme caution. Permanent kidney damage can result from long term or high exposures. Lead exposure increases the risk of high blood pressure. High or repeated exposure may damage the nerves resulting in loss of coordination in the arms and legs. Can cause brain damage and anemia.

Points of Attack: Kidneys, blood, nervous system, brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes*.

Respirator Selection: OSHA: *0.5 mg/m³:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m³:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, strong acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." Lead fluoride falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or extinguishers. Poisonous gases, including lead and phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Lead Phosphate*. Trenton, NJ

Lead stearate L:0190

Molecular Formula: $C_{18}H_{36}O_2 \cdot xPb$

Synonyms: Bleistearat (German); Estearato de plomo (Spanish); Neutral lead stearate; Octadecanoic acid, Lead salt; Octadecanoic acid, lead(2 +) salt; Octadecanoic acid, lead(II) salt; Stearic acid, lead salt; Stearic acid, lead(2 +) Salt; Stearic acid, lead(II) salt; Steric acid, lead salt

CAS Registry Number: 7428-48-0 (stearic acid, lead salt); 1072-35-1 (lead distearate); 56189-09-4 [dioxobis(stearato) dilead]

RTECS®Number: WI4300000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 231-068-1 (stearic acid, lead salt); 214-005-2 (lead distearate); 260-043-8 [dioxobis(stearato)dilead]

Regulatory Authority and Advisory Bodies

Carcinogenicity (*as organic lead compounds*): IARC: Organic lead compounds are not classifiable as to their carcinogenicity to humans, (Group 3, 2004).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, organic lead compounds are *not* included on the Ingredients Disclosure List.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead stearate is an organic lead compound. It is a white powder with a slight fatty odor. Molecular weight = 1734.87; Freezing/Melting point = 116°C; Flash point = 232°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: It is used in extreme-pressure lubricants and as a drier in varnishes.

Incompatibilities: Oxidizers, strong acids. Dust may explode at high temperature or with source of ignition.

Permissible Exposure Limits in Air

As organic lead

ACGIH TLV®[1]: No listing for organic lead compounds.

Determination in Air: Use (*for inorganic lead*) NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: 0.1 mg/L Pb in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg per liter. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Ingestion, skin contact. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short Term Exposure: Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains, and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. Between 1 oz and 1 lb of lead stearate may be fatal.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: While lead stearate has not been identified as a teratogen, or a reproductive hazard, lead and certain lead compounds have been determined to be teratogens and may also cause reproductive damage such as reduced fertility and interfere with menstrual cycles. Handle with extreme caution. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: *for inorganic lead.* Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *for inorganic lead* OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m³:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, strong acids. Dust may explode at high temperature. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: Toxic solids, organic, n.o.s. requires the label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous fumes including lead are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Lead Stearate*. Trenton, NJ

Lead subacetate L:0200

Molecular Formula: $C_4H_{10}O_8Pb_3$

Synonyms: Basic lead acetate; Bis(acetato)tetrahydroxytrilead; Bis(aceto)dihydroxytrilead; BLA; Lead acetate, basic; Lead, bis(acetato-*O*)tetrahydroxytri-; Lead monosubacetate; Monobasic lead acetate; Subacetate lead; Subaceto de plomo (Spanish)

CAS Registry Number: 1335-32-6

RTECS® Number: OF8750000

UN/NA & ERG Number: UN1616/151

EC Number: 215-630-3 [*Annex I Index No.:* 082-007-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: Carcinogenicity (*as organic lead compounds*): IARC: Organic lead compounds are not classifiable as to their carcinogenicity to humans, (Group 3, 2004).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

US EPA Hazardous Waste Number (RCRA No.): U146.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/89.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R61; R33; R40; R48/22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead subacetate is a white, heavy powder or gelatinous solid. Molecular weight = 807.71. Hazard

Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Permissible Exposure Limits in Air

Basic; subacetate

TEEL-0: 35 mg/m^3

PAC-1: 100 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

As organic lead

ACGIH TLV®[1]: No listing for organic lead compounds.

Potential Exposure: Used as a decolorizing agent in sugar solutions and as an analytical chemical.

Incompatibilities: Oxidizers, strong acids.

Determination in Air: Use (*for inorganic lead*) NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: 0.1 mg/L Pb in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short Term Exposure: Lead subacetate can cause headache, irritability, mood changes, reduced memory, and disturbed sleep.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: Lead subacetate may be a carcinogen in humans since it has been shown to cause kidney, lung, and brain cancer in animals. May be a teratogen in humans. May damage the testes. Repeated exposure may cause lead poisoning with symptoms of headache, irritability, disturbed sleep, tiredness, reduced memory, and personality changes. Higher levels can cause muscle or joint pains, weakness, disturbed sleep, and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: (*for inorganic lead*) Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *for inorganic lead* OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, strong acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Lead acetate requires a shipping label of "POISONOUS/TOXIC MATERIALS." Lead acetate falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases, including lead oxide and carbon monoxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Lead Subacetate*. Trenton, NJ

Lead sulfate L:0210

Molecular Formula: O_4PbS

Common Formula: $PbSO_4$

Synonyms: Anglisite; Bleisulfat (German); C.I. 77630; C.I. Pigment white 3; Fast white; Freemans white lead; Lanarkite; Lead bottoms; Lead(2 +) sulfate(1:1); Lead(II) sulfate(1:1); Lead sulphate; Lead(2 +) sulphate(1:1); Lead (II) sulphate (1:1); Milk white; Mulhouse white; Sulfate de plomb (French); Sulfato de plomo (Spanish); Sulfuric acid, lead(2 +) salt(1:1); Sulfuric acid, lead(II) salt(1:1); White lead C.I. Pigment white

CAS Registry Number: 7446-14-2

RTECS® Number: OG4375000

UN/NA & ERG Number: UN1794 (with >3% free acid)/154

EC Number: 231-198-9

Regulatory Authority and Advisory Bodies

IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Hazardous Substance (EPA) (RQ = 5000/2270).[4]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead sulfate is a heavy, white crystalline powder. Molecular weight = 303.25; Freezing/Melting point = 1170°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Lead sulfate is used in storage batteries and paint pigments. Used in the making of alloys, fast-drying oil varnishes, weighting fabrics, in lithography.

Incompatibilities: Contact with oxidizers and chemically active metals may cause violent reactions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

7446-14-2

TEEL-0: 0.0732 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 146 mg/m^3

As inorganic lead

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in “nonferrous foundries with less than 20 employees” is 0.075 mg/m^3. OSHA considers “lead” to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called “soaps;” all other lead compounds are excluded from this definition. See 29CFR1910.1025.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers “lead” to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead “soaps” but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: This chemical is corrosive. Skin contact can cause severe irritation and burns, itching, rash, and pigment changes. Eye contact can cause severe irritation and burns. Inhalation can cause irritation of the respiratory tract. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pain, and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: Highly irritating and corrosive substances can cause lung irritation that may lead to bronchitis. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Lungs, blood, kidneys, brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Note to physician: whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes*.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead sulfate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Lead sulfate with more than 3% free acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead sulfate is not combustible. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous fumes including lead and sulfur oxides are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Lead Sulfate*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April, 2004). *Hazardous Substances Fact Sheet: Lead Sulphate*. Trenton, NJ

Lead sulfide L:0220

Molecular Formula: PbS

Synonyms: C.I. 77640; Galena; Lead monosulfide; Natural lead sulfide; Plumbous sulfide; Sulfuro de plomo (Spanish)

CAS Registry Number: 1314-87-0
RTECS® Number: OG4550000
UN/NA & ERG Number: UN3288/165
EC Number: 215-246-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Hazardous Substance (EPA) (RQ = 5000/2270).[4]

Section 261 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

EPCRA Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead sulfide is a silvery to black crystalline powder. Molecular weight = 239.25; Boiling point = 1281°C (sublimes); Freezing/Melting point = 1114°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Practically insoluble in water (0.000086 g/100-cc water at 13°C).

Potential Exposure: Lead sulfide is used in ceramics, infrared radiation detectors, and semiconductors.

Incompatibilities: Contact with oxidizers and chemically active metals may cause violent reactions. Sulfides react with acids to produce toxic and flammable vapors of hydrogen sulfide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

1314-87-0

TEEL-0: 0.0577 mg/m^3
PAC-1: 0.173 mg/m^3
PAC-2: 115 mg/m^3
PAC-3: 115 mg/m^3

As inorganic lead

OSHA PEL: 0.050 mg[Pb]/m^3 TWA. [*Note*: The PEL also applies to other lead compounds (as Pb).] Other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL (8-h TWA) for lead in "nonferrous foundries with less than 20 employees" is 0.075 mg/m^3. OSHA considers "lead" to mean metallic lead; all inorganic lead compounds (lead oxides and lead salts); and a class of organic compounds called "soaps;" all other lead compounds are excluded from this definition. See 29CFR1910.1025.

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb).] *Note:* NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV®[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (Note: The TLV also applies to lead, inorganic compounds.) *Note:* women of child-bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 mg [Pb]/m^3.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age <45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

In addition, Russia[43] set a MAC of 0.0017 mg/m^3 in the ambient air of residential areas (on a daily average basis; about 6 times the same limits for lead compounds in general).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45-μm filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Lead sulfide is very slightly soluble in water, and sulfides react with water, forming hydrogen sulfide. Eye contact may cause eye irritation and damage. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance; headache, aching bones and muscles, constipation, abdominal pains, and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. *Note:* Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Lungs, blood, kidneys, brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to physician: whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*) are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158, *LEAD, inorganic dusts and fumes*.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Lead sulfide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture and acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. requires a label of "POISONOUS/TOXIC MATERIALS." Lead fluoride falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including lead and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Lead Sulfide*. Trenton, NJ

Lead thiocyanate L:0230

Molecular Formula: $C_2N_2PbS_2$

Common Formula: $Pb(SCN)_2$

Synonyms: Lead sulfocyanate; Lead(2 +) thiocyanate; Lead(II) thiocyanate; Thiocyanic acid, lead(2 +) salt; Thiocyanic acid, lead(II) salt

CAS Registry Number: 592-87-0

RTECS$^®$ Number: XL1538000

UN/NA & ERG Number: UN2291 (Lead compound, soluble, n.o.s.)/151

EC Number: 209-774-6

Regulatory Authority and Advisory Bodies

IARC (*as organic lead compounds*): Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as lead compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 10/1/92 (lead and compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as lead compounds, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lead thiocyanate is a white or light yellow, odorless, crystalline powder. Odorless. Molecular weight = 323.36; Specific gravity (H_2O:1) = 3.82; Freezing/Melting point = 190°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water; solubility = <0.05%.

Potential Exposure: An explosive, thermally unstable material. Used in making safety matches, primers for small-arms cartridges, pyrotechnic devices, and in dyes.

Incompatibilities: Oxidizers, strong acids. Contact with acids or acid fumes caused decomposition with fumes of cyanide. Will decompose in hot water.

Permissible Exposure Limits in Air

No TEEL available.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Determination in Water: 0.1 mg/L Pb in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg/L. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye contact can cause irritation and burns. Lead thiocyanate can cause headache, irritability, mood changes, reduced memory, and disturbed sleep.

Note: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long Term Exposure: Repeated exposure can cause lead poisoning with symptoms of headache, irritability, disturbed sleep, tiredness, reduced memory, and personality changes. Higher levels can cause muscle or joint pains, weakness, disturbed sleep, and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a build up of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased handgrip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 μg of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you.

Note: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 mL blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 mL blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women <45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*), are generally useful in the therapy of acute lead intoxication.

Antidotes and special procedures for lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control, as severe kidney damage can result.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *0.5 mg/m^3:* Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators. *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from hot water, heat, oxidizers, acids, acid fumes. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: Lead compounds, soluble, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Neutralize with lime or sodium bicarbonate. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is slightly flammable when exposed to heat or flame. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases, including cyanides, nitrogen oxides, sulfur oxides, and lead oxide are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be

trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Lead Thiocyanate*. Trenton, NJ

Leptophos L:0240

Molecular Formula: $C_{13}H_{10}BrCl_2O_2PS$

Common Formula: $C_6H_5PS(OCH_3)OC_6H_2BrCl_2$

Synonyms: Abar; *O*-(4-Bromo-2,5-dichlorophenyl) *O*-methyl phenylphosphonothioate; *O*-(2,5-Dichloro-4-bromophenyl) *O*-methyl phenylthiophosphonate; Fosvel; K62-105; MBCP; *O*-Methyl *O*-(4-bromo-2,5-dichlorophenyl) phenyl thiophosphonate; NK711; Phenylphosphonothioic acid *O*-(4-bromo-2,5-bromo-2,5-dichlorophenyl) *O*-methyl ester; Phosphonothioic acid, phenyl-, *O*-(4-bromo-2,5-dichlorophenyl) *O*-methyl ester; Phosvel; PSL; V.C.S.; VCS-506; Velsicol 506; VelsicolVCS 506

CAS Registry Number: 21609-90-5

RTECS® Number: TB1720000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 244-472-8 [*Annex I Index No.:* 015-093-00-3]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (many countries) (UN).[13]

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R25; R39/25; R50/53; Safety phrases: S1/2; S25; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Leptophos is a tan, waxy solid. Molecular weight = 412.07; Freezing/Melting point = about 70°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.028%.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide. Its use is not permitted in the United States.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 6 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 30 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 6.3$.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. This material is highly toxic; it is capable of causing death or permanent injury by exposure during normal use. LD_{50} = (oral-rat) 30 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Leptophos is classified as an organophosphorus pesticide, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, cargo dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including bromine, chlorine, phosphorus oxides, sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be treated with alkali and then burned in a landfill. Large quantities should be incinerated in a unit with effluent gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Leptophos*. Washington, DC: Chemical Emergency Preparedness Program

Lewisite (Agents L-1, L-2, L-3, & HL−WMD) L:0250

Molecular Formula: $C_2H_2AsCl_3$

Common Formula: $ClCH{=}CHAsCl_2$

Synonyms: (2-Chloroethenyl)arsenous dichloride; β-Chlorovinylbichloroarsine; (2-Chlorovinyl)dichloroarsine; 2-Chlorovinyldichloroarsine; Dichloro(2-chlorovinyl)arsine; L-1, L-2, L-3 (military designations); Levista (Spanish); Lewisite (arsenic compound)

Mustard-Lewisite: Agent HL; Sulfur mustard/Lewisite

CAS Registry Number: 541-25-3 (L-1); 40334-69-8 (L-2); 40334-70-1 (L-3); 1306-02-1

RTECS® Number: CH2975000

UN/NA & ERG Number: UN2810/153; UN3162 (Liquefied gas, poisonous, n.o.s.)

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g. (L1, L2, or L3).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high-risk pollutants (Section 63.74), as arsenic compounds.

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as arsenic compounds, n.o.s., waste number not listed.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. (as organic arsenic compound) inhalation hazard.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates.

US DOT 49CFR172.101, Inhalation Hazard Chemical.

WGK (German Aquatic Hazard Class): No value assigned (all above CAS numbers).

Description: Lewisite is a colorless, odorless liquid when pure. Industrially produced lewisite is an amber to dark brown oily liquid with an odor of geraniums. It turns violet to black or green with age. Odor is not a reliable indicator of the presence of toxic amount of vapor. Blister agent, lewisite (L) rapidly decomposes in relative humidity over 70%. Molecular weight = 207.32; Density (20°C) = 1.89 g/cm^3; Volatility = 2500 mg/m^3 at 20°C; Specific gravity = 1.89 at 20°C; Boiling point = 190°C (decomposes); Freezing/Melting point = 0.1°C. Flash point = None. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1. Sinks in water and is slightly soluble; solubility = 0.5 g/L.

Lewisite is a complex mixture of several *cis*- and *trans*-isomer compounds. In chemical-agent-grade lewisite, the L-1 isomer [2-Chlorovinylarsonous dichloride] generally predominates. The three homologues, L-1, L-2 [Bis(2-chlorovinyl)arsinous chloride], and L-3 [Tris(2-chlorovinyl)arsine] form from the catalyzed reaction of arsenic trichloride and acetylene. L-1 forms initially, but it continues to react with acetylene to form L-2 and L-3. L-1 is the vesicant agent. L-2 and L-3 are also toxic but considerably less than L-1.

Mustard−lewisite (military designation HL) is a liquid mixture of distilled mustard (HD) and lewisite (L) and has some properties of both. HL is both a blister agent (vesicant) and an alkylating agent (causes damage to the DNA of rapidly dividing cells). The mustard−lewisite mixture requires lower ambient temperatures before it will freeze; this property allows for improved ground dispersal and aerial spraying. Due to its low freezing point, the mixture remains a liquid in cold weather and at high altitudes. The mixture with the lowest freezing point consists of 63% Lewisite and 37% mustard. Mustard−Lewisite mixture may have a garlic odor. Odor however, should not be depended on to detect HL mixture.[NIOSH] Exposure to large amounts of HL may be fatal.

Potential Exposure: Those involved in the manufacture or use of this chemical warfare agent which is a vesicant. L-1, L-2, and L-3 have been used as a blister-agent-type war gas.

Mustard−lewisite mixture was developed to achieve a lower freezing point for ground dispersal and aerial spraying.

Persistence of Chemical Agent: Agents L or HL: Summer: 1−3 days; Winter: May last for weeks.

Incompatibilities: Lewisite reacts with water and sweat; and, as it breaks down in water or sweat, it produces arsenic-containing materials which are less dangerous than lewisite but still dangerous. Heating causes lewisite to yield arsenic trichloride, tris-(2-chlorovinyl)arsine, and bis-(2-chlorovinyl)chloroarsine. Mustard−lewisite mixture is rapidly corrosive to brass at 65°C and will corrode steel at a rate of 0.0001 in. of steel per month at 65°C. It will hydrolyze into hydrochloric acid, thiodiglycol, and nonvesicant arsenic compounds.

Permissible Exposure Limits in Air The Surgeon General's Working Group (US Department of Health and Human Services) recommends (for the working place) 0.003 mg/m^3, Ceiling Concentration.

Protective Action Criteria (PAC) L-1; L-2; L-3

TEEL-0: 0.12 mg/m^3

PAC-1: 0.12 mg/m^3

PAC-2: 0.12 mg/m^3

PAC-3: 0.74 mg/m^3

Determination in Water: Lewisite dissolves rapidly in water and breaks down into toxic products that are much less dangerous than lewisite, but still poisonous, containing arsenic products. Warn pollution control authorities and advise shutting water intakes. Octanol−water coefficient: Log K_{ow} (estimated) = 2.56. Log $K_{benzene-water}$ = 0.15.

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Lewisite is a cell irritant, blister agent, and systemic poison that can be absorbed through skin; a few drops can cause death. It produces an immediate searing sensation in the eye and permanent loss of sight *if not decontaminated within 1 min.* It produces an immediate and strong stinging sensation to the skin, followed by reddening within 30 min and blistering after about 13 h. This material causes pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure. Inhalation of high concentrations may be fatal in as short a time as 10 min. Lethal dose in humans is 6 ppm (inhalation), 20 mg/kg (skin). Eye injury below 300 mg-min/m^3. Pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long term Exposure: May cause sensitization and chronic lung impairment. It is a suspected carcinogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash—strip—wash—evacuate upwind and uphill: the approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available), and then move away from the hot zone in an upwind and up-hill direction. Wash the victim with warm water and soap. There are differing guidelines for decontamination and more research is needed to identify the optimal decontamination method. The effect of lewisite and mustard−lewisite can be prevented by rapid topical application of 2,3-dimercaptopropanol, known as British anti-lewisite (BAL) which reacts with Lewisite to form a stable nontoxic cyclic product. Decontaminate with diluted household bleach (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Be sure you have decontaminated the victims as much as you can before they leave the area so that they do not spread the Lewisite. Use the antidote "Anti-Lewisite." Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes, and other items.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full face-piece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe (UN3162): Flammability Hazard: Store separately from all other flammable materials. Color Code—Blue (UN2810): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone A] requires a shipping label of "POISONOUS/TOXIC MATERIALS." Inhalation Hazard. Technical name required.

Spill Handling: BACK OFF! Isolate a wide area around the release and call for expert help. If in a building, evacuate and confine vapors by closing doors and shutting down HVAC systems. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid contact with eyes and skin; avoid breathing vapors. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with

time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (*From a small package or a small leak from a large package*)

Agents L-1, L-2, L-3, & HL when used as a weapon

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (*From a large package or from many small packages*)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.7/1.2

Small spills: Cover with vermiculite, diatomaceous earth, clay, or fine sand and neutralize as soon as possible using large amounts of alcoholic caustic, carbonate, or Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]. Caution: acetylene given off. Place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Can be decontaminated by supertropical bleach or caustic soda. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Heating causes lewisite to yield arsenic compounds such as arsenic trichloride (A: 1570), tris-(2-chlorovinyl)arsine, and bis-(2-chlorovinyl)chloroarsine. Firefighting gear (including SCBA) does not provide adequate protection. Use unattended equipment whenever possible. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Specially trained personnel operating from a safe distance can fight fires using foam or dry chemicals, or use fog streams to extinguish burning liquids. Poisonous gases, including chlorine and arsenic, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray from unattended equipment to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

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US Department of Health and Human Services. (November 2, 2006). *ATSDR Medical Management Guidelines for Blister Agents: Lewisite (L) ($C_2H_2AsCl_3$) and Mustard—Lewisite Mixture (HL)*. Atlanta, GA

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Lindane L:0260

Molecular Formula: $C_6H_6Cl_6$

Synonyms: Aalindan; Aficide; Agrisol G-20; Agrocide; Agronexit; Ameisenatod; Ameisenmittel (Merck); Aparasin; Aphtiria; Aplidal; Arbitex; BBH; Ben-Hex; Bentox 10; γ-Benzene hexachloride; Benzene hexachloride; Benzene hexachloride g isomer; Bexol; γ-BHC; BHC; Celanex; Chloresene; Codechine; 2,5-Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1a,2a,3b,4a,5a,6b)-; DBH; Delsanex dairy fly spray; Detmol-extrakt; Detox 25; Devoran; DOL Granule; Drill Tox-Spezial Aglukon; Dual murganic RPB seed treatment; ENT7,796; Entomoxan; Exagama; Forlin; Fumite tecnalin smoke generators; Gallogama; Gamacid; Gamaphex; Gamene; Gammabenzene hexachlorocyclohexane (g isomer); gamma-BHC; gamma-Col; gamma HCH; gamma-HCH; Gammahexa; Gammahexane; Gammalex; Gammalin; Gammalin 20; Gammaphex; Gammasan 30; Gammaterr; Gammex; Gammexane; Gammexene; Gammopaz; Gexane; HCCH; γ-HCH; HCH; HCH BHC; Heclotox; Hexa; γ-Hexachloran; Hexachloran; γ-Hexachlorane; Hexachlorane; γ-Hexachlorobenzene; γ-1,2,3,4,5,6-Hexachlorocyclohexane; γ-Hexachlorocyclohexane; 1a,2a,3b,4a,5a,6b-Hexachlorocyclohexane; 1,2,3,4,5,6-

Hexachlorocyclohexane, *g* isomer; Hexachlorocyclohexane (*g* isomer); Hexachlorocyclohexane, 1,2,3,4,5,6-hexachlorcyclohexane; γ-Hexaclorobenzene; Hexaflow; Hexatox; Hexaverm; Hexicide; Hexyclan; HGI; Hortex; Inexit; Isotox; Jacutin; Kokotine; Kwell; Lendine; Lentox; Lidenal; Lindafor; Lindagam; Lindagrain; Lindagram; Lindagranox; γ-Lindane; Lindane; Lindapoudre; Lindatox; Lindosep; Lintox; Lorexane; Marstan fly spray; Mergamma 30; Milbol 49; Mist-O-Matic Lindex; Mszycol; NCI-C00204; Neo-Scabicidol; Nexen FB; Nexit; Nexit-Stark; Nexol-E; Nicochloran; Novigam; Omnitox; Ovadziak; Owadziak; Pedraczak; Pflanzol; Quellada; Rodesco insect powder; Sang gamma; Silvano; Silvano L; Spritz-Rapidin; Spruehpflanzol; Streunex; TAP85; TRI-6; Viton

CAS Registry Number: 58-89-9; *(alt)* 8007-42-9; *(alt)* 55963-79-6

RTECS® Number: GV4900000

UN/NA & ERG Number: UN2761/151

UN/NA & ERG Number: 200-401-2 [*Annex I Index No.:* 602-043-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B.

NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; IARC: Animal Limited Evidence, 1987.

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion; Positive/limited: Carcinogenicity—mouse/rat; Inconclusive: Host-mediated assay; *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 423, Appendix A, Priority Pollutants; Section 313.

Water Priority Chemicals (57FR41331, 9/9/92); 40CFR 401.15 Section 307 Toxic Pollutants, as hexachlorocyclohexane.

US EPA Hazardous Waste Number (RCRA No.): U129.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.4 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: MCL, 0.0002 mg/L; MCLG, 0.0002 mg/L; Regulated chemical (47 FR 9352).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0017; Nonwastewater (mg/kg), 0.066.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as lindane) See also HCH (mixed isomers) 608-73-1.

California Proposition 65 Chemical: *(Lindane and other hexachlorocyclohexane isomers*) Cancer 1/1/89.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R20/21; R25; R48/22; R64; R50/53; Safety phrases: S1/2; S13; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Lindane is a white to yellow, crystalline powder with a slight, musty odor (pure material is odorless). Molecular weight = 390.82; Specific gravity (H_2O:1) = 1.85; Boiling point = 323.3°C; Freezing/Melting point = 112.8°C; Vapor pressure = 0.00001 mmHg; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water. Noncombustible solid but may be dissolved in flammable liquids.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Lindane has been used against insects in a wide range of applications including treatment of animals, buildings, humans for ectoparasites, clothes, water for mosquitoes, living plants, seeds, and soils. Some applications have been abandoned due to excessive residues, e.g., stored foodstuffs. Formulators, distributors, and users of lindane represent a special risk group. The major use of lindane in recent years has been to pretreat seeds. Thus, those engaged in treatment and planting can be exposed.

Incompatibilities: Lindane decomposes on contact with powdered iron, aluminum, zinc, and with alkalis producing trichlorobenzene. Corrosive to metals.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK: 0.1 mg/m3, inhalable fraction; [skin]; Carcinogen Category 4; Pregnancy Risk Group C.

Austria: MAK 0.5 mg/m^3, [skin], 1999; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, [skin], 1999; Norway: TWA 0.5 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 4 μg/m^3, [skin], 2003; Turkey: TWA 0.5 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for lindane in ambient air[60] ranging from zero (North Dakota) to 0.068 μg/m^3 (Massachusetts) to 1.19 μg/m^3 (Kansas) to 1.2 μg/m^3 (Pennsylvania) to 1.67 μg/m^3 (New York) to 5.0 μg/m^3 (Connecticut, Florida, South Carolina) to 8.0 μg/m^3 (Virginia) to 12.0 μg/m^3 (Nevada).

Determination in Air: Collection on a filter, workup with isooctane, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method 5502.[18]

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.080 μg/L as a 24-h average, never to exceed 2.0 μg/L. *To protect saltwater aquatic life:* never to exceed 0.16 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.186 μg/L.[6] Mexico[35] has set allowable limits on 0.2 μg/L in coastal waters and 2.0 μg/L in estuaries. WHO has set a limit of 3.0 μg/L in drinking water. The US EPA has set 120 μg/L as a long-term health advisory and 2 μg/L as a lifetime health advisory[47] for adults. The state of Maine has set a guideline of 4.0 μg/L for lindane in drinking water. EPA[62] has proposed a maximum level of 0.2 μg/L in drinking water.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen-specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = >3.5.

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact. Fish Tox = 0.11310000 MATC (EXTRA HIGH).

Harmful Effects and Symptoms

Short Term Exposure: Lindane irritates the eyes and the respiratory tract and may affect the central nervous system. Symptoms of exposure include vomiting, faintness, tremor, restlessness, muscle spasms, unsteady gait, and convulsions may occur as a result of exposure. Elevated body temperature and pulmonary edema have been reported in children. Coma, respiratory failure, and death can result. Exposure to vapors of this compound or its thermal decomposition products may lead to headache, nausea, vomiting, and irritation of the eyes, nose, and throat. Lindane is a stimulant of the nervous system; causing violent convulsions that are rapid in onset and generally followed by death or recovery within 24 h. The probable human oral lethal dose is 50−500 mg/kg, or between 1 teaspoon and 1 oz for a 150-lb (70 kg) person. Human Tox = 0.20000 ppb MCL (EXTRA HIGH).

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May damage the liver and kidneys. May damage the nerves in the arms and legs, possibly with weakness and poor coordination. May cause a serious drop in the blood cell count (aplastic anemia) or in the white blood cell count (agranulocytopenia). The Department of Health and Human Services has determined that HCH (hexachlorocyclohexanes) may reasonably be anticipated to be carcinogenic. Liver cancer has been seen in laboratory rodents that ate HCH for long periods of time. In animals, there is evidence that oral exposure to lindane during pregnancy results in an increased incidence of fetuses with extra ribs. However, ATSDR reports that animal studies have not shown birth defects in the babies of animals fed HCH during pregnancy. BCH has been detected in human breast milk.

Points of Attack: Eyes, central nervous system, blood, liver, kidneys, skin.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), blood serum, complete blood count, urine (chemical/metabolite). Blood test for lindane (may not be accurate longer than 1 week following last exposure). Liver and kidney function tests. See *Occupational Health Guidelines for Chemical Hazards*. NIOSH Pub Nos. 81-123; 88-118, Suppls. I−IV. 1981−1995.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: *up to 5 mg/m*^{3}: Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter).* *Up to 25 mg/m^3*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 50 mg/m^3:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly sealed containers in a cool, dry place away from light and incompatible materials. Protect containers against physical damage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Lindane falls under the category of Organochlorine pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam for small fires. Use water spray, fog, or foam for large fires. Move container from fire area if this can be done without risk. Use water to keep fire-exposed containers cool. Isolate hazard area and deny entry. Stay upwind and keep out of low areas. Ventilate closed spaces before entering. Wear positive breathing apparatus and special protective clothing. Fight fire from maximum distance, dike fire control water for later disposal. Poisonous gases, including phosgene and hydrogen chloride, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For the disposal of lindane, a process has been developed involving destructive pyrolysis at 400−500°C with a catalyst mixture which contains 5−10% of either cupric chloride, ferric chloride, zinc chloride, or aluminum chloride on activated carbon. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Hexachlorocyclohexane: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Gamma-Hexachlorocyclohexane: Health and Environmental Effects Profile No. 113*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 62−66

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Lindane*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Gamma-BHC*. Albany, NY: Bureau of Toxic Substance Assessment
US Department of Health and Human Services. (June 1999). *ATSDR ToxFAQs, Hexachlorocyclohexanes*. Atlanta, GA
US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC
New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Lindane*. Trenton, NJ

Liquefied petroleum gas (LPG) L:0270

Molecular Formula: C_3H_8—C_3H_6—C_4H_{10}—C_4H_8 (mixture)
A mixture of propane (C_3H_8) and butane (C_4H_{10}).
Synonyms: Bottled gas; Compressed petroleum gas; Gas de petroleo licuado (Spanish); Liquefied hydrocarbon gas; L.P. G.; Petroleum gas, liquefied; Propane-butane-(propylene); Pyrofax
CAS Registry Number: 68476-85-7
RTECS® Number: SE7545000
UN/NA & ERG Number: UN1075/115
EC Number: 270-704-2 [*Annex I Index No.:* 649-202-00-6]
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
European/International Regulations: Hazard Symbol: F + , T; Risk phrases: R45; R46; R12; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: LPG is a colorless, noncorrosive, odorless gas when pure. A foul-smelling odorant is usually added. Shipped as a liquefied compressed gas (a mixture of propane, butanes, propylene, and butylenes). Boiling point ≥6°C; 42−44°C (propane); −1°C (butane); Flash point = (flammable gas): −104°C (propane); −60°C (butane). Explosive limits: LEL = 2.1%; UEL = 9.5% (propane); LEL = 1.9%; UEL = 8.5% (butane); Autoignition temperature = about 400°C: 466°C (propane); 405°C (butane). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.
Potential Exposure: LPG is used as a fuel propellant, in metal cutting, and in the production of petrochemicals.
Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers and chlorine dioxide may cause fire and explosions. Attacks some plastics, rubber, and coatings.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 1.72−2.37 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 1000 ppm/1800 mg/m^3 TWA.
NIOSH REL: 1000 ppm/1800 mg/m^3 TWA.
ACGIH TLV®[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1−C_4).
NIOSH IDLH: 2000 ppm [LEL].
Protective Action Criteria (PAC)
TEEL-0: 1000 ppm
PAC-1: 2000 ppm
PAC-2: 2000 ppm
PAC-3: 2000 ppm
The Philippines: TWA 1000 ppm (1800 mg/m^3), 1993; Switzerland: MAK-W 1000 ppm (1800 mg/m^3), 1999; Turkey: TWA 1000 ppm (1800 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (1750 mg/m^3); STEL 1250 ppm, 2000; the Netherlands: MAC-TGG 1800 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000.
Routes of Entry: Inhalation, skin and/or eye contact (liquid).
Harmful Effects and Symptoms
Short Term Exposure: Liquefied petroleum gas can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels could cause suffocation and death from lack of oxygen. Contact with liquid liquefied petroleum gas can cause frostbite.
Long Term Exposure: Unknown at this time.
Points of Attack: Respiratory system, central nervous system.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.
First Aid: *Skin Contact:* Do not rub. Seek medical attention. *Breathing:* Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.
Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid a unless full facepiece respiratory protection is worn. Employees should

wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash

Respirator Selection: *2000 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Metal containers involving the transfer of 5 gallons or more of liquefied petroleum gas should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Sources of ignition, such as smoking and open flames, are prohibited where liquefied petroleum gas is handled, used, or stored. Wherever liquefied petroleum gas is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Liquefied petroleum gas is a flammable gas. Use dry chemical, CO_2, water spray, or foam extinguishers. The flame may be invisible. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Flaring using smokeless flare designs.

Reference

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Liquefied Petroleum Gas*. Trenton, NJ

Lithium L:0280

Molecular Formula: Li

Synonyms: Li; Lithium, elemental; Lithium metal; Lithium monohydride

CAS Registry Number: 7439-93-2

RTECS® Number: OJ5540000

UN/NA & ERG Number: UN1415/138; UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-102-5 [*Annex I Index No.:* 003-001-00-4]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R14/15; R34; Safety phrases: S1/2; S8; S43; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Lithium is a silvery to grayish-white metal that turns yellow on exposure to air and/or moisture. Molecular weight = 6.94; Boiling point = 1336−1342°C; Freezing/Melting point = 181°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Violent reaction with water.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector. Lithium is used in inorganic syntheses, manufacture of storage batteries, heat transfer liquids, and metal alloys.

Incompatibilities: Violent reaction with water, forming flammable hydrogen gas and corrosive lithium hydroxide, a strong caustic solution. Heating may cause violent combustion or explosion. Finely divided particles or powdered form may ignite spontaneously in air. Contact with air forms corrosive fumes of lithium hydroxide. Violent reaction with oxidizers, acetonitrile, nitric acid, arsenic, bromobenzene, carbon tetrachloride, hydrocarbons, halogens, halons, sulfur, and many other substances. Forms impact- and friction-sensitive mixtures with bromobenzene, carbon tetrabromide, chloroform (weak explosion), iodoform, halogens, halocarbons, methyl dichloride, methyl diiodide, and other substances. Attacks plastics, rubber, ceramic materials, concrete, sand, and metal alloys: cobalt, iron, manganese, nickel.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 12.5 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 400 mg/m^3

Determination in Air: Use OSHA Analytical Method ID-121; NIOSH Analytical Method #8005, Elements in blood or tissue.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Contact can cause severe skin and eye burns. Inhalation can irritate the respiratory tract causing coughing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure to lithium can cause loss of appetite, nausea, tremor, muscle twitches, apathy, convulsions, coma, and death.

Long Term Exposure: Exposure can cause loss of appetite, nausea, vomiting, diarrhea, and abdominal pain, headache, muscle weakness, loss of coordination, confusion, seizures, and coma. May affect the thyroid gland causing goiter. May affect the kidneys and heart function. Exposure may cause an allergy to develop, affecting the skin, blood vessels, and/or possibly the lungs.

Points of Attack: Lungs, thyroid, kidneys, heart, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: EKG, blood test for lithium. Thyroid function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to lithium, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powdered-air purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Reacts with body moisture, forming corrosive lithium hydroxide: (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (3) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Protect storage containers from physical damage. Lithium must be stored to avoid contact with water, halogenated compounds, carbon dioxide, oxidizers, strong acids, alcohols, metals, chlorinated arsenic compounds, hydrocarbons, sulfur, acetonitrile, nitrogen, and many other materials, since violent reactions occur. Store in tightly closed containers under kerosene or neutral oil in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where lithium is used, handled or stored in a manner that could create a potential fire or explosion hazard. Wherever lithium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group I. For Metal powder, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall into Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep lithium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly reactive, combustible solid that is difficult to extinguish. *Do not use water*, foam, dry chemical, halogenated hydrocarbons, CO_2 on fire or adjacent fire. Use Class D extinguishers, dry clay, dry graphite, limestone, or appropriate special metal fire-extinguishing powder. Poisonous gases, including lithium oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November, 1999). *Hazardous Substances Fact Sheet: Lithium*. Trenton, NJ

Lithium aluminum hydride L:0285

Molecular Formula: AlH_4Li
Common Formula: $LiAlH_4$
Synonyms: Aluminum lithium hydride; Lithium alanate; Lithium aluminohydride; Lithium aluminum tetrahydride; Lithium tetrahydroaluminate
CAS Registry Number: 16853-85-3
RTECS® Number: BD0100000
UN/NA & ERG Number: UN1410 (dry)/138; UN1411 (ether solution)/138
EC Number: 240-877-9 [*Annex I Index No.:* 001-002-00-4]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R15; R35; Safety phrases: S1/2; S7/8; S26; S36/37/39; S43; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lithium aluminum hydride is a white to gray powder. A combustible solid. Decomposes at 125°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: This material is used as a catalyst and as a specialty reducing agent in organic synthesis.

Incompatibilities: Combustible solid. Can ignite spontaneously in moist air or heat. Decomposes on heating at 125°C forming aluminum, lithium hydride, and flammable hydrogen gas. A strong reducing agent. Violent reaction with water, oxidizers, alcohols, acids, dimethylether, ethers, tetrahydrofuran, benzoyl peroxide, boron trifluoride etherate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 2.81 mg/m^3
PAC-1: 2.81 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 35 mg/m^3

Permissible Concentration in Water: No criteria set. Reacts violently with water.

Routes of Entry: Inhalation, ingestion, eyes and/or skin.

Harmful Effects and Symptoms

Short Term Exposure: Lithium aluminum hydride can affect you when breathed in. Contact can cause severe burns of the eyes and skin. Exposure can irritate the eyes, nose, throat, and lungs, causing coughing and sneezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause loss of appetite, nausea, confusion, tremor, and muscle twitching. High exposure can cause coma and death.

Long Term Exposure: Can cause loss of appetite, nausea, vomiting, diarrhea and abdominal pain, headache, muscle weakness, loss of coordination, confusion, seizures, and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Thyroid gland, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. Thyroid function tests. If symptoms develop or overexposure is suspected, the following may be useful: serum lithium level. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Lithium aluminum hydride must be stored to avoid contact with water, air, acids, alcohols, benzoyl peroxide, boron trifluoride etherate, ethers, tetrahydrofuran, and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where lithium aluminum hydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of lithium aluminum hydride. Wherever lithium aluminum hydride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Open only in inert atmospheres or very low humidity rooms.

Shipping: Lithium aluminum hydride (dry) requires a shipping label of “DANGEROUS WHEN WET.” It falls in Hazard Class 4.3 and Packing Group I. Lithium aluminum hydride, ethereal, requires a shipping label of “DANGEROUS WHEN WET, FLAMMABLE LIQUID.” It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Do not use water*, CO_2, or foam. Use Class D extinguishers, dry sand, dry clay, dry limestone, dry graphite. Poisonous gases, including lithium hydride and aluminum oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. Fire may restart after it has been extinguished. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Lithium Aluminum Hydride*. Trenton, NJ

Lithium carbonate L:0290

Molecular Formula: Li_2CO_3
Synonyms: Camcolit; Candamide; Carbolith; Carbolithium; Carbonato de litio (Spanish); Carbonic acid, dilithium salt; Carbonic acid lithium salt; Ceglution; CP-15,467-61; Dilithium carbonate; Eskalith; Hypnorex; Limas; Liskonum; Litard; Lithane; Lithea; Lithicarb; Lithinate; Lithium phasal; Lithizine; Lithobid; Litho-carb; Lithonate; Lithotabs; Manialith; Neurolepsin; NSC 16895; PFI-lithium; PFL-lithium; Plenur; Priadel; Quilonorm; Quilonum retard
CAS Registry Number: 554-13-2
RTECS® Number: OJ5800000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 209-062-5
Regulatory Authority and Advisory Bodies
Listed in the TSCA inventory.
FDA—proprietary drug.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
California Proposition 65 Developmental/Reproductive toxin 1/1/91.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Lithium carbonate is a white hygroscopic powder. Molecular weight = 73.89; Boiling point = 1310°C (decomposes below BP); Freezing/Melting point = 618–735°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Slightly soluble in water.
Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Lithium carbonate is used in treatment of manic-depressive psychoses, to make ceramics and porcelain glaze, varnishes, dyes, pharmaceuticals, coating of arc-welding electrodes, battery alloys, nucleonics, luminescent paints, glass ceramics, lubricating greases, in aluminum production.
Incompatibilities: The aqueous solution is a strong base. Reacts violently with acids and fluorine. Incompatible with oxidizers, moisture. Corrodes aluminum, copper, zinc.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 200 mg/m^3
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: LD_{50} = (oral-rat) 525 mg/kg. Contact causes skin, eye, and respiratory tract irritation. Inhalation can cause nausea, vomiting, diarrhea, and abdominal pain. Can cause lung irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, muscle weakness, muscle twitching, blurred vision, loss of coordination, confusion, seizures, and coma. May affect the central nervous system; cardiovascular, and gastrointestinal systems if ingested.
Long Term Exposure: May cause damage to the developing fetus. May cause skin allergy and dermatitis. High exposure can cause enlarged thyroid (goiter). May damage the stomach, kidneys, and may affect the heart function. May cause reproductive toxicity in humans.
Points of Attack: Skin, thyroid, kidneys, heart.
Medical Surveillance: Blood tests for lithium level. Kidney function tests. Thyroid function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. Refer to FDA regulation for Good Manufacturing Practices 21CFR210.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, fluorine, oxidizers, acids. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: Label: "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1998). *Hazardous Substances Fact Sheet: Lithium Carbonate*. Trenton, NJ

Lithium chromate L:0300

Molecular Formula: $CrH_2O_4 \cdot 2Li$

Synonyms: Lithium chromate(VI); Chromic acid, dilithium salt; Chromium lithium oxide; Dilithium chromate

CAS Registry Number: 14307-35-8

RTECS® Number: GB2915000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 238-244-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical: Cancer (developmental).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Toxic Pollutant (Section 401.15); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as chromium compounds, waste number not listed.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: E, T+, N; Risk Phrases: R45; R46; R60; R61; R2; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Lithium chromate is a yellow crystalline powder. Molecular weight = 165.92; 129.87 (lithium chromate (VI)); 131.90 (*dilithium chromate*); Melting point = 75°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Used as a corrosion inhibitor, heat-transfer agent, and oxidizing agent in leather and metal finishing. Also used in photography, wood preservatives, batteries, safety matches, and cement.

Incompatibilities: Aqueous solution is caustic. An oxidizer; strong reaction with hydrazine, chromic acid, sulfur, reducing agents, combustibles, organic materials, acids. Attacks plastics and aluminum.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0125 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 37.5 mg/m^3

As chromium(VI) inorganic soluble compounds
OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.
NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.
ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.
NIOSH IDLH: 15 mg[Cr(VI)]/m^3.
DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Determination in Air: Use NIOSH Analytical Method (IV) #7024, Chromium.

Permissible Concentration in Water: For the protection of freshwater aquatic life: *Hexavalent chromium:* 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L according to EPA.[6]

US EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62]

Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water.

The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] as 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide); or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45-μm filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, eye and/or skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact causes severe skin and eye irritation and burns. Inhalation can irritate the nose and throat causing coughing and wheezing.

Long Term Exposure: Repeated exposure can cause loss of appetite, nausea, tremor, and convulsions. Lithium chromate is a hexavalent chromium compound and a possible human carcinogen. Handle with care. Related chromium compounds are teratogenic. Can irritate the lungs; may cause bronchitis to develop. May cause skin allergy. Repeated exposure may cause personality changes of depression, anxiety, or irritability. Prolonged exposure may cause deep slow-healing ulcers on the skin, and a sore or hole in nasal septum. May damage the liver and kidneys.

Points of Attack: Lungs, liver, kidneys, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests, pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Lung function tests. Evaluation by a qualified allergist. Liver and kidney function tests. Check skin daily for blisters or little bumps, the first sign of "chrome ulcers." If not treated early, these can last for years following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from acids, hydrazine, chromic acid, combustible materials, sulfur, aluminum, plastics, and reducing agents.

Shipping: Toxic solid, inorganic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding fire. Poisonous gases, including lithium oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Lithium Chromate*. Trenton, NJ

Lithium hydride L:0310

Molecular Formula: HLi

Common Formula: LiH

Synonyms: Hydrure de lithium (French); Hydruro de litio (Spanish); Lithium monohydride

CAS Registry Number: 7580-67-8

RTECS® Number: OJ6300000

UN/NA & ERG Number: UN1414/138; UN2805 (fused, solid)/138

EC Number: 231-484-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Lithium hydride is an off-white to grayish, translucent, odorless solid or white powder that darkens rapidly on exposure to light. Molecular weight = 7.95; Specific gravity (H_2O:1) = 0.78; Boiling point = 850°C (decomposes below BP); Freezing/Melting point = 689°C; Autoignition temperature = 200°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2. A combustible solid that can form airborne dust clouds which may explode on contact with flame, heat, or oxidizers.

Potential Exposure: Compound Description: Human Data. Lithium hydride is used in preparation of lithium aluminum hydride, as a desiccant, used in hydrogen generators and in organic synthesis as a reducing agent and condensing agent with ketones and acid esters, and reportedly used in thermonuclear weapons.

Incompatibilities: Incompatible with oxidizers, halogenated hydrocarbons; acids can cause fire and explosion. Reacts with water, forming caustic lithium hydroxide and flammable hydrogen gas; reaction may cause ignition. May ignite *spontaneously* in moist air and may reignite after fire is extinguished. Reacts with water to form hydrogen and lithium hydroxide. Powdered form and liquid oxygen form an explosive compound. Decomposes exothermically on contact with acids and upon heating to about 500°C, producing flammable hydrogen gas. Reacts with carboxylic acids, lower alcohols, chlorine, and ammonia (at 400°C), forming explosive hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.025 mg/m^3 TWA.

NIOSH REL: 0.025 mg/m^3 TWA.

ACGIH TLV®[1]: 0.025 mg/m^3 TWA.

NIOSH IDLH: 0.5 mg/m^3.

Protective Action Criteria (PAC)*

TEEL-0: 0.025 mg/m^3

PAC-1: **0.025** mg/m^3

PAC-2: **0.100** mg/m^3

PAC-3: **0.500** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.025 mg/m^3, 1993; Austria: MAK 0.025 mg/m^3, 1999; Belgium: TWA 0.025 mg/m^3, 1993; Denmark: TWA 0.025 mg/m^3, 1999; Finland: TWA 0.025 mg/m^3; STEL 0.075 mg/m^3, 1999; France: VME 0.025 mg/m^3, 1999; the Netherlands: MAC-TGG 0.025 mg/m^3, 2003; the Philippines: TWA 0.025 mg/m^3, 1993; Poland: MAC (TWA) 0.025 mg/m^3, 1999; Switzerland: MAK-W 0.025 mg/m^3, 1999; Turkey: TWA 0.025 mg/m^3, 1993; United Kingdom: TWA 0.025 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.025 mg/m^3. Several states have set guidelines or standards for lithium hydride in ambient air[60] ranging from 0.4 μg/m^3 (Virginia) to 0.5 μg/m^3 (Connecticut) to 2.0 μg/m^3 (North Dakota) to 6.0 μg/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 0.3 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Lithium hydride is an alkaline-corrosive agent. Contact with eyes may result in severe damage to the cornea, conjunctiva, and blood vessels. Extreme caution is advised. Acute exposure to lithium hydride may result in irritation and burning of the skin, eyes, and mucous membranes. Increased salivation, dysphagia (difficulty in swallowing), abdominal pain, and spontaneous vomiting may occur. Stridor (high-pitched, noisy respirations), dyspnea (shortness of breath), and pulmonary edema are also common. Apathy and mental confusion may develop, with progression to coma and death.

Long Term Exposure: Lithium can cause loss of appetite, nausea, vomiting, diarrhea, and abdominal pain, headache, muscle weakness, loss of coordination, confusion, seizures, and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, thyroid, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Thyroid function tests. Kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear appropriate clothing to prevent any possibility of contact with air of >0.1 mg/m^3 content. Wear eye protection to prevent any possibility of eye contact. Provide emergency showers and eyewash if air containing >0.5 mg/m^3 is involved. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *up to 0.25 mg/m^3:* 100XQ (any air-purifying respirator with a high-efficiency particulate filter) or Sa (APF = 10) (any supplied-air respirator). *up to 0.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Protect containers against physical damage. Store in isolated, well-ventilated, cool, dry area.

Shipping: Lithium hydride requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group I.

Lithium hydride, fused solid, requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled materials.

Do not allow material to contact water. Shovel up *small spills* with noncombustible absorbent material. Confine *large spills* with dikes, sheets, or tarps to stop spreading. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: In a fire, irritating alkali fumes may form. Lithium hydride can form airborne dust clouds which may explode on contact with flame, heat, or oxidizing materials. Additionally, spontaneous ignition occurs when nitrous oxide and lithium hydride are mixed. Lithium hydride also forms explosive mixtures with liquid oxygen. *Do not use water*, carbon dioxide, dry chemical, or halogenated extinguishing agents, such as carbon tetrachloride. Use Class D extinguishers, dry sand, dry graphite, dry limestone, or ground dolomite-based dry chemical extinguishers, such as "Lith-X." Wear protective goggles or face shield, rubberized gloves, flame-proof outer clothing, respirator, and high boots or shoes. *Large fires:* withdraw from area and let fire burn, as lithium hydride may continue to reignite. A fire, once started, cannot be extinguished by ordinary methods. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Lithium hydride may be mixed with sand, sprayed with butanol and then with water, neutralized and flushed to a sewer with water.

References

US Environmental Protection Agency. (September 1, 1976). *Chemical Hazard Information Profile: Lithium and Lithium Compounds*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Lithium Hydride*. Washington, DC: Chemical Emergency Preparedness Program

Lithium nitrate L:0320

Molecular Formula: $LiNO_3$
Synonyms: Nitric acid, lithium salt
CAS Registry Number: 7790-69-4
RTECS® Number: QU9200000
UN/NA & ERG Number: UN2722/140
EC Number: 232-218-9

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Lithium nitrate is a colorless deliquescent powder. Specific gravity (H_2O:1) = 2.38; Freezing/Melting point = 264°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Lithium nitrate is used in ceramics, pyrotechnics, salt baths, refrigeration systems, and rocket propellants.

Incompatibilities: May explode when exposed to sparks, shock, and heat. Violent reactions with combustible materials, oxidizers, organic materials, reducing agents, strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 50 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Lithium nitrate can affect you when breathed in. Repeated heavy exposure may lead to lithium poisoning. This can cause loss of appetite, nausea, tremor, muscle twitches, apathy, convulsions, coma, and death. Contact with lithium nitrate water solution or powder can cause severe skin and eye burns. A very low sodium diet can increase your risk of health problems from exposure to lithium.

Long Term Exposure: Lithium can cause loss of appetite, nausea, vomiting, diarrhea and abdominal pain, headache, muscle weakness, loss of coordination, confusion, seizures, and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Thyroid, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum lithium level. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to solid lithium nitrate use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposures to liquid lithium nitrate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Lithium nitrate must be stored to avoid contact with wood, paper, oil and heat, and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Protect containers against physical damage, heat, shock, sparks. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use water only. Do not use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Lithium Nitrate*. Trenton, NJ

Lomustine L:0330

Molecular Formula: $C_9H_{16}ClN_3O_2$

Synonyms: Belustine; CCNU; Cecenu; CEENU; 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea; (Chloro-2-ethyl)-1-cyclohexyl-3-nitrosourea; *N*-(2-Chloroethyl)-*N*′-cyclohexyl-*N*-nitrosourea; Chloroethylcyclohexylnitrosourea; CINU; ICIG1109; Lomustine; NCI-C04740; NSC-79037; RB 1509; SRI2200

CAS Registry Number: 13010-47-4

RTECS® Number: YS4900000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 235-859-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (ipr); clear evidence: mouse, no evidence: rat, 1977; NTP: 7th Report on Carcinogens: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, Group 2A, 1999.

California Proposition 65 Chemical: Cancer as 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea.

Regulatory Authority and Advisory Bodies

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 7/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Lomustine is a pale yellow powder. Molecular weight = 233.73; Freezing/Melting point = 90°C. Insoluble in water.

Potential Exposure: Those involved in the manufacture, administration, or consumption of this antineoplastic (anticancer) agent.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long Term Exposure: There is sufficient evidence that 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) is carcinogenic in experimental animals. CCNU caused lung cancers in rats following intraperitoneal or intravenous injection. In mice, intraperitoneal injections of CCNU resulted in a slight increase in the incidence of lymph system neoplasms. Applied to the skin of mice, CCNU did not induce skin tumors, but the duration of the experiment was inadequate. Evidence for the carcinogenicity of CCNU in humans is inadequate. In several reported cases, cancer patients who received CCNU developed leukemia. With one exception, all of these patients also had received other cytotoxic agents and/or irradiation.

Points of Attack: Blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), blood serum, biologic tissue/biopsy, urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

M

Magnesium M:0100

Molecular Formula: Mg
Common Formula: Mg
Synonyms: Magnesium metal; Magnesium pellets; Magnesium powder; Magnesium ribbons; Magnesium scalpings; Magnesium shavings; Magnesium sheet; Magnesium turnings
CAS Registry Number: 7439-95-4
RTECS® Number: OM210000
UN/NA & ERG Number: UN1869/138; UN1418 (powder)/138
EC Number: 012-002-00-9 (pellets); 012-001-00-3 (powder, pyrophoric)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 100 (ACG).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Magnesium is a light, silvery-white metal in various forms and is a fire hazard. Molecular weight = 24.31; Boiling point = 1100°C; Freezing/Melting point = 649°C (pellets); 651°C (powder); Autoignition temperature = 473°C (powder). Explosive limits: LEL = 0.03 kg/m^3. Ignition temperature of dust cloud = 520°C; Minimum Explosive concentration = 0.020 oz/ft^3.[USBM] Relative explosion hazard of dust: Severe. Hazard Identification (based on NFPA-704 M Rating System): (*powder, turnings and ribbon*) Health 0, Flammability 2, Reactivity 2. Reacts with water; insoluble.

Potential Exposure: Magnesium alloyed with manganese, aluminum, thorium, zinc, cerium, and zirconium is used in aircraft, ships, automobiles, hand tools, etc., because of its lightness. Dow metal is the general name for a large group of alloys containing over 85% magnesium. Magnesium wire and ribbon are used for degassing valves in the radio industry and in various heating appliances; as a deoxidizer and desulfurizer in copper, brass, and nickel alloys; in chemical reagents; as a powder in the manufacture of flares, incendiary bombs, tracer bullets, and flashlight powders; in the nuclear energy process; and in a cement of magnesium oxide and magnesium chloride for floors. Magnesium is an essential element in human and animal nutrition and also in plants, where it is a component of all types of chlorophyll. It is the most abundant intracellular divalent cation in both plants and animals. It is an activator of many mammalian enzymes.

Incompatibilities: The substance is a strong reducing agent. Reacts violently with oxidizers, strong acids, acetylene, ammonium salts, arsenic, beryllium fluoride, carbon tetrachloride, carbonates, chloroform, cyanides, chlorinated hydrocarbons, ethylene oxide, hydrocarbons, metal oxides, methanol, phosphates, silver nitrate, sodium peroxide, sulfates, trichloroethylene, and many other substances, causing fire and explosion hazards. Finely powdered, chip or sheet form reacts with moisture or acids, evolving flammable hydrogen gas, causing fire and explosion hazard. Finely divided form is readily ignited by a spark or flame and splatters and burns at above 1260°C.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 150 mg/m^3

No standards set for elemental magnesium.

Determination in Air: Filter collection and atomic absorption analysis.

Permissible Concentration in Water: The World Health Organization (WHO) has established European and International desirable limits ranging from 30 to 125 mg/L, depending on the sulfate concentration. If the sulfate exceeds 250 mg/L, the magnesium is limited to 30 mg/L. The WHO specifies an absolute maximum of 150 mg/L for magnesium in drinking water. In view of the fact that concentrations of magnesium in drinking water are less than those that impart astringent taste, they pose no health problem and are more likely to be beneficial; no limitation for reasons of health is needed. The USSR-UNEP/IRPTC joint project[43] set a MAC of 50 mg/L in water bodies used for fishery purposes.

Determination in Water: Magnesium in water can be determined by atomic-absorption spectrophotometry, with a sensitivity of 15 mg/L, and by photometry with a sensitivity of 100 μg/L.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. Inhaling dust can irritate the respiratory tract, causing coughing, wheezing, and/or shortness of breath. Magnesium and magnesium compounds are mild irritants to the conjunctiva and nasal mucosa, but are not specifically toxic. Inhalation may cause metal fume fever; the symptoms may be delayed for 4−12 h following exposure. On the skin, these hot particles are capable of producing second- and third-degree burns, but they respond to treatment as other thermal burns do. Metallic magnesium foreign bodies in the skin cause no unusual problems in humans. In animal experiments, however, they have caused “gas gangrene”—massive localized gaseous tumors with extensive necrosis. Magnesium salts at levels over 700 gm/L (especially magnesium sulfate) have a laxative effect, particularly on new users, although the human body can adapt to the effects of magnesium with time.

Long Term Exposure: Repeated exposure can cause an accumulation in the body, causing upset stomach.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00012-6

Medical Surveillance: There is no special test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If fragments have become imbedded in the skin and removal cannot be ensured by thorough scrubbing, medical attention for thorough removal is recommended. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: It burns with an intense flame; do not look directly at fire; wear adequate eye protection. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to magnesium, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe (*powder, turnings, and ribbon are flammable solids*): Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Magnesium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), and chlorine trifluoride, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water. Use only nonsparking tools and equipment, especially when opening and closing containers of magnesium. Protect storage containers from physical damage.

Shipping: Magnesium pellets, turnings, or ribbons (UN1869) require a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III. Magnesium powder requires a shipping label of "DANGEROUS WHEN WET, SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.3 and Packing Group III.

Magnesium granules, coated (particle size not <149 μm) require a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use a vacuum to reduce dust during cleanup. Do not dry sweep. Collect powdered material and deposit in sealed containers. Ventilate area after cleanup is complete. Keep magnesium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium is a combustible solid or a flammable powder. It burns with an intense flame. Reacts violently with fire extinguishing agents, such as water, carbon dioxide, and powder. Dangerous when wet. It burns in a current of steam. Powders form explosive mixtures with air. Poisonous gas including magnesium oxide is produced in fire. Fire may restart after it has been extinguished. Use dry sand, MetL-X® powder, or G-1 graphite powder, soda ash, Class D extinguishers, or talc. *Do not use water* or hydrous agents. Fire may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators

recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 79−81

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Magnesium*. Trenton, NJ

Magnesium chlorate M:0110

Molecular Formula: Cl_2MgO_6

Common Formula: $Mg(ClO_3)_2$

Synonyms: Chlorate salt of magnesium; Chloric acid, De-Fol-Ate®; Chloric acid, magnesium; E-Z-Off®; Magnesium dichlorate; Magnesium salt; Magron; MC defoliant; Ortho MC

CAS Registry Number: 10326-21-3

RTECS® Number: FO0175000

UN/NA & ERG Number: UN2723/140

EC Number: 233-711-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Magnesium chlorate is white crystalline solid. Molecular weight = 191.21; Boiling point = 120°C; Freezing/Melting point = 35°C. Soluble in water (reaction).

Potential Exposure: Used as a drying agent and defoliant.

Incompatibilities: A strong oxidizer. Violent reactions with arsenic, carbon, charcoal, copper, phosphorus, sulfur, magnesium oxide, metal sulfides (copper sulfide, arsenic sulfide, tin sulfide, fuels, and strong acids. Reacts with moisture.

Permissible Exposure Limits in Air: Russia[43] set a MAC of 0.1 mg/m^3 in ambient air in residential areas both on a momentary and a daily average basis.

No standards or TEEL available.

Permissible Concentration in Water: Russia[43] set a MAC of 0.35 mg/L in water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium chlorate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Inhaling the dust irritates the respiratory system. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness, dizziness, trouble breathing, collapse, and possible death. Breathing the dust can irritate the air passages, cause sore throat and/or cough with phlegm.

Long Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop with coughing, phlegm, and/or shortness of breath. May affect the kidneys.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to magnesium chlorate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with magnesium chlorate you should be trained on its proper handling and storage. Magnesium chlorate must be stored to avoid contact with aluminum, arsenic, carbon, copper, phosphorus, sulfur, magnesium oxide, metal sulfides, fuels, and strong acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Spilled magnesium chlorate tends to become very sensitive to shock or friction and is an explosion hazard. Keep magnesium chlorate out of sewers since it can ignite flammable or combustible materials and thus cause a fire or explosion hazard. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Magnesium chlorate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Containers may explode in fire; use water spray to keep fire-exposed containers cool. Poisonous gases, including chlorine and magnesium oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Magnesium Chlorate*. Trenton, NJ

Magnesium hydride M:0120

Molecular Formula: H_2Mg

Common Formula: MgH_2

Synonyms: Magnesium(II) hydride; Magnesium dihydride

CAS Registry Number: 7693-27-8; 60616-74-2

RTECS® Number: OM3560000

UN/NA & ERG Number: UN2010/138

EC Number: 231-705-3

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Magnesium hydride is a coarse, gray crystalline solid. Molecular weight = 26.33; Freezing/Melting point $\geq$200°C; flash point = 110°C. Insoluble in water (dangerous reaction). Decomposes at 280°C in high vacuum.

Potential Exposure: Used in the production of hydrogen and magnesium alcoholates.

Incompatibilities: A strong reducing agent. Pyrophoric; the powder or dust may ignite spontaneously in air or in the presence of moisture. Contact with water or steam forms magnesium hydroxide, flammable hydrogen gas, and enough heat to ignite the hydrogen. Violent reaction with oxidizers, alcohols, halogens, chlorinated solvents. Incompatible with strong acids, acid chlorides. Store under nitrogen.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium hydride can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm.

Long Term Exposure: Long-term effects are unknown at this time.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to magnesium hydride, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a particulate (dust/fume/mist) filter. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Store under nitrogen in tightly closed containers in cool (decomposes >250°C), well-ventilated area. Keep containers dry at all times. Magnesium hydride reacts violently with water, releasing caustic material, heat, and flammable gas. Sources of ignition, such as smoking and open flames, are prohibited where magnesium hydride is handled, used, or stored.

Shipping: Magnesium hydride requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use vacuum to reduce dust during cleanup. Do not use dry sweep. Collect powdered material in the safest manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep magnesium hydride out of sewers because of possibility of fire or explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium hydride is a flammable and reactive solid. Use dry chemical, sand, soda ash, or lime extinguishers. *Do not use water*, carbon dioxide, or foam. Magnesium hydride can catch fire spontaneously in air or in the presence of moisture. Fire may restart after it has been extinguished. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Magnesium Hydride*. Trenton, NJ

Magnesium nitrate M:0130

Molecular Formula: MgN_2O_6

Common Formula: $Mg(NO_3)_2$

Synonyms: Nitric acid, Magnesium salt; Nitromagnesite

CAS Registry Number: 10377-60-3; 10213-15-7 (hexahydrate)

RTECS® Number: OM3750000

UN/NA & ERG Number: UN1474/140

EC Number: 233-826-7 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Magnesium nitrate is white crystalline solid. Molecular weight = 148.33; 256.45 (hexahydrate); Freezing/Melting point = 129°C (dihydrate); 95−100°C (hexahydrate). It decomposes at 330°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2 OX. A strong oxidizer. Soluble in water.

Potential Exposure: Magnesium nitrate is used in fireworks and in the production of concentrated nitric acid.

Incompatibilities: A powerful oxidizer. Violent reaction with dimethylformamide, reducing agents, combustibles, fuels, organic and easily oxidizable matter.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium nitrate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. The dust can irritate the eyes and air passages, causing sore throat and/or cough with phlegm. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness, nausea, and a bluish color to the skin and lips (methemoglobinemia). Higher levels can cause trouble breathing, collapse, and even death.

Long Term Exposure: Repeated exposure can cause headache, weakness, and dizziness.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to magnesium nitrate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard (*strong oxidizer*); Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Magnesium nitrate must be stored to avoid contact with dimethyl formamide, fuels, and strong reducing agents, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Avoid storage on wood floors. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep magnesium nitrate out of sewers since it can ignite flammable and combustible materials and thus cause a fire or explosion hazard. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Magnesium nitrate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Use water spray to keep fire-exposed containers cool. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Magnesium Nitrate*. Trenton, NJ

Magnesium oxide M:0140

Molecular Formula: MgO

Synonyms: Akro-mag; Animag; Calcined brucite; Calcined magnesia; Calcined magnesite; Granmag; Magcal; Magchem 100; Maglite; Magnesia; Magnesia fume; Magnesia USTA; Magnesium oxide fume; Magox; Marmag; Periclase; Seawater magnesia

CAS Registry Number: 1309-48-4

RTECS® Number: OM3850000

UN/NA & ERG Number: UN1418 (powder)/138

EC Number: 215-171-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

Water Pollution Standard Proposed (EPA).[32]

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Magnesium oxide forms a finely divided white particulate dispersed in air. Molecular weight = 40.31; Boiling point = 3600°C; Freezing/Melting point = 2800°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1. Poor solubility in water.

Potential Exposure: Compound Description: Tumorigen; Human Data. Used in oil refining, pulp, and paper mills, in tire manufacturing, in the manufacture of refractory crucibles, fire bricks, magnesia cements, and boiler scale compounds. Exposure may occur when magnesium is burned, thermally cut, or welded upon.

Incompatibilities: Violent reaction with halogens, chlorine trifluoride, bromine pentalfluoride, phosphorous pentachloride, strong acids. May ignite and explode when heated with sublimed sulfur, magnesium powder, or aluminum powder.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (*total particulate; fume*) TWA.

NIOSH: There is inadequate data to propose an exposure limit. See Appendix D of *The NIOSH Pocket Guide.*

ACGIH TLV®[1]: 10 mg/m^3 TWA (*inhalable fraction*); not classifiable as a human carcinogen.

NIOSH IDLH: 750 mg/m^3 (fume).

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 4 mg/m^3, inhalable fraction; 1.5 mg/m^3, respirable fraction; see sections V(f) and V(g). See V(h) for fume; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 10 mg/m^3, 1993; Australia: TWA 10 mg/m^3, 1993; Austria: MAK 6 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; France: VME 10 mg/m^3, 1999; Hungary: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; Norway: TWA 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Poland: MAC (TWA) fume 5 mg/m^3, MAC (TWA) dust 10 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 6 mg/m^3, 1999; Turkey: TWA 15 mg/m^3, 1993; United Kingdom: TWA 10 mg[Mg]/m^3, total inhalable dust; TWA 4 mg[Mg]/m^3, fume and respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for magnesium oxide fume in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7300 (Elements by ICP), #7301, #7303; OSHA Analytical Method #ID-125G.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 138 μg/L for magnesium oxide based on health effects.

Routes of Entry: Inhalation of fume, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Magnesium in the form of nascent magnesium oxide can cause metal fume fever with cough, chest pain, flu-like fever, if inhaled in sufficient quantity. The symptoms of metal fume fever may be delayed for 4−12 h following exposure.

Long Term Exposure: It has been noted that magnesium workers show a rise in serum magnesium, although no significant symptoms of ill health have been identified. Some investigators have reported higher incidence of digestive disorders and have related this to magnesium absorption, but the evidence is scant.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: NIOSH lists the following test for fume exposure: whole blood (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 h following exposure: it may last less than 36 h.

Note to physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *as fume* OSHA: *up to 150 mg/m^3*: 95XQ [Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. Sa (APF = 10) (any supplied-air respirator). *Up to 375 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PAPRDMFu* (any powered, air-purifying respirator with a dust, mist, and fume filter). *Up to 750 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store finely divided powder, chips, or shavings separately in detached fire-resistant building isolated from flammables, combustibles, or other yellow coded materials. Protect against physical damage. Prior to working with this chemical you should be trained on its proper handling and storage. Magnesium oxide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates, and chlorine trifluoride), halogens, strong acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated, "No Smoking" area away from moisture. Use nonsparking-type tools and equipment, including explosion-proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

Shipping: Magnesium *powder* requires a shipping label of "DANGEROUS WHEN WET, SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.2 & 4.3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. May ignite and explode when heated with sublimed sulfur, magnesium powder, or aluminum powder. Use any extinguisher suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Magnesium Oxide (Fume)*. Trenton, NJ

Magnesium perchlorate M:0150

Molecular Formula: Cl_2MgO_8

Common Formula: $Mg(ClO_4)_2$

Synonyms: Ammonium perchlorate, anhydrous; Ammonium perchlorate, hexahydride; Anhydrone®; Dehydrite®; Perchlorate de magnesium (French); Perchloric acid, Magnesium salt

CAS Registry Number: 10034-81-8

RTECS® Number: SC8925000

UN/NA & ERG Number: UN1475/140

EC Number: 233-108-3

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Magnesium perchlorate is a white crystalline solid. Molecular weight = 223.21; Freezing/Melting point ≥250°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Magnesium perchlorate is used as a drying agent for gases and as an oxidizing agent.

Incompatibilities: A powerful oxidizer. Violent reaction with reducing agents, alkenes (above 220°C), ammonia gas, organic matter, ethylene oxide, powdered metals, phosphorus, dimethylsulfoxide, mineral acids, wet argon, hydrazines, alcohols, wet fluorobutane, butyl fluorides, organic materials. Forms explosive material with ethyl alcohol. Incompatible with many materials. Shock may cause magnesium perchlorate to explode.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 6 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 125 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium perchlorate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm. High levels can interfere with the ability of the blood to carry oxygen, causing headaches, dizziness, and a bluish color to the skin. Very high levels could cause death.

Long Term Exposure: Can irritate the lungs. Repeated exposure may cause bronchitis.

Points of Attack: Lungs, blood.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following maybe useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to magnesium perchlorate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Magnesium perchlorate must be stored to avoid contact with fuels, finely powdered metals, mineral acids, ammonia, ethylene oxide, phosphorus, dimethyl sulfoxide, and trimethyl phosphite, since violent reactions occur. Shock may cause magnesium perchlorate to explode. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Do not store on wood floors. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use vacuum to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the safest manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Magnesium perchlorate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Poisonous gases, including chlorides and magnesium oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999) *Hazardous Substances Fact Sheet: Magnesium Perchlorate*. Trenton, NJ

Magnesium peroxide M:0160

Molecular Formula: MgO_2

Synonyms: IXPER 25M; Magnesium dioxide; Magnesium superoxol; Peromag; Peróxido de magnesio (Spanish); Peroxyde de magnésium (French)

CAS Registry Number: 14452-57-4 (MgO); 1335-26-8 (MgO_2)

RTECS® Number: OM4100000

UN/NA & ERG Number: UN1476/140

EC Number: 238-438-1

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Magnesium peroxide is a white, odorless crystalline solid. Molecular weight = 56.31 (MgO_2); 40.3 (MgO); Decomposes above 100°C. Insoluble in water.

Potential Exposure: Magnesium peroxide is used as a bleaching and oxidizing agent and in the manufacture of antacids and anti-infective drugs.

Incompatibilities: Powerful oxidizer. Dangerous fire risk with flammable and combustible materials. Violent reaction with acids. Keep away from moisture; causes the release of oxygen and heat.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium peroxide can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm.

Long Term Exposure: This chemical is a very irritating substance and it may cause lung effects or damage.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Where there is potential for exposures to magnesium peroxide, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Magnesium peroxide must be stored to avoid contact with acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep magnesium peroxide dry. In contact with moisture, it is a dangerous fire hazard because it releases oxygen and much heat. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use a vacuum or a wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Magnesium peroxide itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Poisonous gases, including magnesium oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Magnesium Peroxide*. Trenton, NJ

Magnesium silicide M:0170

Molecular Formula: Mg_2Si

Synonyms: Dimagnesium silicide

CAS Registry Number: 22831-39-6; 39404-03-0

RTECS® Number: OM4367000

UN/NA & ERG Number: UN2624/138

EC Number: 245-254-5

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Magnesium silicide is a slate-blue crystalline solid. Molecular weight = 76.71; Freezing/Melting point = 778°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1 ₩. Dangerous reaction with water.

Potential Exposure: Magnesium silicide is used in the semiconductor industry and to produce certain aluminum alloys.

Incompatibilities: Pyrophoric; mixtures with air are spontaneously explosive. Reacts with water; evolves explosive hydrogen and self-igniting toxic silane gas. Incompatible with mineral acids.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: No criteria set.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin and/or eyes. Breathing the dust can irritate the air passages, causing cough with phlegm. In contact with moisture or acid or acid mist, a highly irritating and flammable gas (silane) is released.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to magnesium silicide, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Flammable solid. Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids. Keep dry at all times. Sources of ignition, such as smoking and open flames, are prohibited where magnesium silicide is handled, used, or stored.

Shipping: Magnesium silicide requires a shipping label of “DANGEROUS WHEN WET.” It falls in Hazard Class 4.3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum; do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep magnesium silicide out of sewers because of possibility of fire or explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium silicide is a flammable solid. Forms flammable hydrogen or silane gas on contact with water. Use dry chemical, soda ash, or lime extinguishers. *Do not use water* or foam. Poisonous fumes of sodium monoxide are produced in a fire. Ignites spontaneously in air. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Magnesium Silicide*. Trenton, NJ

Magnesium silicofluoride M:0180

Molecular Formula: F_6MgSi

Common Formula: $MgSiF_6$

Synonyms: Eulava SM; Fluosilicate de magnesium (French); Magnesium fluorosillicate; Magnesium hexafluorosillicate; Magnesium hexahydrate; Magnesium silicofluoride; Silicate(2-), hexafluoro-

CAS Registry Number: 16949-65-8; 18972-56-0 (Hexafluorosilicate); *(alt.)* 1310-00-5

RTECS® Number: W8575000

UN/NA & ERG Number: UN2853/151

EC Number: 241-022-2 [*Annex I Index No.:* 009-018-00-3] (magnesium hexafluorosilicate)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

European/International Regulations (*16949-65-8; magnesium hexafluorosilicate*): Hazard Symbol: T; Risk phrases: R25; Safety phrases: S1/2; S24/25; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Magnesium silicofluoride is a white crystalline solid. Molecular weight = 274.52. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Magnesium silicofluoride is used as a concrete hardener and waterproofing agent. Hexafluoro is used as an agricultural chemical.

Incompatibilities: Strong acids.

Permissible Exposure Limits in Air

As fluorides

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA 2.5 mg(F)/m^3, 1993; Austria: MAK 0.5 mg(Sb)/m^3, 1993; Austria: MAK 2.5 mg(F)/m^3, 1999; Belgium: TWA 0.5 mg (Sb)/m^3, 1993; Belgium: TWA 2.5 mg(F)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Finland: TWA 0.5 mg (Sb)/m^3, 1993; Finland: TWA 2.5 mg(F)/m^3, 1993; France: VME 0.5 mg(Sb)/m^3, 1993; France: VME 2.5 mg(F)/m^3, 1999; Hungary STEL 0.5 mg(Sb)/m^3, 1993; Hungary: TWA 1 mg(F)/m^3, STEL 2 mg(F)/m^3, 1993; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.6 mg(F)/m^3, 1999; the Philippines: TWA 0.5 mg(Sb)/m^3, 1993; the Philippines: TWA 2.5 mg(F)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3, 1993; Poland: MAC (time-weighted average) 1 mg(HF)/m^3; MAC (STEL) 3 mg(HF)/m^3, 1999; Russia: STEL 0.3 mg/m^3, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2.5 mg

(F)/m^3; United Kingdom: TWA 0.5 mg(Sb)/m^3; TWA 2.5 mg(F)/m^3, 2000.

Note: the OSHA PEL for fluorides (measured as fluorine) is 2.5 mg/m^3 TWA for an 8-h work-shift.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Magnesium silico-fluoride can affect you when breathed in. Skin contact may cause irritation, rash, and ulcers. Eye contact causes irritation with possible permanent damage.

Long Term Exposure: Repeated exposure can cause brittle bones, and muscle and ligament stiffness, with eventual crippling. Overexposure causes irritation of the throat and air passages. Repeated exposure may cause poor appetite, nausea, constipation, or diarrhea. May cause lung damage.

Points of Attack: Lungs.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic Fluorides.*

Respirator Selection: NIOSH/OSHA as fluorine *1 ppm:* Sa (APF = 10) (any supplied-air respirator). *2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *25 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS end of service life indicator (ESLI) required [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric).

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases and fumes are produced in a fire, including hydrogen fluoride, silicon tetrafluoride, and magnesium oxide fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference
New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Magnesium Silico-Fluoride*. Trenton, NJ

Malathion M:0190

Molecular Formula: $C_{10}H_{19}O_6PS_2$
Synonyms: Agrichem greenfly spray; AI3-17034; All purpose garden insecticide; American Cyanamid 4,049; Banmite; *S*-[1,2-Bis(aethoxy-carbonyl)-aethyl]-*O*,*O*-dimethyl-dithiophosphat (German); *S*-[1,2-Bis(carbethoxy)ethyl] *O*, *O*-dimethyl dithiophosphate; *S*-[1,2-Bis(ethoxycarbonyl) ethyl] *O*,*O*-dimethyl phosphorodithioate; *S*-1,2-Bis(ethoxycarbonyl)ethyl *O*,*O*-dimethyl thiophosphate; Butanedioic acid, [(dimethoxyphosphinothioyl)thio]-, diethyl ester; Calmathion; Carbethoxy malathion; Carbetovur; Carbetox; Chemathion; Cimexan; Compound 4049; Cromocide; Cythion; Detmol 96%; Detmol MA; Detmol malathion; *S*-(1,2-Dicarbethoxyethyl) *O*,*O*-dimethyl phosphorodithioate; Dicarboethoxyethyl *O*,*O*-dimethyl phosphorodithioate; Diethyl [(dimethoxyphosphinothioyl)-thio]butanedioate; Diethyl (dimethoxyphosphinothioylthio)-succinate; Diethyl (dimethoxythiophosphorylthio)succinate; Diethyl mercaptosuccinate, *O*,*O*-dimethyl dithiophosphate, *S*-ester; Diethyl mercaptosuccinate, *O*,*O*-dimethyl phosphorodithioate; Diethyl mercaptosuccinate, *O*,*O*-dimethyl thiophosphate; Diethyl mercaptosuccinate, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; [(Dimethoxyphosphinothioyl)thio]butanedioic acid diethyl ester; *O*,*O*-Dimethyl *S*-(1,2-dicarbaethoxyaethyl)-dithiophosphat (German); *O*,*O*-Dimethyl *S*-(1,2-dicarbethoxyethyl) dithiophosphate; *O*,*O*-Dimethyl *S*-(1,2-dicarbethoxyethyl) phosphorodithioate; *O*,*O*-Dimethyl *S*-1,2-di(ethoxycarbamyl)ethyl phosphorodithioate; *O*,*O*-Dimethyl dithiophosphate diethyl mercaptosuccinate; *O*,*O*-Dimethyl dithiophosphate of diethyl mercaptosuccinate; Dithiophosphate de *O*,*O*-dimethyle et de *S*-(1,2-dicarboethoxyethyle) (French); Duramitex; EL 4049; Emmatos; Emmatos extra; ENT 17,034; Ethiolacar; Etiol; Eveshield captan/malathion; Extermathion; Fisons greenfly and blackfly killer; FOG 3; Formal; Forthion; Fosfothion; Fosfotion; Greenfly aerosol spray; Hilthion (Indian); Karbofos; Kop-thion; Kypfos; Malacide; Malafor; Malagran; Malakill; Malamar; Malamar 50; Malasol; Malaspray; Malataf; Malathion 60; Malathion E50; Malathion LB concentrate; Malathion organophosphorous insecticide; Malathon; Malathyl; Malation (Spanish); Maldison (in Australia, New Zealand); Malmed; Malphos; Mercaptosuccinic acid diethyl ester; Mercaptothion; Moscarda; NCI-C00215; Oleophosphothion; Orthomalathion; PBI crop saver; Phosphothion; Prioderm; Sadofos; Sadophos; SF 60; Siptox I; Spray concentrate; STCC 4941156; Succinic acid, mercapto-, diethyl ester, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; Sumitox; TAK; TM-4049; Vetiol; Zithiol

CAS Registry Number: 121-75-5
RTECS® Number: WM8400000
UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152
EC Number: 204-497-7 [*Annex I Index No.:* 015-041-00-X]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); no evidence: rat; IARC: Animal Inadequate Evidence.
US EPA Gene-Tox Program, Positive/dose response: *In vitro* SCE—human; Negative: Carcinogenicity—mouse/rat; Histidine reversion—Ames test; Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
FDA—proprietary drug.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R43; R50/53; Safety phrases: S2; 24; S37; S46; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: It is a deep-brown to yellow liquid with a garlic-like odor. Clear and colorless when pure; Freezing/Melting point = 3°C; Molecular weight = 330.38; Boiling point = 156−157°C; Vapor pressure = 8×10^{-6} mmHg at 20°C; Flash point ≥163°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Malathion is marketed as 99.6% technical grade liquid. Available formulations include wetable powders (25% and 50%), emulsifiable concentrates, dusts, and aerosols. Malathion is used as a broad spectrum insecticide and acaricide in the control of certain insect pests on fruits, vegetables, and ornamental plants. It has been used in the control of houseflies, mosquitoes, lice, and on farm and livestock animals.
Incompatibilities: Reacts violently with strong oxidizers, magnesium, alkaline pesticides. Attacks metals including iron, steel, tin plate, lead, copper, and some plastics, coatings, and rubbers.
Permissible Exposure Limits in Air
OSHA PEL: 15 mg/m^3 (*total dust*) TWA [skin].
NIOSH REL: 10 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 1 mg/m^3 TWA measured as inhalable fraction and vapor; [skin]; not classifiable as a human carcinogen; TLV-BEI$_A$ issued as Acetylcholinesterase-inhibiting pesticides.
NIOSH IDLH: 250 mg/m^3.
Protective Action Criteria (PAC)*
TEEL-0: 1 mg/m^3
PAC-1: **15** mg/m^3
PAC-2: **120** mg/m^3
PAC-3: **390** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 15 mg/m^3 inhalable fraction TWA; Peak Limitation Category II(4); Pregnancy Risk Group D.
Arab Republic of Egypt: TWA 10 mg/m^3, [skin], 1993; Australia: TWA 10 mg/m^3, [skin], 1993; Austria: MAK: 10 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, [skin], 1993; Denmark: TWA 5 mg/m^3, [skin], 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 10 mg/m^3, [skin], 2003; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 15 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3, [skin], 1993; Switzerland: MAK-W 10 mg/m^3, [skin], 1999; Thailand: TWA 15 mg/m^3, 1993; Turkey: TWA 15 mg/m^3, [skin], 1993; United Kingdom: TWA 10 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Argentina[35]: STEL 1.5 mg/m^3. Russia[43] has set MAC values in the ambient air of residential areas at 0.015 mg/m^3 on a momentary basis and 0.006 mg/m^3 on a daily average basis. Several states have set guidelines or standards for malathion, in ambient air[60] ranging from 33.3 μg/m^3 (New York) to 100 μg/m^3 (Florida, North Dakota, South Carolina) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method ID-62.

Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/L in water bodies used for domestic purposes. The MAC in water bodies used for fishery purposes is zero. Several states have set guidelines for malathion in drinking water[61] ranging from 40 μg/L (Maine to 140 μg/L (Kansas) to 160 μg/L (California).

Determination in Water: Fish Tox = 0.28991000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation of vapor, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Malathion is representative of a general class called organophosphates. The effects caused by many short-term exposures during a week's time can be accumulated and felt as one intense response. Sometimes effects are not felt until hours or days after exposure. *Inhalation:* No effects were reported from exposures of up to 86 mg/m^3 for 42 days. The only effect reported due to inhalation was the reduction in activity of an important nervous system enzyme. *Skin:* Important route of exposure during formulation and usage. Prolonged contact (hours) along with poor hygiene has resulted in irritation, as well as symptoms listed under ingestion. *Eyes:* Direct contact can lead to irritation and discomfort. *Ingestion:* Swallowing of malathion has caused severe poisoning and death. Swallowing of 1½–3 oz of a moisture (50% malathion) has caused severe poisoning with symptoms which include nausea, vomiting, headache, abdominal pain, diarrhea, difficulty in breathing, fall in blood pressure, muscle spasms, paralysis, loss of reflexes, convulsions, and coma. Between 3½ and 5 oz of a mixture (50% malathion) has caused death. Human Tox = 100.00000 ppb (VERY LOW).

Long Term Exposure: Prolonged, daily contact with exposed areas of skin has led to skin irritation and sensitization. May cause genetic changes (mutations). High or repeated exposure may damage the nerves, causing weakness, dizziness, and poor coordination in arms and legs. Repeated exposures may cause personality changes, depression, anxiety, or irritability.

Points of Attack: Eyes, skin, respiratory system, liver, blood cholinesterase, central nervous system, cardiovascular system, gastrointestinal tract.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Preplacement and periodic medical examination shall include comprehensive initial or interim medical and work histories. A physical examination which shall be directed toward, but not limited to evidence of frequent headache, dizziness, nausea, tightness of the chest, dimness of vision, and difficulty in focusing the eyes. Determination, at the time of the preplacement examination, of a baseline or working baseline erythrocyte ChE activity. A judgment of the worker's physical ability to use negative or positive-pressure regulators as defined in 29 CFG 1910.134. Periodic examinations shall be made available on an annual basis or at some other interval determined by the responsible physician. Medical records shall be maintained for all workers engaged in the manufacture or formulation of malathion and such records shall be kept for at least 1 year after termination of employment. Pertinent medical information shall be available to medical representatives of the US Government, the employer, and the employees. Erythrocyte cholinesterase levels should be checked as noted above and as described in detail by NIOSH Criteria Document No. 76-205.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician or trained medical personnel: Administer atropine, 2 mg (0.030 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3−8 min until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 1 mg of atropine. Watch respiration and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. Give 2-PAM (Pralidoxime; Protopam), 2.5 g in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 min; if sufficient fluid is not available, give 1 g of 2-PAM in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **4 h**: Teflon™ gloves, suits, boots; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Respirator Protection:* Engineering controls shall be used wherever feasible to maintain airborne malathion concentrations below the recommended work-place environment limit. Compliance with the work-place environmental limit by the use of respirators is allowed only when airborne malathion concentrations exceed the work-place environmental limit because required engineering controls are being installed or tested, when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with NIOSH requirements.

Respirator Selection: *100 mg/m³:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator) SCBA (any self-contained breathing apparatus). *250 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter) SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated, uninhabited area below 25°C. Store to avoid contact with oxidizers and alkaline pesticides. Store where possible leakage from containers cannot endanger the worker. Maintain regular inspection of containers for any leakage. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Malathion is combustible but ignites with difficulty. A fire should be extinguished with agents suitable to the surrounding combustibles. Poisonous gases, including sulfur dioxide and phosphoric acid, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Malathion is reported to be "hydrolyzed almost instantly" at pH 12; 50%; hydrolysis at pH 0 requires 12 h. Alkaline hydrolysis under controlled conditions (0.5 N NaOH in ethanol) gives quantitative yields of $(CH_3O)_2P(S)SNa$, whereas hydrolysis in acidic media yields $(CH_3O)_2P(S)OH$. On prolonged contact with iron or iron-containing material, it is reported to break down and completely lose insecticidal activity. Incineration together with a flammable solvent in a furnace equipped with afterburner and scrubber is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

National Institute for Occupational Safety and Health. (June 1976). *Criteria for a Recommended Standard: Occupational Exposure to Malathion*, NIOSH Document No. 76-205. Washington, DC

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Malathion*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 5, 63−74

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Malathion*. Trenton, NJ

Maleic acid M:0200

Molecular Formula: $C_4H_4O_4$

Common Formula: HOOCCH = CHCOOH

Synonyms: *cis*-Butenedioic acid, (Z)-; Butenedioic acid, (Z)-; *cis*-Butenedioic anhydride; (Z)-1,2-Ethylenedicarboxylic acid; *cis*-1,2-Ethylenedicarboxylic acid; 1,2-Ethylenedicarboxylic acid, (Z); *cis*-1,2-Ethylenedicarboxylic acid, toxilic acid; Maleinic acid; Malenic acid; Toxilic acid

CAS Registry Number: 110-16-7

RTECS® Number: OM9625000

UN/NA & ERG Number: UN2215/156

EC Number: 203-742-5 [*Annex I Index No.*: 607-095-00-3]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36/37/38; R43; Safety phrases: S2; S24; S26; S28; S37; 46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Maleic acid is a white crystalline solid with a faint, acidulous odor. Molecular weight = 116.08; Specific gravity (H_2O:1) = 1.59; Boiling point = (decomposes below BP at 135°C); Freezing/Melting point = 131°C; also listed at 138−139°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water; solubility = $>75\%$.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Maleic acid is used to make artificial resins, antihistamines, and to preserve (retard rancidity) fats and oils.

Incompatibilities: Oxidizers, strong bases, amines, reducing agents, alkali metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 300 mg/m^3

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <-0.6$.

Routes of Entry: Inhalation, skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Maleic acid can affect you when breathed in and by passing through your skin. Contact can cause severe eye burns leading to permanent damage. Contact can irritate the skin. Exposure may cause you to feel dizzy and lightheaded. Exposure can irritate the nose, throat, and lungs and cause coughing or shortness of breath. Very high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation and bronchitis. May affect the kidneys.

Points of Attack: Lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following maybe useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For maleic acid (>70%) Natural rubber, Neoprene™, nitrile + PVC, nitrile, polyethylene, and Viton™ are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: Where there is potential for exposure to maleic acid as dust, mist, or fume, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for exposures to maleic acid as a liquid, or for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Maleic acid must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), amines (such as aniline), and alkali metals (such as sodium and potassium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. For *small spills*, cover with soda ash or sodium bicarbonate, mix, add water, neutralize, and wash down drain with copious amounts of water. Use HEPA vacuum; do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, polymer, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. *Liquid:* incinerate after mixing with a flammable solvent. Use afterburner for complete combustion. *Solid:* dissolve in a flammable solvent or package in paper and burn. See above.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 1, 61−65

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Maleic Acid*. Trenton, NJ

Maleic anhydride M:0210

Molecular Formula: $C_4H_2O_3$

Common Formula: $(CHCO)_2O$

Synonyms: Acido malico (Spanish); BM 10; *cis*-Butenedioic anhydride; Dihydro-2,5-dioxofuran; 2,5-Dihydrofuran-2,5-dione; 2,5-Furandione; 2,5-Furanedione; Maleic acid anhydride; Toxilic anhydride

CAS Registry Number: 108-31-6

RTECS® Number: ON3675000

UN/NA & ERG Number: UN2215/156

EC Number: 203-571-6 [*Annex I Index No.:* 607-096-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U147.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R22; R34; R42/43; Safety phrases: S2; S22; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Maleic anhydride is colorless needles, white lumps, or pellets with an irritating, choking odor. The odor threshold is 0.32 ppm. Molecular weight = 98.06; Specific gravity (H_2O:1) = 1.48; Boiling point = 202.2°C; Freezing/Melting point = 52.8°C; Vapor pressure = 0.2 mmHg at 20°C; Flash point = 102°C (cc); Autoignition temperature = 477°C. Explosive limits: LEL = 1.4%; UEL = 7.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly reacts with and is soluble in water; solubility = 40%. Maleic anhydride may be transported as hot (70°C) liquid.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Maleic anhydride is used in unsaturated polyester resins, agricultural chemical and lubricating additives, in the manufacture of unsaturated polyester resins, in the manufacture of fumaric acid, in alkyd resin manufacture, and in the manufacture of pesticides (e.g., malathion, maleic hydrazide, and captan).

Incompatibilities: Reacts slowly with water (hydrolyzes) to form maleic acid, a medium strong acid. Reacts with strong oxidizers, oil, water, alkali metals, strong acids, strong bases. Violent reaction with alkali metals and amines above 66°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.01 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.25 ppm/1 mg/m^3/TWA.

NIOSH REL: 0.25 ppm/1 mg/m^3/TWA.

ACGIH TLV®[1]: 0.1 ppm/0.4 mg/m^3/TWA; danger of sensitizaton. Notice of intended change: 0.01 measured as inhalable fraction and vapor.

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.2** ppm

PAC-2: **2** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.1 ppm/0.41 mg/m^3 TWA; Peak Limitation Category I(1), a momentary value of 0.2 mL/m^3/0.81 mg/m^3 should not be exceeded; danger of skin and airways; Pregnancy Risk Group C; danger of sensitization of airways and skin.

NIOSH IDLH: 10 mg/m^3; [danger of skin sensitization and airways]; Pregnancy Risk Group C.

Australia: TWA 0.25 ppm (1 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.4 mg/m^3), 1999; Belgium: TWA 0.25 ppm (1 mg/m^3), 1993; Denmark: TWA 0.2 ppm (0.8 mg/m^3), 1999; Finland: TWA 0.1 ppm, ceiling 0.2 ppm, 1999; France: VLE 1 mg/m^3, 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; the Netherlands: MAC-TGG 0.4 mg/m^3, 2003; Norway: TWA 0.2 ppm (0.8 mg/m^3), 1999; the Philippines: TWA 0.25 ppm (1 mg/m^3), 1993; Poland: TWA 0.5 mg/m^3; STEL 1.0 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: NGV 0.3 ppm (1.2 mg/m^3), KTV 0.6 ppm (2.5 mg/m^3), 1999; Switzerland: MAK-W 0.2 ppm (0.8 mg/m^3), KZV-(week) 0.4 ppm (1.6 mg/m^3), 1999; United Kingdom: TWA 1 mg/m^3; STEL 3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The Czech Republic: TWA 1.0 mg/m^3 with the same value as an STEL.[35] Russia[35, 43] set a MAC of 0.2 mg/m^3 for ambient air in residential areas on a momentary basis and 0.05 mg/m^3 on a daily average basis. Several states have set guidelines or standards for maleic anhydride in ambient air[60] ranging from 0.14 μg/m^3 (Massachusetts) to 3.3 μg/m^3 (New York) to 10.0 μg/m^3 (Florida and South Carolina) to 12.0 μg/m^3 (North Carolina) to 17 μg/m^3 (Virginia) to 20 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada) to 100.0 μg/m^3 (North Carolina and North Dakota).

Determination in Air: Use NIOSH (IV), Method #3512; OSHA Analytical Method 25 or 86.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Maleic anhydride severely irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation may cause asthmatic reactions. The symptoms of asthma may be delayed for several hours and are aggravated by physical effort. Subacute inhalation of maleic anhydride can cause severe headaches, nosebleeds, nervousness, nausea, and temporary impairment of vision. It can also lead to conjunctivitis and corneal erosion. Maleic anhydride may be transported as hot liquid; skin contact causes burns.

Long Term Exposure: Repeated or prolonged skin contact may cause allergy and dermatitis. Repeated or prolonged inhalation exposure may cause bronchial asthma. Repeated exposure to concentrations above 1.25 ppm has caused asthmatic responses in workers. Allergies have developed so that lower concentrations of maleic anhydride can no longer be tolerated. An increased incidence of bronchitis and dermatitis has also been noted among workers with long-term exposure to maleic anhydride. Repeated exposure may cause photophobia (abnormal visual intolerance to light), double vision, bronchial asthma.

Points of Attack: Eyes, respiratory system, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Anyone who has developed symptoms of asthma due to contact with maleic anhydride should avoid all further contact with this chemical. Consider chest X-ray following acute overexposure. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. The symptoms of asthma may be delayed for several hours and are aggravated by physical effort. Rest and medical observation are highly recommended. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. **8 h**: Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends rubber, Neoprene™, nitrile, polyvinyl chloride and polystyrene as protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: May causes eye damage; eye protection needed.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Maleic anhydride must be stored to avoid contact with water and strong oxidizers (such as chlorine and bromine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum; do not dry sweep. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep maleic anhydride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Maleic anhydride is a combustible solid. Dust clouds of the vapor of molten maleic anhydride are explosive on contact with spark or flame. Use CO_2 or alcohol foam extinguishers. Use of dry chemicals or water extinguishers may cause an explosion. Dust clouds or maleic anhydride or the vapors of molten maleic anhydride are explosive on contact with spark or flame. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration: care must be taken that complete oxidation to nontoxic products occurs.

References

US Environmental Protection Agency. (August 1, 1978). *Chemical Hazard Information Profile: Maleic Anhydride*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Maleic Anhydride, Health and Environmental Effects Profile No. 122*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 79−81

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Maleic Anhydride*. Trenton, NJ

Maleic hydrazide M:0220

Molecular Formula: $C_4H_4N_2O_2$

Common Formula: $C_4H_4O_2N_2$

Synonyms: BH dock killer; Bos MH; Burtolin; Chemform; De-cut; Desprout; 1,2-Dihydro-3,6-pyradazinedione; 1,2-Dihydro-3,6-pyridazinedione; 1,2-Dihydropyridazine-3,6-dione; Drexel-Super P; EC 300; ENT 18,870; Fair 30; Fair PS; Hydrazida maleica (Spanish); 6-Hydroxy-3(2H)-pyridazinone; KMH; MAH; Maintain 3; Malazide; Maleic acid hydrazide; Maleic hydrazide fungicide; Maleic hydrazine; Malein 30; Maleinsaurehydrazid (German); *N*,*N*-Maleoylhydrazine; Malzid; Mazide; MH; MH 30; MH 36 Bayer; MH 40; Regulox; Regulox 50W; Regulox W; Retard; Royal MH 30; Royal Slo-Gro; Slo-Gro; Sprout-stop; Stuntman; Sucker-stuff; Super de-sprout; Super sprout stop; 1,2,3-Tetrahydro-3,6-dioxopyridazine; Vondaldhyde; Vondrax

CAS Registry Number: 123-33-1

RTECS® Number: UR5950000

UN/NA & ERG Number: Not regulated

EC Number: 204-619-9

Regulatory Authority and Advisory Bodies

IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Banned or Severely Restricted (Germany, Guatemala, United States) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U148.

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Maleic Hydrazide is a crystalline solid. Molecular weight = 112.10; Freezing/Melting point = 292°C (decomposes at 260°C); also reported as >300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in cold water; more soluble in hot.

Potential Exposure: Those involved in the manufacture, formulation, and application of this plant growth retardant.

Incompatibilities: Strong oxidizers. Slightly corrosive to iron and zinc.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.6 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 500 mg/m^3

Permissible Concentration in Water: A lowest-observed-adverse-effect-level (LOAEL) of 500 mg/kg/day has been calculated. On the basis of this, the US EPA has calculated a lifetime health advisory of 3.5 mg/L for an adult.

Routes of Entry: Inhalation, ingestion, skin and/eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of eyes, skin and mucous membranes, tremors, muscle spasms, and skin sensitization are among the consequences of MH exposure. LD_{50} = (oral-rat) 3800 mg/kg (slightly toxic).

Long Term Exposure: May cause liver damage and acute central nervous system effects. May cause mutations (genetic changes).

Points of Attack: Central nervous system, liver, skin.

Medical Surveillance: Liver function tests. Examination by a qualified allergist. Tests of the nervous system.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−23 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with acetone to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

U.S. Environmental Protection Agency. (August 1987). *Health Advisory: Maleic Hydrazide*. Washington, DC: Office of Drinking Water

Malononitrile M:0230

Molecular Formula: $C_3H_2N_2$
Common Formula: $NCCH_2CN$
Synonyms: AI3-24285; Cyanoacetonitrile; α-Cyanoacetonitrile; Dicyanmethane; Dicyanomethane; Malonic acid dinitrile; Malonic dinitrile; Malonodinitrile; Malononitrilo (Spanish); Methane, dicyano-; Methylene cyanide; Methylenedinitrile; NSC 3769; Propanedinitrile; Propanedinitrite
CAS Registry Number: 109-77-3
RTECS® Number: OO3150000
UN/NA & ERG Number: UN2647/153
EC Number: 203-703-2 [*Annex I Index No.*: 608-009-00-7]
Listed on the TSCA inventory. Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA Hazardous Waste Number (RCRA No.): U149.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R50/53; Safety phrases: S1/2; S23; S27; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Malononitrile is a white powder or colorless, odorless crystalline substance. Molecular weight = 66.07; Specific gravity (H_2O:1) = 1.19; Boiling point = 218.9°C; Freezing/Melting point = 32.2°C; Flash point = 130°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solubility = 13%.
Potential Exposure: Compound Description: Primary Irritant. Malononitrile is used in organic synthesis, as a lubricating oil additive, for thiamine synthesis, for pteridine-type anti-cancer agent synthesis, and in the synthesis of photosensitizers, acrylic fibers, and dyestuffs. It has also been used in the treatment of various forms of mental illness. It has been used as a leaching agent for gold.
Incompatibilities: Strong bases. May polymerize violently on prolonged heating at 129°C or in contact with strong bases at lower temperatures.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.70 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 3 ppm/8 mg/m^3 TWA.
Protective Action Criteria (PAC)*
TEEL-0: 3 ppm
PAC-1: 3 ppm
PAC-2: **4.9** ppm
PAC-3: **10** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Connecticut has set a guideline or standard of 160 μg/m^3 for malononitrile in ambient air.[60]
Determination in Air: Malononitrile may be determined in air by charcoal tube, Toluene, Gas chromatography/Flame ionization detection, NIOSH Nitriles Criteria Document.
Permissible Concentration in Water: Russia[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Metabolized by body to cyanide and thiocyanate; effects of inhalation of toxic fumes will be related to cyanide. Causes brain and heart damage related to lack of cellular oxygen. It is classified as extremely toxic. Probable oral lethal dose for humans is 5−50 mg/kg, or between 7 drops and 1 teaspoonful, for a 70-kg (150 lb) person. Symptoms of cyanide poisoning include rapid and irregular breathing, anxiety, confusion, odor of bitter almonds (on breath or vomitus), nausea, vomiting (if oral exposure), irregular heartbeat, a feeling of tightness in the chest, bright pink coloration of the skin, unconsciousness followed by convulsions, involuntary urination and defecation, paralysis, and respiratory arrest (heart will beat after breathing stops).
Medical Surveillance: See NIOSH Criteria Document *212 Nitriles*.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 80 mg/m³:* Sa (APF = 10) (any supplied-air respirator). *Up to 200 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 400 mg/m³:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 667 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere for prolonged storage. Keep away from strong bases. May polymerize violently on prolonged heating at 129°C or in contact with strong bases at lower temperatures. May spontaneously explode on storing above 70−80°C.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid all skin contact, inhalation, and ingestion. Take up *small spills* with sand or other noncombustible material. Dike far ahead of *large spills* for later disposal. Do not touch spilled material; stop leak if you can do so without risk. Stay upwind and out of low areas. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use chemical, carbon dioxide, water spray, fog, or foam. Move container from fire area if you can do it without risk. Poisonous gases, including nitrogen oxides and cyanide, are produced in fire. Wear positive pressure breathing apparatus and special protective clothing. When heated to decomposition, malononitrile emits highly toxic fumes. May explode spontaneously or polymerize violently on heating. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

U.S. Environmental Protection Agency. (April 30, 1980). *Malononitrile: Health and Environmental Effects Profile No. 123.* Washington, DC: Office of Solid Waste

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard. Occupational Exposure to Nitriles*. US DHEW (NIOSH) Report No. 78-212. Bethesda, MD

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Malononitrile*. Washington, DC: Chemical Emergency Preparedness Program

Maneb M:0240

Molecular Formula: $C_4H_6MnN_2S_4$

Synonyms: Aamangan; Akzo Chemie Maneb; BASF-Maneb Spritzpulver (German); Bavistin M, cosmic; Carbamic acid, ethylenebis(dithio-), manganese salt; Carbamodithioic acid, 1,2-ethanediylbis-, manganese salt; Chem neb; Chloroble M; Cleanacres; CR 3029; Delsene M flowable; Dithane M 22 special; EBDC; ENT 14,875; 1,2-Ethanediylbis(carbamodithioato)(2−)-manganese; 1,2-Ethanediylbiscarbamodithioic acid, manganese complex; 1,2-Ethanediylbiscarbamodithioic acid, manganese(2+) salt (1:1); 1,2-Ethanediylbismaneb, manganese(2+) salt (1:1); Ethylenebisdithiocarbamate manganese; *N,N′*-Ethylene bis (dithiocarbamate manganeux) (French); Ethylenebis(dithiocarbamato), manganese; Ethylenebis(dithiocarbamic acid), manganese salt; Ethylenebis(dithiocarbamic acid) manganous salt; 1,2-Ethylenediylbis(carbamodithioato)manganese; F 10; Griffin manex; Kypman 80; Lonocol M; Manam; Maneb 80; Maneba; Manebe (French); Manebe 80; Manebgan; Manesan; Manex; Mangan (II)-[*N,N′*-aethylen-bis (dithiocarbamate)] (German); Manganese ethylene-1,2-bis-dithiocarbamate; Manganese(II) ethylene di(dithiocarbamate);

Manganous ethylenebis(dithiocarbamate); Manoc; Manzate; Manzate D; Manzate Maneb fungicide; Manzeb; Manzin; M-Diphar; MEB; MNEBD; Multi-W, kascade; Nespor; Plantifog 160M; Polyram M; Remasan chloroble M; Rhodianehe; Sopranebe; Squadron and Quadrangle Manex; Superman Maneb F; Sup'r flo; Tersan-LSR; Trimangol; Trimangol 80; Trimanoc; Trithac; Tubothane; Unicrop Maneb; Vancide; Vancide Maneb 80; Vassgro Manex

CAS Registry Number: 12427-38-2; *(alt.)* 301-03-1; *(alt.)* 11004-49-2; *(alt.)* 12125-33-6; *(alt.)* 20316-06-7; *(alt.)* 28355-56-8; *(alt.)* 133317-06-3

RTECS® Number: OP0700000

UN/NA & ERG Number: UN2210 (with not <60% maneb)/135; UN2968 (preparation, stabilized against self-heating)/135

EC Number: 235-654-8 [*Annex I Index No.*: 006-077-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: *S. cerevisiae*—homozygosis; Weakly Positive: *In vitro* UDS—human fibroblast; Negative: *S. cerevisiae* gene conversion.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Banned or Severely Restricted (in agriculture) (former USSR-UNEP/IRPTC project).[13]

Carcinogenicity: (New Jersey) (See "References" Below) (California Prop. 65).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, appendix B).

California Proposition 65 Chemical: Cancer 1/1/90.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20; R36; R43; R63; R50/53; Safety phrases: S2; S25; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Maneb is a yellow powder or crystalline solid with a faint odor. Molecular weight = 265.30; Freezing/Melting point = 130°C (decomposes below MP). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Moderately soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those involved in manufacture, formulation, and application of this broad spectrum fungicide. Some dithiocarbamates have been used as rubber components. DFG warns of danger of skin sensitization

Incompatibilities: Water, acid, oxidizing materials. Heat or contact with moisture or acids causes rapid decomposition and the generation of toxic and flammable hydrogen sulfide and carbon disulfide.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration.

NIOSH: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL.

No TEEL available.

DFG MAK: Danger of skin sensitization.

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 2.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg [Mn]/m^3, short-term exposure limit 0.6 mg[Mn]/m^3, 1993; Poland: MAC (TWA) 0.3 mg[Mn]/m^3, 1993; Russia: STEL 0.5 mg/m^3, 1993; United Kingdom: TWA 5 mg[Mn]/m^3, 2000.

Determination in Water: Use OSHA Analytical Method 107.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been determined by MAS/NRC to be 0.035 mg/L. An acceptable daily intake (ADI) of 0.005 mg/kg/day has been calculated for maneb. The state of Maine has set a guideline of 10 μg/L for maneb in drinking water.[61]

Determination in Water: Fish Tox = 0.00193000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Maneb irritates the eyes, skin, and respiratory tract. Maneb is low in acute toxicity and does not present alarming properties during long-term administration to experimental animals, except at very high dosages. However, it is a material of concern because of evidence of mutagenic and teratogenic effects as well as the possibility of nitrosation to carcinogenic nitrosamines. A rebuttable presumption against registration of maneb for pesticide uses was issued by EPA on August 10, 1977 on the basis of oncogenicity, teratogenicity, and hazard to wildlife. Human Tox = 5.73770 ppb (HIGH).

Long Term Exposure: Repeated skin contact can cause skin sensitization and rash. High or repeated exposures may interfere with thyroid function (causing goiter), damage the central nervous system, affect liver function, or cause kidney damage.

Points of Attack: Skin, thyroid, liver, kidneys, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Thyroid function tests. Consider kidney and liver function tests with higher or repeated exposures. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to maneb, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Maneb must be stored to avoid contact with water, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, moisture, heat, and oxidizing materials. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Maneb, stabilized or maneb preparations, stabilized against self-heating requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group III.

Maneb (with not <60% maneb) requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE, DANGEROUS WHEN WET." It falls in Hazard Class 4.2 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep maneb out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, soda ash, sand, or lime extinguishers. *Do not use water*. Poisonous gases are produced in fire, including nitrogen oxides, hydrogen sulfide, sulfur oxides, and carbon disulfide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Maneb is unstable in moisture and is hydrolyzed by acids and hot water. It decomposes at about 100°C but may spontaneously decompose vigorously when stored in bulk. Incineration is the preferred disposal means.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

U.S. Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Maneb*. Trenton, NJ

Manganese (dust & fume) M:0250

Molecular Formula: Mn

Synonyms: Colloidal manganese; Cutaval; Elemental manganese; JIS-G 1213; Manganese-55; Manganese element; Manganeso (Spanish); Tripart liquid; Tronamag

CAS Registry Number: 7439-96-5 (metal)
RTECS® Number: OO9275000
UN/NA & ERG Number: UN3077/171
EC Number: 231-105-1

Regulatory Authority and Advisory Bodies

EPA (*Mn and inorganic compounds*): Not classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds.

Safe Drinking Water Act: SMCL, 0.05 mg/L.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Manganese is a combustible, lustrous, brittle, silvery soft metal. The most important ore containing manganese is pyrolusite. Manganese may also be produced from ferrous scrap used in the production of electric and open-hearth steel. Molecular weight = 54.94; Specific gravity (H_2O:1) = 7.20 (metal); Boiling point = 1962°C; Freezing/Melting point = 123.8°C. Hazard Identification (based on NFPA-704 M Rating System): (*dust*): Health 0, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Manganese is used in the production of steel, in the manufacture of welding rod coatings and fluxes, in iron and steel industry in steel alloys, e.g., ferromanganese, silicomanganese, manganin, spiegeleisen, and as an agent to reduce oxygen and sulfur content of molten steel. Other alloys may be formed with copper, zinc, and aluminum. Manganese and its compounds are utilized in the manufacture of dry cell batteries (MnO_2), paints, varnishes, inks, dyes, matches and firework, as a fertilizer, disinfectant, bleaching agent, laboratory reagent, drier for oils, an oxidizing agent in the chemical industry particularly in the synthesis of potassium permanganate, and as a decolorizer and coloring agent in the glass and ceramics industry. Exposure may occur during the mining, smelting, and refining of manganese, in the production of various materials, and in welding operations with manganese-coated rods. Manganese normally is ingested as a trace nutrient in food. The average human intake is approximately 10 mg/day.

Incompatibilities: Dust or powder may be pyrophoric or explosive in air. Reacts with water (slowly), steam, or acid producing flammable hydrogen gas. Reacts violently with concentrated hydrogen peroxide. Incompatible with nitrogen gas above 200°C. Oxidizers, nitric acid, nitrogen, finely divided aluminum and other metals, sulfur dioxide, carbon dioxide + heat may cause fire and explosions.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume).

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL.

ACGIH TLV®[1]: 0.2 mg[Mn]/m^3, inorganic compounds; *Notice of intended change*: 0.02 mg[Mn]/m^3, respirable fraction; 0.2 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

NIOSH IDLH: 500 mg[Mn]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.2 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 500 mg/m^3

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 1 mg/m^3; STEL 3 mg/m^3 (fume), 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 1 mg/m^3; STEL 3 mg/m^3 (fume), 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 1 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3, 1993; France: VME 1 mg/m^3 (fume), 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Japan: 0.3 mg/m^3, respirable dust, 1999; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, 1993; Russia: STEL 0.2 mg/m^3 (fume), 1993; Sweden: NGV 1 mg/m^3, TGV 2.5 mg/m^3 (respirable dust); NGV 2.5 mg/m^3, TGV 5 mg/m^3 (total dust), 1999; Switzerland: MAK-W 1 mg/m^3 (fume); MAK-W 5 mg/m^3, 1999; Thailand: TWA 5 mg/m^3, 1993; Turkey: TWA 5 mg/m^3 (fume), 1993; United Kingdom: TWA 1 mg [Mn]/m^3; STEL 3 mg[Mn]/m^3, fume; TWA 5 mg[Mn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg. the Czech Republic 2.0 mg/m^3 (6.0 mg/m^3 as a ceiling value). Standards for ambient air in residential areas have been set as follows: the Czech Republic; momentary basis (mg/m^3) 0.03; daily average basis (mg/m^3) 0.01; Russia; momentary basis (mg/m^3) 0.01; daily average basis (mg/m^3) 0.001. Several states have set guidelines or standards for manganese in ambient air[60] ranging from 2.0 μg/m^3 (Rhode Island) to 10 μg/m^3 (North Dakota) to 17 μg/m^3 (Virginia) to 20 μg/m^3 (Connecticut and South Dakota) to 25 μg/m^3 (Pennsylvania) to 119 μg/m^3 (Nevada) to 300 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID-121.

Permissible Concentration in Water: There are a variety of maximum allowable concentrations set in various countries[35] (mg/L): the Czech Republic: 0.1 (drinking water); 0.2 (drinking water reserve); 0.5 (surface water); EEC 50.0 (drinking water); United States 0.05 (bottled water); Former USSR-UNEP/IRPTC joint project 0.1 (drinking and surface water); World Health Organization (WHO): 0.05

(maximum desirable); 0.10 (for esthetic quality); 0.50 (maximum permissible in drinking water). In addition, several states have set values for manganese in drinking water. These include a standard of 0.15 mg/L in Illinois and a guideline of 0.05 mg/L in Kansas.

Determination in Water: The manganese detection limit by direct flame atomization is 2 μg/L. However, solvent extraction is used for many determinations. Analytic conditions are more critical for the extraction of manganese than for most other metals, because many manganese-chelate complexes are unstable in solution. With pH control and immediate analysis after extraction, accurate determinations are possible. When the graphite furnace is used to increase sample atomization, the detection limit is lowered to 0.01 μg/L or ng/L according to NAS/NRC.

Routes of Entry: Inhalation of dust or fume, limited percutaneous absorption of liquids, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Manganese dust and fumes are irritants to the eyes and mucous membranes of the respiratory tract, and apparently are completely innocuous to the intact skin. Inhalation of dust may cause bronchitis and pneumonitis. The effects may be delayed.

Long Term Exposure: The substance may have effects on the lungs and nervous system resulting in bronchitis, pneumonitis, neurologic, and neuropsychiatric disorders (manganism). Animal tests show that this substance possibly causes toxic effects upon human reproduction. Chronic manganese poisoning has long been recognized as a clinical entity. The dust or fumes (manganous compounds) enter the respiratory tract and are absorbed into the blood stream. Manganese is then deposited in major body organs with a special predilection for the liver, spleen, and certain nerve cells of the brain and spinal cord. Among workers there is a very marked variation in individual susceptibility to manganese. Some workers have worked in heavy exposure for a lifetime and shown no signs of the disease; others have developed manganese intoxication within as little as 49 days of exposure. The early phase of chronic manganese poisoning is most difficult to recognize, but it is also important to recognize since early removal from the exposure may arrest the course of the disease. The onset is insidious, with apathy, anorexia, absthenia. Headache, hypersomnia, spasms, weakness of the legs, arthralgias, and irritability are frequently noted. Manganese psychosis follows with certain definitive features: unaccountable laughter, euphoria, impulsive acts, absent-mindedness, mental confusion, aggressiveness, and hallucinations. These symptoms usually disappear with the onset of true neurological disturbances, or may resolve completely with removal from manganese exposure. Progression of the disease presents a range of neurological manifestations that can vary widely among individuals affected. Speech disturbances are common: monotonous tone, inability to speak above a whisper, difficult articulation, incoherence, even complete muteness. The face may take on mask-like quality, and handwriting may be affected by micrographia. Disturbances in gait and balance occur, and frequently propulsion, retropropulsion, and lateropropulsion are affected, with no movement for protection when falling. Tremors are frequent, particularly of the tongue, arms, and legs. These will increase with intentional movements and are more frequent at night. Absolute detachment, broken by sporadic or spasmodic laughter, ensues, and as in extrapyramidal affections, there may be excessive salivation and excessive sweating. At this point the disease is indistinguishable from classical Parkinson's disease. Chronic manganese poisoning is not a fatal disease although it is extremely disabling. Manganese dust is not longer believed to be a causative factor in pneumonia. If there is any relationship at all, it appears to be as an aggravating factor to a preexisting condition. Freshly formed fumes have been reported to cause fever and chills similar to metal fume fever.

Points of Attack: Respiratory system, central nervous system, lungs, blood, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), biologic tissue/biopsy, complete blood count, chest X-ray, pulmonary function tests, urine (chemical/metabolite), urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: A complete examination of the nervous system. Complete blood count. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4—12 h following exposure: it may last less than 36 h. Medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) Ascba (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Manganese must be stored to avoid contact with water and steam since flammable hydrogen gas is produced. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates). Protect storage against physical damage.

Shipping: Manganese is not specifically cited in DOT's Performance-Oriented Packaging Standards.[19] However as an Environmentally hazardous solid, n.o.s. falls in Hazard Class 9 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Manganese metal-sanitary landfill. Manganese chloride or sulfate-chemical conversion to the oxide followed by land filling, or conversion to the sulfate for use in fertilizer. Consult with environmental regulatory agencies for guidance on acceptable disposal practices.

References

Illinois Institute for Environmental Quality. (September 1975). *Airborne Manganese Health Effects and Recommended Standard, Document No. 75-18.* Chicago, IL

National Academy of Sciences. (1973). *Manganese (in a Series on Medical and Biologic Effects of Environmental Pollutants).* Washington, DC

National Academy of Sciences. (1973). *Medical and Biologic Effects of Environmental Pollutants: Manganese*. Washington, DC

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 44−45

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Manganese (Dust and Fume)*. Trenton, NJ

Manganese dioxide M:0260

Molecular Formula: MnO_2

Synonyms: Black manganese oxide; Bog manganese; Braunstein (German); Cement black; C.I. 77728; C.I. Pigment black 14; C.I. Pigment brown 8; Mangandioxid (German); Manganese binoxide; Manganese (bioxyd de) (French); Manganese black; Manganese (dioxyde de)

(French); Manganese peroxide; Manganese superoxide; Pyrolusite brown

CAS Registry Number: 1313-13-9

RTECS® Number: OP0350000

UN/NA & ERG Number: UN1479 (oxidizing solid, n.o.s.)/140

EC Number: 215-202-6 [*Annex I Index No.:* 025-001-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

EPCRA Section 313: Includes any unique chemical substance that contains manganese as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as manganese compounds, n.o.s.

European/International Regulations: Hazard Symbol: Xn; Risk phrases R20/22; Safety phrases: S2; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Manganese dioxide is a black crystalline solid. Molecular weight = 86.94; Freezing/Melting point = (decomposes) 553°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Manganese dioxide is used as depolarizer for dry cell batteries, for production of manganese metal, as an oxidizing agent, laboratory reagent, and in making pyrotechnics and matches, in dry cell batteries.

Incompatibilities: A powerful oxidizer. Incompatible with strong acids, reducing agents, combustible materials (such as fuel, clothing and organic materials). Mixtures with calcium hydride is a heat- and friction-sensitive explosive. Vigorous reaction with hydrogen sulfide, diboron tetrafluoride, calcium hydride, chlorine trifluoride, hydrogen peroxide, hydroxyaluminum chloride, anilinium perchlorate. Decomposes when heated above 553°C producing manganese(III)oxide and oxygen, which increases fire hazard. Reacts violently with aluminum (thermite reaction), potassium azide, rubidium acetylide, in the presence of heat.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (compounds and fume).

NIOSH: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL.

ACGIH TLV®[1]: TWA 0.2 mg[Mn]/m^3, inorganic compounds.

Protective Action Criteria (PAC)

TEEL-0: 0.317 mg/m^3

PAC-1: 4.75 mg/m^3

PAC-2: 7.91 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C.

NIOSH IDLH: 500 mg[Mn]/m^3.

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 0.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg[Mn]/m^3; STEL 0.6 mg[Mn]/m^3, 1993; Japan 0.3 mg [Mn]/m^3, respirable dust, 1999; Norway: TWA 2.5 mg [Mn]/m^3, 1999; Poland: MAC (TWA) 0.3 mg[Mn]/m^3, MAC 5 mg[Mn]/m^3, 1999; Sweden: NGV 1 mg[Mn]/m^3, TGV 2.5 mg[Mn]/m^3 (respirable dust), 1993; Sweden: NGV 2.5 mg[Mn]/m^3, TGV 5 mg[Mn]/m^3 (total dust), 1993; United Kingdom: TWA 5 mg[Mn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg [Mn]/m^3.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Manganese dioxide can affect you when breathed in. Inhalation can cause irritation of the respiratory system. Manganese dioxide can cause a flu-like illness, with chills, fever, and aching. Chest congestion can occur with cough and shortness of breath. It can cause an asthma-like lung allergy. The effects may be delayed.

Long Term Exposure: Repeated exposure can cause permanent brain damage. Early symptoms include poor appetite, weakness, and sleepiness. Later effects include speech, balance, and personality changes. Later symptoms are identical to Parkinson's disease. High or repeated exposure may cause permanent lung damage, kidney and liver damage, and anemia. May affect the lungs and nervous system causing bronchitis, pneumonitis, neurologic and neuropsychiatric disorders (manganism). Animal tests show that this substance may cause toxic effects upon human reproduction.

Points of Attack: Lungs, blood, central nervous system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: complete examination of the nervous system. Complete blood count (CBC). Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. Evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); Ascba (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard (strong oxidizer); Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Manganese dioxide must be stored to avoid contact with heat and flammable materials and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. See also incompatibilities above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Oxidizing solid, n.o.s. requires a shipping label of “OXIDIZER.” It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Manganese dioxide itself does not burn, but it will intensify an existing fire. Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Manganese Dioxide.* Trenton, NJ

Manganese nitrate M:0270

Molecular Formula: MnN_2O_6

Common Formula: $Mn(NO_3)_2$

Synonyms: Manganese dinitrate; Manganous nitrate; Manganous dinitrate; Nitric acid, manganese(2 +) salt

CAS Registry Number: 10377-66-9; 15710-66-4 (hydrate)

RTECS$^{®}$ Number: QU9780000

UN/NA & ERG Number: UN2724/140

EC Number: 233-828-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

EPCRA Section 313: Includes any unique chemical substance that contains manganese as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as manganese compounds, n.o.s.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (CAS: 10377-66-9).

Description: Manganese nitrate is a colorless to pink crystalline solid. Molecular weight = 178.96. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Highly soluble in water.

Potential Exposure: Manganese nitrate is used as a color agent in porcelain and ceramic manufacture, as a catalyst, and in the production of manganese dioxide.

Incompatibilities: A strong oxidizer. Violent reaction with reducing agents, organics, and combustible materials.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (compounds and fume).

NIOSH: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL.

ACGIH TLV®[1]: TWA 0.2 mg[Mn]/m^3, inorganic compounds.

Protective Action Criteria (PAC)

TEEL-0: 1.04 mg/m^3

PAC-1: 15.7 mg/m^3

PAC-2: 26.1 mg/m^3

PAC-3: 500 mg/m^3

Hydrate

TEEL-0: 0.717 mg/m^3

PAC-1: 10.8 mg/m^3

PAC-2: 17.9 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C.

NIOSH IDLH: 500 mg[Mn]/m^3.

Harmful Effects and Symptoms

Short Term Exposure: Manganese nitrate can affect you when breathed in. Eye or skin contact with the dust or concentrated liquid can cause irritation or burns. The dust or mist can irritate the nose, throat, and bronchial tubes, with cough and phlegm. Higher levels may irritate the lungs and could lead to a fluid buildup in the lungs (pulmonary edema). This can cause death. Overexposure can cause methemoglobinemia and anemia.

Long Term Exposure: Repeated exposure can cause permanent brain damage. Early symptoms include poor appetite, weakness, and sleepiness. Later effects include speech, balance, and personality changes. Later symptoms are identical to Parkinson's disease. High or repeated exposure may cause permanent lung damage, kidney and liver damage, and anemia. May affect the lungs and nervous system causing bronchitis, pneumonitis, neurologic and neuropsychiatric disorders (manganism).

Points of Attack: Blood, nervous system, lungs, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Complete examination of the nervous system. Complete blood count. Lung function and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. Evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); Ascba (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard (*strong oxidizer*); Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Manganese nitrate must be stored to avoid contact with organic materials since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep manganese nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Manganese nitrate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Manganese Nitrate*. Trenton, NJ

Manganese, tricarbonyl methylcyclopentadienyl M:0280

Molecular Formula: $C_9H_7MnO_3$

Common Formula: $C_5H_4(CH_3)\text{-}Mn(CO)_3$

Synonyms: Ak-33X; Antiknock-33; CI-2; Combustion improver-2; Manganese, (methylcyclopentadienyl)tricarbonyl-; Methylcyclopentadienyl manganese tricarbonyl; 2-Methylcyclopentadienyl manganese tricarbonyl; Methylcyklopentadientrikarbonylmanganium (German); MMT; TDS-1510; Tricarbonyl(methylcyclopentadienyl) manganese

CAS Registry Number: 12108-13-3

RTECS® Number: OP1450000

UN/NA & ERG Number: UN2810/153; UN3281 (Metal carbonyls, liquid, n.o.s.)/151

EC Number: 235-166-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 (as manganese compound) Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Manganese, tricarbonyl methylcyclopentadienyl is a dark orange liquid. Faintly pleasant, herb-like odor. Molecular weight = 218.10; Boiling point = 232°C; Freezing/Melting point = −18°C; Flash point = 74°C; 96°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Organometallic, Primary Irritant. MMT is used as an octane improver in unleaded gasoline, other distillate fuels and fuel oils, and as a smoke abater in fuels.

Incompatibilities: May be air-reactive. Keep away from oxidizers, halogens. Light causes decomposition.

Permissible Exposure Limits in Air

OSHA PEL: None [5 mg[Mn]/m^3 Ceiling Concentration (vacated 6/30/1993)].

NIOSH REL: 0.2 mg[Mn]/m^3 TWA [skin].

ACGIH TLV®[1]: 0.2 mg[Mn]/m^3 TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 0.6 mg/m^3

PAC-3: 7.5 mg/m^3

Australia: TWA 0.2 mg/m^3, [skin], 1993; Belgium: TWA 0.2 mg/m^3, [skin], 1993; Denmark: TWA 0.1 ppm (0.2 mg [Mn]/m^3), [skin], 1999; Finland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; France: VME 0.2 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.1 ppm (0.2 mg[Mn]/m^3), 1999; United Kingdom: TWA 0.2 mg[Mn]/m^3; STEL 0.6 mg[Mn]/m^3, [skin], 2000; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Mn]/m^3 [skin]. States have set guidelines or standards for MCT in ambient air[60] ranging from 2.0 μg/m^3 (North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada). These compare to values for methyl cyclopentadienyl manganese tricarbonyl of 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 8 mg/kg. Irritates the eyes, skin, and respiratory tract. Medical observation is indicated. In concentrated form this compound is highly toxic by all routes of exposure. Approximately 5−15 mL, when spilled on the hand and wrist of a worker, produced toxic effects within 3−5 min. Giddiness, "thick tongue," nausea, and headache were reported to occur after skin exposure. Human exposure data are limited; the primary site of action is reported to be the central nervous system; may cause tissue lesions.

Long Term Exposure: Can cause kidney damage.

Points of Attack: Respiratory system, skin, central nervous system, kidneys.

Medical Surveillance: Examination of the nervous system. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); Ascba (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Metal carbonyls, liquid, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1. and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Large spills can be cleaned up using JP-4L or JP-5 (jet engine fuels). Isopropyl alcohol may be used to clean up moderate spills, while methyl ethyl ketone should be used for cleaning *small spills* and quick disconnects. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.9/1.5
Night 3.1/4.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0 + /11.0 +
Night 7.0 + /11.0 +

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (October 21, 1983). *Chemical Hazard Information Profile: Methylcyclopentadienyl Manganese Tricarbonyl*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Manganese, Tricarbonyl Methylcyclopentadienyl.* Washington, DC: Chemical Emergency Preparedness Program

MCPA M:0290

Molecular Formula: $C_9H_9ClO_3$

Common Formula: $H_3CC_6H_3ClOCH_2CO_2H$

Synonyms: Acetic acid (4-chloro-2-methylphenoxy)-; Acetic acid [(4-chloro-*o*-tolyl)-oxy]-; ACME MCPA amine 4; Agritox; Agroxone; Anicon kombi; Anicon M; BH MCPA; Bordermaster; Brominal M & plus; (4-Chloro-*o*-cresoxy)acetic acid; Chiptox; 4-Chloro-*o*-cresoxyacetic acid; (4-Chloro-2-methylphenoxy)acetic acid; 4-Chloro-2-methylphenoxyacetic acid; 4-Chloro-*o*-toloxyacetic acid; (4-Chloro-*o*-toloxy)acetic acid; [(4-Chloro-*o*-tolyl)oxy] acetic acid; Chwastox; Cornox M; Ded weed; Dicopur-M; Dicotex; Dow MCP amine weed killer; Emcepan; Empal; Hedapur M 52; Hedarex M; Hedonal M; Herbicide M; Hormotuho; Hornotuho; Kilsem; 4K-2M; Legumex DB; Leuna M; Leyspray; Linormone; M 40; 2M-4C; 2M-4CH; MCP; MCPA; Mephanac; Metaxon; Methoxone; Methylchlorophenoxyacetic acid; 2-Methyl-4-chlorophenoxyacetic acid; (2-Methyl-4-chlorophenoxy)acetic acid; 2-Methyl-4-chlorophenoxyessigsaeure (German); 2M-4KH; Okultin; Phenoxylene 50; Phenoxylene plus; Phenoxylene super; Razol dock killer; Rhonox; B-Selektonon M; Seppic MMD; U 46; U 46 M-Fluid; Vacate; Vesakontuho; Weedar; Weedar MCPA concentrate; Weedone MCPA ester; Weed RHAP; Zelan

CAS Registry Number: 94-74-6

RTECS® Number: AG1575000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152

EC Number: 202-360-6 [*Annex I Index No.:* 607-051-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence; Animal No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1987

US EPA Gene-Tox Program, Positive: *D. melanogaster* sex-linked lethal; *S. cerevisiae*—reversion; Negative: *D. melanogaster*—whole sex chrom. loss; Negative: *D. melanogaster*—nondisjunction; Host-mediated assay.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R38; R41; R50/53 Safety phrases: S2; S26; S37; S39; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: MCPA is a colorless crystalline solid. Molecular weight = 200.63; Freezing/Melting point = 118.8°C; Vapor pressure = 1.5×10^{-6} mmHg at 20°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Those involved in the manufacture, formulation, and application of this postemergence herbicide, used for control of broadleaf weeds in agricultural applications.

Incompatibilities: A weak acid. Incompatible with alkalis.

Permissible Exposure Limits in Air

No TEEL available.

Poland: MAC (TWA) 1 mg/m^3, MAC (STEL) 3 mg/m^3, 1999

Determination in Air: No method available.

Permissible Concentration in Water: Russia set a MAC of 0.25 mg/L in surface water. The US EPA has determined a no-observed-adverse-effects-level (NOAEL) of 1.0 mg/kg/day from which they have calculated a long-term advisory of 0.35 mg/L (350 μg/L) for an adult. They have further calculated a lifetime health advisory of 0.0036 mg/L (3.6 μg/L) for an adult. In addition, Maine has set a guideline for MCPA in drinking water[61] of 2.5 μg/L.

Determination in Water: No method available. Fish Tox = 17986.45312000 ppb (VERY LOW). Octanol−water coefficient: Log K_{ow} = 3.29.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Irritates the eyes, skin, and respiratory tract. This material is moderately toxic. LD_{50} = (oral-rat) 700 mg/kg. Human Tox = 4.00000 (HIGH). The approximate lethal dose to a 150-lb man is 3.3 tablespoonfuls (Sax).

Long Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction. MCPA is classified as a chlorophenoxy-herbicide. These herbicides are a possible carcinogen to humans. May cause decreased blood pressure. May cause genetic changes.

Medical Surveillance: Monitor blood pressure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This material falls into the category of Phenoxy pesticides, solid, toxic n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Also, can be precipitated with divalent cations. Carbon or peat can be used as sorbents.

Fire Extinguishing: Solid material not combustible. Liquid formulations containing organic solvents may be flammable. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added flammable solvent; incinerator equipped with fume scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (1975). *Initial Scientific and Minieconomic Review No. 21: MCPA*. Washington, DC: Office of Pesticide Programs

US Environmental Protection Agency. (August 1987). *Health Advisory: MCPA*. Washington, DC: Office of Drinking Water

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 6, 35−41

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Mechlorethamine (Agent HN-2, WMD) M:0300

Molecular Formula: $C_5H_{11}Cl_2N$

Common Formula: $CH_3N(CH_2CH_2Cl)_2$

Synonyms: *N*,*N*-Bis(2-chloroethyl)methylamine; Bis (β-chloroethyl)methylamine; Bis(2-chloroethyl)methylamine; Caryolysin; Chloramine; Chlorethazine; Chlormethine; 2-Chloro-*N*-(2-chloroethyl)-*N*-methylethanamine; Cloramin; Dichloramine; Dichloren (German); β,β-Dichlorodiethyl-*N*-methylamine; *N*,*N*-Di(chloroethyl)methylamine; Di(2-chloroethyl)methylamine; 2,2′-Dichloro-*N*-methyldiethylamine; Diethylamine, 2,2′-dichloro-*N*-methyl-(8CI); Embichin; ENT-25294; Ethanamine, 2-chloro-*N*-(2-chloroethyl)-*N*-methyl-; HN-2 (military designation); MBA; Mechlorethamine; *N*-Methyl-bis-chloraethylamin (German); *N*-Methyl-bis (β-chloroethyl)amine; *N*-Methyl-bis(2-chloroethyl)amine; Methylbis(β-chloroethyl)amine; Methylbis(2-chloroethyl) amine; *N*-Methyl-2,2′-dichlorodiethylamine; Methyldi(2-chloroethyl)amine; *N*-Methyllost (German); Mostaza de nitrogeno (Spanish); Mustargen; Mustine; Nitrogen Mustard-2; Nitrogen mustard agent HN-2; *N*-Lost (German); NSC 762; TL 146

CAS Registry Number: 51-75-2; 55-86-7 (hydrochloride); 126-85-2 (nitrogen mustard *N*-oxide); 302-70-5 (nitrogen mustard, *N*-oxide hydrochloride)

RTECS® Number: IA1750000

UN/NA & ERG Number: UN2810 (toxic liquids, organic, n.o.s.)/153

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 2.2 lb. (≥30.00% concentration) (hydrochloride); *Theft hazard* CUM 100 g. (*51-75-2*).

Carcinogenicity: IARC: Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1998; NTP (hydrochloride): Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: (*hydrochloride*) Cancer 4/1/88; Developmental/Reproductive toxin 7/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrogen mustard is a pale yellow, oily, mobile liquid with a faint odor of herring. *Nitrogen mustards* are colorless when pure but are typically a yellow to brown oily substance. Odors are variably described as sweet, agreeable, slightly garlic- or mustard-like. NIOSH reports HN-2 as having "a fruity odor at high concentrations and a soapy or fishy odor at low concentrations." Molecular weight = 156.07; Specific gravity = 1.12 at 25°C; Boiling point = 87°C at 18 mmHg; 75°C at 10 mmHg [HN-2 decomposes before its boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion];[NIOSH] Freezing/Melting Point: −60°C; Vapor Pressure = 0.29 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. This compound is very sparingly soluble in water; releases corrosive vapors on contact with water or steam.

Potential Exposure: Drug used in treatment of cancer. Sulfur mustards were formerly used as a gas warfare agent.

Nitrogen mustards have not previously been used in warfare.[NIOSH] Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal.[NIOSH]

Incompatibilities: HN-2 is not stable except as dry crystals. Polymerization of HN-2 results in components that present an explosion hazard in open air.[NIOSH] Avoid contact or contamination with oxidizers (e.g., nitrates, oxidizing acids; chlorine bleaches pool chlorine) which may result in ignition. Unstable in the presence of light and heat and forms dimers at temperatures above 50°C. Corrosive to ferrous alloys beginning at 65°C. Polymerizes slowly and so munitions would be effective for several years. When heated to decomposition emits hydrogen chloride and nitrogen oxide. Contact with metals may evolve flammable hydrogen gas.[NIOSH]

Note: Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine vigorously chlorinate nitrogen mustards to the carbon chain, giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Permissible Exposure Limits in Air

The Surgeon General's Working Group (US Department of Health and Human Services) recommends (for the workplace) 0.003 mg/m^3, Ceiling Concentration. Same for US military. Several states have set guidelines for nitrogen mustard in ambient air[60] and New York and South Carolina at zero.

Protective Action Criteria (PAC) HN-2*
TEEL-0: 0.001 mg/m^3
PAC-1: 0.003 mg/m^3
PAC-2: **0.022** mg/m^3
PAC-3: **0.37** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Hydrochloride
TEEL-0: 0.75 mg/m^3
PAC-1: 2.5 mg/m^3
PAC-2: 4 mg/m^3
PAC-3: 4 mg/m^3

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2A; Germ Cell Mutation Category 2.

Determination in Water: A water contaminant. Octanol−water coefficient: Log K_{ow} = (estimated) 0.91 at pH 7.4; 1.53.[NIOSH]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact (vapor or liquid).

Harmful Effects and Symptoms

Nitrogen mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells. Clinical effects do not appear until hours after exposure. Nitrogen mustards penetrate and bind quickly to cells of the body; their health effects develop slowly. The full extent of cellular injury may not be known for days. The sooner after exposure the health effects occur, the more likely it is that the patient/victim was exposed to a high concentration of HN-2. Similarly, the sooner the health effects occur, the more likely it is that they will progress and become severe. *Eye exposure*: The eyes are the organs that are most sensitive to mustard vapor; eye injury may occur within 1−2 h after severe exposure, or 3−12 h after a mild to moderate exposure. *Inhalation exposure*: Airway injury may occur within 2−6 h after severe exposure and within 12−24 h after mild exposure. Skin exposure: The symptom-free (latent) period is 6−12 h in temperate conditions; hot, humid weather strikingly increases the action of nitrogen mustards. Some skin injury may appear as late as 48 h after exposure.[NIOSH]

Short Term Exposure: Extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although this agent can cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Irritates and burns the eyes, with possible permanent damage. Skin contact can cause irritation, burns with itching and blisters. Inhalation can cause irritation of the respiratory tract with wheezing and coughing. Higher exposure can cause headache, nausea, vomiting, and dizziness. Symptoms of exposure include nausea and vomiting, bleeding, skin lesions, menstrual irregularities. Toxic doses as low as 400 mg/kg have been reported in humans. Blood clots may occur at site of intravenous injection, and tissue damage if outside vein. Powerful vesicant (causes blisters) when it contacts skin, mucous membranes, or eyes. *Delayed toxicity*—missed menstrual periods, alopecia (hair loss), hearing loss, tinnitus (ringing in ears), jaundice, impaired spermatogenesis and germinal aplasia, swelling, and hypersensitivity. High exposure can cause tinnitus (ringing in the ears) and possible hearing loss.

Long Term Exposure: Bone marrow suppression resulting in damage to the blood-forming (hematopoietic) system. Early signs of bone marrow suppression include a low white blood cell count, an increased risk for developing infections, a tendency for easy bruising and bleeding. May cause lymph node damage and a weakened immune system. It also causes liver and kidney damage, damage to the reproductive systems of both men and women leading to decreased fertility. It is mutagenic, toxic to the developing embryo, and carcinogenic. Following significant whole-body (systemic) absorption of nitrogen mustard, injury to the bone marrow, lymph nodes, and spleen may cause a drop in white blood cell counts (beginning on days 3−5), which can result in an increased risk for developing (life-threatening) infections. Counts of red blood cells and platelets may also fall due to bone marrow damage.

Points of Attack: Bone marrow, hearing.

Medical Surveillance: Complete blood count. Audiogram.

First Aid: There is no antidote for nitrogen mustard toxicity. Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage.[NIOSH] Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 h. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear Totally Encapsulating Chemical Protective (TECP) suit that provides protection against CBRN agents; chemical-resistant inner and outer gloves, chemical-resistant boots with a steel toe and shank, coveralls, long underwear, and a hard hat worn under the TECP suit are optional items. Take all necessary precautions to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage.[NIOSH] Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first 2 min following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/health-care providers or the health-care facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing. (2) Patients exposed to liquid should be decontaminated by (a) washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged, because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes, or open wounds with sterile saline or water. (3) The health-care provider should (a) check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process. (b) Be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time-consuming process. The health-care provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified by NIOSH for CBRN Environments.* Where a potential exposure to the chemical exists, use a NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone B] requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

HN-2, when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

HN-2, when used as a weapon

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: Heated to decomposition emits hydrogen chloride and nitrogen oxide. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mechlorethamine*. Washington, DC: Chemical Emergency Preparedness Program

Melamine M:0310

Molecular Formula: $C_3H_6N_6$

Common Formula: $NC(NH_2)NC(NH_2)NC(NH_2)$

Synonyms: Cyanuramide; Cyanurotriamide; Cyanurotriamine; 1,3,5-Triazine-2,4,6-triamine; 2,4,6-Triaminotriazine

CAS Registry Number: 108-78-1; *(alt.)* 504-18-7; *(alt.)* 65544-34-5; *(alt.)* 67757-43-1; *(alt.)* 68379-55-5; *(alt.)* 70371-19-6; *(alt.)* 94977-27-2

RTECS® Number: OS0700000

EC Number: 203-615-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (feed); clear evidence: rat; NCI: Carcinogenesis Studies (feed); no evidence: mouse.

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Melamine is a white crystalline solid. Molecular weight = 126.15; Specific gravity (H_2O:1) = 1.6; Freezing/Melting point = <250°C (decomposes); Flash point ≥300°C; Autoignition temperature ≥500°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Manufactured from urea, melamine is used in the manufacture of plastics, melamine-formaldehyde resins, rubber, synthetic textiles, laminates, adhesives, and molding compounds.

Incompatibilities: Strong oxidizers, strong acids.

Permissible Exposure Limits in Air: Kansas[60] has set a guideline of 24.39 μg/m^3 for melamine in ambient air.

AIHA WEEL: 10 mg/m^3, inhalable TWA; 5 mg/m^3, respirable TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Irritates, eyes, skin, and mucous membranes. May cause dermatitis in humans.

Long Term Exposure: May cause kidney damage. There is limited evidence that melamine causes cancer in animals.

Points of Attack: Kidneys, skin.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Melamine itself does not burn. Use any extinguishing agent suitable for surrounding fire. Poisonous gases, including carbon monoxide, hydrogen cyanide, nitrogen oxides, and ammonia, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (December 29, 1982). *Chemical Hazard Information Profile Draft Report: Melamine*. Washington, DC

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 4, 40−41

New Jersey Department of Health and Senior Services. (June 1998). *Hazardous Substances Fact Sheet: Melamine*. Trenton, NJ

Melphalan M:0320

Molecular Formula: $C_{13}H_{19}Cl_2N_2O_2$

Common Formula: $HOOCH(NH_2)CHCH_2C_6H_4N(CH_2CH_2Cl)_2$

Synonyms: Alanine nitrogen mustard; Alkeran; AT-290; 1-3-(*p*-[Bis(2-chloroethyl)amino]phenyl)alanine; *p*,*N*-Bis(2-chloroethyl)amino-l-phenylalanine; 3-[*p*-(*p*-[Bis(2-chloroethyl) amino]phenyl)]-l-alanine; 4-[Bis(2-chloroethyl)amino]-l-phenylalanine; CB 3025; *p,N*-Di(chloroethyl)aminophenylalanine; *p*-Di(2-chloroethyl)amino-l-phenylalanine; 3-*p*-[Di(2-chloroethyl)amino]-phenyl-l-alanine; 2-(Diethoxyphosphinylimino)-4-methyl-1,3-dithiolane; I-PAM; L-Sarcolysin; Melfalano (Spanish); NCI-CO4853; NSC-8806; *i*-Phenylalanine nitrogen mustard; Phenylalanine nitrogen mustard; P-I-Sarcolysin; SK-15673

CAS Registry Number: 148-82-3

RTECS® Number: AY3675000

UN/NA & ERG Number: UN1851/151

EC Number: 205-726-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, Group 1, 1998; NTP: Known to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U150.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 2/27/87; Developmental/Reproductive toxin 7/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Melphalan forms solvated crystals from methanol. Molecular weight = 305.23; Freezing/Melting point = 182−183°C. (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: An alkylating agent. Health-care workers may be exposed. As a drug it is an immunosuppressant, used in the treatment of multiple myeloma and cancer of the ovary. It is also used in investigation of other types of cancer and as an antineoplastic in animals. Human exposure to melphalan occurs principally during its use in cancer treatment. Melphalan is administered orally or intravenously. Adult dosage is 6 mg/day, 5 days per month. Has been used as a military poison gas (a nitrogen mustard, alkaline, crystals).

Permissible Exposure Limits in Air

No standards or TEEL available.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 11.2 mg/kg. This material is highly toxic; local irritant of the skin, eyes, and mucous membranes. Skin rash, nausea, vomiting.

Long Term Exposure: A Confirmed Human Carcinogen capable of causing leukemia and Hodgkin's disease. High or repeated exposure causes marked bone marrow depression with possible anemia, neutropenia, and thrombocytopenia.

Points of Attack: Blood.

Medical Surveillance: Complete blood count (CBC).

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Speed in removing material from skin is of extreme importance. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; move to the fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that his airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This material falls into the category of Poisonous liquid, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical

as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including HCl and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Mephosfolan M:0330

Molecular Formula: $C_8H_{16}NO_3PS_2$

Synonyms: AC 47470; American cyanamid CL-47470; CL-47,470; Cyclic propylene(diethoxyphosphinyl) dithioimidocarbonate; Cytrolane; *p*,*p*-Diethyl cyclic propylene ester of phosphonodithioimidocarbonic acid; Diethyl (4-methyl-1,3-dithiolan-2-ylidene)phosphoroamidate; 2-(Diethoxyphosphinylimino)-4-methyl-1,3-dithiolane; EI-47470; ENT 25,991; (4-Methyl-1,3-dithiolan-2-ylidene) phosphoramidic acid, diethyl ester

CAS Registry Number: 950-10-7

RTECS® Number: JP1050000

UN/NA & ERG Number: UN2784 (organophosphorus pesticide, liquid, flammable, toxic)/131

EC Number: 213-447-3 [*Annex I Index No.:* 015-094-00-9]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (India) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R27/28; R51/53; Safety phrases: S1/2; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mephosfolan is a yellow to amber liquid. Molecular weight = 269.34; Boiling point = 120°C at 1.0 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Moderately soluble in water.

Potential Exposure: Those involved in the production, formulation, and application of this insecticide and acaricide. An organophosphorus pesticide, liquid, poisonous, flammable, n.o.s.

Incompatibilities: Strong oxidizers, strong acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 9 mg/m^3

PAC-3: 9 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This is a highly to extremely toxic material. LD_{50} = (oral-rats) 9 mg/kg. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids.

Shipping: This material falls into the category of Organophosphorus pesticides, liquid, toxic, flammable, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use water spray to knock down vapors. Build dikes to contain material as necessary. Avoid breathing vapors. Keep upwind. Avoid bodily contact with the material. Downwind evacuation should be considered. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible material. Vapors may travel to a source of ignition, and flash back. Use foam, carbon dioxide, or dry chemical. When heated to decomposition, this material emits very toxic fumes of nitrogen oxides, phosphorus oxides, and sulfur oxides. Use water spray to absorb vapors. Avoid breathing vapors. Keep upwind. Wear self-contained breathing apparatus. Avoid bodily contact with the material. Wear full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 72−74

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mephosfolan*. Washington, DC: Chemical Emergency Preparedness Program

Mercuric acetate M:0340

Molecular Formula: $C_4H_6HgO_4$

Common Formula: $(CH_3COO)_2Hg$

Synonyms: Acetic acid, mercury(2 +) salt; Acetic acid, mercury(II) salt; bis(Acetyloxy)mercury; Diacetoxymercury; Mercuriacetate; Mercuric diacetate; Mercury acetate;

Mercury(2+) acetate; Mercury(II) acetate; Mercury diacetate; Mercuryl acetate

CAS Registry Number: 1600-27-7; *(alt.)* 6129-23-3; *(alt.)* 7619-62-7; *(alt.)* 19701-15-6

RTECS® Number: AI8575000

UN/NA & ERG Number: UN1629/151

EC Number: 216-491-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1993.

US EPA Gene-Tox Program, Negative: *In vivo* cytogenetics—mammalian oocyte.

Air Polutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric acetate is a white crystalline solid with a mild vinegar-like odor. Molecular weight = 318.69; Freezing/Melting point = 178−180°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Mercuric acetate is used chiefly for mercuration of organic compounds, for the absorption of ethylene, as a chemical intermediate for phenylmercuric acetate, a mildewcide, and other organomercury compounds. It is used as a catalyst in organic synthesis and in the manufacture of pharmaceuticals.

Incompatibilities: Strong oxidizers, such as chlorine, acids. Light and heat cause decomposition.

Permissible Exposure Limits in Air

As mercury alkyl compounds

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg/m^3 (skin) STEL [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.0159 mg/m^3

PAC-1: 0.0477 mg/m^3

PAC-2: 3.2 mg/m^3

PAC-3: 3.2 mg/m^3

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1993; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg [Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3, 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, ZEALAND, Singapore, Vietnam; ACGIH TLV®: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3 [skin].

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric acetate is corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Inhalation of the aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Signs and symptoms of acute exposure to mercuric acetate may be severe and include increased salivation, foul breath, inflammation and ulceration of the mucous membranes, abdominal pain, and bloody diarrhea. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances, dyspnea (shortness of breath), chest pain, and circulatory collapse may be observed.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin) or may cause skin to turn gray. Skin allergy may also occur. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. Has been shown to be a teratogen in animals.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with eye examination. Consider lung function tests for persons with frequent exposure. Examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes, and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #73-11024.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS* (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m³:* CcrFS* (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus)*.

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), light, heat, and acids.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Avoid breathing dusts. If material is not involved in fire, keep material out of water sources and sewers. Do not touch spilled material; stop leak if you can do so without risk. *Small wet spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. Acute exposure to mercuric acetate may require decontamination and life support for the victim. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies, such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but is difficult to ignite. Poisonous fumes including mercury are produced in fire. Extinguish fire using agent suitable for type of surrounding fire. Material itself does not burn or burns with difficulty. Use water in flooding quantities as fog. Use foam, carbon dioxide or dry chemical to extinguish fires. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Wear boots, protective gloves, and goggles. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear self-contained breathing apparatus when fighting fires involving this material. If contact with the material is anticipated, wear full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 70

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mercuric Acetate*. Washington, DC: Chemical Preparedness Program

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Mercuric Acetate*, Trenton, NJ

Mercuric bromide M:0350

Molecular Formula: Br_2Hg

Common Formula: $HgBr_2$

Synonyms: Mercuric bromide, solid; Mercury bromide; Mercury(II) bromide (1:2)

CAS Registry Number: 7789-47-1
RTECS® Number: OV7415000
UN/NA & ERG Number: UN1634/154
EC Number: 232-169-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric Bromide is a crystalline solid. Molecular weight = 360.41; Boiling point = 322°C; Freezing/Melting point = 236°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: This compound has applications in medicine.

Incompatibilities: Violent reaction with active metals, potassium, sodium. Store away from heat and light.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

NIOSH IDLH: 10 mg[Hg]/m^3.

No TEEL available.

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979–1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric bromide can affect you when breathed and by passing through skin. Overexposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums, memory loss, increased saliva, personality changes, and permanent brain damage may result. Skin contact may cause burns or skin allergy, or gray skin color. Contact causes eye burns with permanent damage. Heating or use near acid releases toxic mercury vapors. Mercury can build up with permanent damage. Mercury can build up in the body. Health effects have been reported below NIOSH exposure levels.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6–12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA), urine test for mercury (should be less than 0.02 mg/L). Eye examination. After suspected illness or overexposure, repeat the test above and get a blood test for mercury. Consider chest x-ray after acute overexposure. Consider nerve conduction tests, urinary enzymes, and neurobehavioral testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.
Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS* (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
*End-of-service life indicator (ESLI) required.
Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5* mg/m^3*:* CcrFS* (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus)*.
*End-of-service life indicator (ESLI) required.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and

storage. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and acids. Mercuric bromide must be stored to avoid contact with sodium and potassium, since violent reactions occur.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercuric bromide may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including mercury and bromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Mercuric Bromide*. Trenton, NJ

Mercuric chloride M:0360

Molecular Formula: Cl_2Hg

Common Formula: $HgCl_2$

Synonyms: Bichloride of mercury; Bichlorure de mercure (French); Calochlor; Chlorure mercurique (French); Cloruro mercurico (Spanish); Corrosive mercury chloride; Fungchex; MC; Mercuric bichloride; Mercury bichloride; Mercury(2+) chloride; Mercury(II) chloride; Mercury perchloride; Mercury vichloride; NCI-C60173; Quecksilber chlorid (German); Perchloride of mercury; TL 898

CAS Registry Number: 7487-94-7

RTECS® Number: OV9100000

UN/NA & ERG Number: UN1624/154

EC Number: 231-299-8 [*Annex I Index No.:* 080-010-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1993; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; EPA: Possible Human Carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; *B. subtilis* rec assay; Negative: *N. crassa—aneuploidy.*

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (in agriculture) (UK).[13]

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R28; R34; R48/24/25; R50/53; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric chloride is an odorless white crystalline solid. Molecular weight = 271.49; Boiling point = 302°C; Freezing/Melting point = 276°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 7.38% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Organometallic, Mutagen, Reproductive Effector; Human Data; Primary Irritant. Mercuric chloride is used as dip for bulbs and tubers, for earthworm control; as repellent to ants, roaches, etc; in preserving wood and anatomical specimens; embalming, browning, etching steel and iron; as a catalyst for organic synthesis; disinfectant, antiseptic, tanning; textile printing aid; manufacture of dyes; in agricultural chemicals; dry batteries; pharmaceuticals, and photographic chemicals.

Incompatibilities: Mercuric chloride may explode with friction or application on heat. Mixtures of mercuric chloride and sodium or potassium are shock sensitive and will explode on impact. Avoid contact with acids or acid fumes. Also avoid the presence of formats, sulfites, hypophosphites, phosphates, sulfide, albumin, gelatin, alkalies, alkaloid salts, ammonia, lime water, antimony, arsenic, bromides, borax, carbonates, reduced iron, copper, iron, lead, silver salts, infusions of cinchona, columbo, oak bark or senna, and tannic acid.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

Protective Action Criteria (PAC)

TEEL-0: 0.0338 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 13.5 mg/m^3

PAC-3: 13.5 mg/m^3

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 1 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3, [skin], 1999; Thailand STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/mg, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general. In addition, the former USSR-UNEP/IRTC project[43] set a MAC of 0.005 μg/L for water bodies used for domestic purposes.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption. Octanol−water coefficient: Log K_{ow} = 0.12.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. The substance is corrosive to the eyes, the skin, and the respiratory tract. Corrosive on ingestion. Inhalation of its aerosol may cause lung edema. The substance may cause effects on the kidneys. Exposure far above OEL may result in death. The effects may be delayed. Medical observation is indicated. It is classified as extremely toxic. All forms of mercury are poisonous if absorbed. Probable oral lethal dose is 5−50 mg/kg and between 7 drops and 1 teaspoonful for a 150-lb person. Mercuric chloride is one of the most toxic salts of mercury. Material attacks the gastrointestinal tract and renal systems. Signs and symptoms of acute exposure or mercuric chloride may be severe and include increased salivation, foul breath, inflammation and ulceration of the mucous membranes, abdominal pain, and bloody diarrhea. Dermal exposure may result in dermatitis (red, inflamed skin) and burns. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances, circulatory collapse, chest pain, and dyspnea (shortness of breath) may be observed.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye examination. Consider lung function tests for persons with frequent exposure. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider chest X-ray after sudden overexposure. Consider nerve conduction tests, urinary enzymes, and neurobehavioral testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with limited success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS* (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 μg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern];* or GmFS* (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercuric chloride must be stored to avoid contact with potassium and sodium, since violent reactions occur. See also "Incompatibilities," above. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible. Extinguish with water spray, fog, foam, dry chemical, or carbon dioxide. Move container from fire area. Wear self-contained breathing apparatus and full body protective clothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mercuric Chloride*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Mercuric Chloride*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Mercuric Chloride.* Trenton, NJ

Mercuric cyanide M:0370

Molecular Formula: C_2HgN_2

Common Formula: $Hg(CN)_2$

Synonyms: Cianuro mercurico (Spanish); Cyanure de mercure (French); Mercury(2+) cyanide; Mercury(II) cyanide

CAS Registry Number: 592-04-1

RTECS® Number: OW1515000

UN/NA & ERG Number: UN1636/154

EC Number: 209-741-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric cyanide is an odorless, white crystalline solid; turns gray to dark brown when exposed to light. Molecular weight = 252.63; Decomposes at 319°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Mercuric cyanide is used in medicine, germicidal soaps, photography and in making cyanogen gas.

Incompatibilities: Violent reaction with fluorine, magnesium, sodium nitrite, acids. Heating or contact with acid releases toxic mercury and flammable HCN.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0315 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 12.6 mg/m^3

PAC-3: 12.6 mg/m^3

As inorganic mercury compound

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

As cyanide compound (for reference)

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

NIOSH IDLH: 25 mg[CN]/m^3.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140. See also NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979–1980.[6] These are the limits for inorganic mercury compounds in general. See also the entry on "Cyanides."

Determination in Water

Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric cyanide can affect you when breathed and by passing through skin. Direct contact causes eye irritation and possible damage. Overexposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums, memory loss, increased saliva, metallic taste, personality changes, and brain damage. Skin contact can cause irritation, skin allergy, or a gray skin color. Mercury can build up in the body. Heating or contact with acid or acid mist causes the release of toxic mercury and cyanide vapors; may cause bronchitis and lung irritation. Overexposure to cyanide can cause sudden death.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. Organic mercury substances have been identified as human teratogens. Some related compounds damage the developing fetus and decrease fertility in males and females. It is unknown for certain if mercuric cyanide causes these effects and so care is indicated.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6–12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye examination. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes, and neurobehavioral testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercuric cyanide must be stored to avoid contact with fluorine, magnesium, and sodium nitrite, since violent reactions occur. Mercuric cyanide should not contact acid or heat because it will release flammable hydrogen cyanide gas. Store in tightly closed containers in a cool, well-ventilated area away from light. Protect containers from physical damage.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury cyanide may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including hydrogen cyanide, oxides of nitrogen, and mercury, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return to supplier for mercury recovery and deactivation.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercuric Cyanide*. Trenton, NJ

Mercuric iodide M:0380

Molecular Formula: HgI_2

Synonyms: Hydrargyrum bijodatum (German); Mercuric iodide, red; Mercury biniodide; Mercury diiodide; Mercury (II) iodide; Red mercuric iodide

CAS Registry Number: 7774-29-0

RTECS® Number: OW5250000

UN/NA & ERG Number: UN1638 (solution and solid)/151

EC Number: 231-873-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric iodide is a heavy, scarlet red, odorless, crystalline solid. It may be shipped as a red solution. It turns to a yellow powder at 127°C and red upon cooling. Molecular weight = 454.40; Boiling point = (sublimes) 354°C; Freezing/Melting point = 259°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Mercuric iodide is used in medicine and in analytical chemistry.

Incompatibilities: Violent reaction with active metals, potassium, sodium, acids, chlorine trifluoride. Inorganic mercury compounds are incompatible with acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0566 mg/m^3

PAC-1: 0.0566 mg/m^3

PAC-2: 0.227 mg/m^3

PAC-3: 22.7 mg/m^3

As iodides

ACGIH TLV®[1]: 0.01 ppm/0.1 mg/m^3, inhalable fraction and vapor, TWA.

As inorganic mercury compound

OSHA PEL: 0.1 $mg[Hg]/m^3$ Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 $mg[Hg]/m^3$ TWA [skin]; Other: 0.1 $mg[Hg]/m^3$ Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 $mg[Hg]/m^3$ TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

DFG MAK: 0.1 $mg[Hg]/m^3$; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 $mg[Hg]/m^3$.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric iodide can affect you when breathed and by passing through skin. Overexposure can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums, memory loss, increased saliva, metallic taste, and personality changes. Permanent brain damage may result. Skin contact may cause skin burns, skin allergy, or a gray skin color. Eye contact can cause permanent damage. Heating or contact with acid or acid mist releases toxic mercury vapors. Mercury accumulates in the body. Health effects have been reported below exposure levels of 0.1 mg/m^3.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider lung function tests for persons with frequent exposure. Eye examination. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider chest X-ray after sudden exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercuric iodide must be stored to avoid contact with chlorine trifluoride, sodium, and potassium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from light, acids, and heat. Protect containers from physical damage.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS" (solution). It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including iodine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercuric Iodide*. Trenton, NJ

Mercuric nitrate M:0390

Molecular Formula: HgN_2O_6

Common Formula: $Hg(NO_3)_2$

Synonyms: Mercury(2+) nitrate (1:2); Mercury(II) nitrate (1:2); Mercury nitrate; Mercury pernitrate; Nitrate mercurique (French); Nitrato mercurico (Spanish); Nitric acid, mercury(2+) salt; Nitric acid, mercury(II) salt

CAS Registry Number: 10045-94-0

RTECS® Number: OW8225000

UN/NA & ERG Number: UN1625/154

EC Number: 233-152-3 [*Annex I Index No.:* 080-002-00-6] pesticide in the group of plant protection products; banned or severely restricted

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R6; R26; R48/23; R50/53; Safety phrases: S53; S45; S60; S61; as mercury.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric Nitrate is a white to yellowish crystalline solid with a nitric acid-like odor. Normally exists as hemihydrate or dihydrate. Molecular weight = 324.61; Boiling point = (decomposes); Freezing/Melting point = 70−79°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Mercuric nitrate is used in making other chemicals; in felt manufacture, and in making mercury fulminate.

Incompatibilities: A strong oxidizer. Reacts violently with combustibles, petroleum hydrocarbons, reducing agents. Reacts with acetylene, alcohol, phosphine and sulfur to form shock-sensitive compounds. Aqueous solution attacks most metals. Vigorous reaction with petroleum hydrocarbons. Incompatible with organic materials, acetylene, ethanol, phosphine, sulfur, hypophosphoric acid. Inorganic mercury compounds are incompatible with acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper. Decomposes in heat or on exposure to light, producing toxic fumes (mercury, nitrogen oxides).

Permissible Exposure Limits in Air

As inorganic mercury compounds

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

Protective Action Criteria (PAC)

TEEL-0: 0.0405 mg/m^3

PAC-1: 0.2 mg/m^3

PAC-2: 1.62 mg/m^3

PAC-3: 16.2 mg/m^3

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg [Hg]/m^3, [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric nitrate can affect you when breathed in and passed through skin (causing systemic poisoning). Eye contact causes ulceration of conjunctiva and cornea. Skin contact causes irritation and possible dermatitis. Acute systemic poisoning can be fatal within a few minutes. Death by uremic poisoning can be delayed 5−12 days. Overexposure can damage kidneys. Mercury poisoning can cause "shakes," irritability, sore gums, increased saliva, personality change and brain damage. Eye contact may cause burns. Heating or contact with acid or acid mist causes release of toxic mercury vapors and lung effects. Mercury accumulates in the body. Health effects have been reported below TLV levels of 0.1 mg/m^3. Acute poisoning has resulted from inhaling dust concentrations of 1.2−8.5 mg/m^3.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin), or cause skin to turn gray. Skin allergy may occur. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. There is limited evidence that this chemical reduces fertility in males and females. Repeated exposures may cause brown staining of the eyes and may affect peripheral vision.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye examination. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes, and neurobehavioral testing. Eye examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m³*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m³*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m³:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m³*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m³:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercuric nitrate must be stored to avoid contact with organic materials; acetylene, ethanol, phosphine, sulfur, and hypophosphoric acid, since violent reactions occur. See also "Incompatibilities." Do not store on wooden floors.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but enhances combustion of other substances. Mercuric nitrate is a dangerous fire risk on contact with combustible and organic materials (wood, paper, oils, etc). Use dry chemical, CO_2, water spray. Poisonous gases, including mercury and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercuric Nitrate*. Trenton, NJ

Mercuric oxide M:0400

Molecular Formula: HgO

Synonyms: C.I. 77760; Kankerex; Mercuric oxide, red; Mercuric oxide, yellow; Mercury monoxide; Mercury oxide; Oxido mercurico rojo (Spanish); Oxido mercurico amarillo (Spanish); Oxyde de mercure (French); Red mercuric oxide; Red oxide of mercury; Red precipitate; Santar; Yellow mercuric oxide; Yellow oxide of mercury; Yellow precipitate

CAS Registry Number: 21908-53-2; *(alt.)* 1344-45-2; *(alt.)* 8028-34-0

RTECS$^{®}$ Number: OW8750000

UN/NA & ERG Number: UN1641/151

EC Number: 244-654-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1993.

Banned or Severely Restricted (in agriculture) (EEC) (UK).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 (as mercury compound): Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric oxide is a red or orange-red heavy crystalline powder; yellow when finely powdered. Molecular weight = 216.59; Freezing/Melting point = 500°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen; Reproductive Effector. Mercuric oxide is used for wound sealing and canker treatment of fruit and rubber trees; chemical intermediate for mercury salts; organic mercury compounds; chlorine monoxide; as an antiseptic in pharmaceuticals; component of dry cell batteries; pigment and glass modifier; fungicide; preservative in cosmetics; analytical reagent; formerly used in antifouling paints.

Incompatibilities: A powerful oxidizer. Decomposes on exposure to light, when heated above 500°C, producing highly toxic fumes including mercury and oxygen, which will add to the intensity of an existing fire. Violent reaction with combustible materials, other oxidizers, acetyl nitrate, aluminum, diboron tetrafluoride, reducing agents, phospham, hydrogen trisulfide (on ignition), hydrazine hydrate, hydrogen peroxide, hypophosphorous acid, acetyl nitrate, chlorine, magnesium (when heated), disulfur dichloride, alcohols, alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium). Forms heat- or impact-sensitive explosive mixtures with sulfur, phosphorus and other nonmetals, potassium, magnesium, sodium and other chemically active metals. Incompatible with strong bases and light.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

NIOSH IDLH: 10 mg[Hg]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.027 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 1.08 mg/m^3

PAC-3: 10.8 mg/m^3

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg [Hg]/m^3, [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg[Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia set a MAC for ambient air in residential areas of 0.003 mg/m^3 on a daily average basis.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric oxide dust has a corrosive effect on eyes, skin, and respiratory tract. This material is highly toxic by ingestion, inhalation, or skin absorption. Very short exposure to small quantities may cause death or permanent injury. Following ingestion, mercuric oxide is readily converted to mercuric chloride, the most dangerous mercury compounds. Signs and symptoms of acute exposure to mercuric oxide may be severe and include increased salivation, foul breath, inflammation and ulceration of the mucous membranes, abdominal pain, and bloody diarrhea. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances, circulatory collapse, chest pain, and dyspnea (shortness of breath) may be observed.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, and kidney failure. There is limited evidence that this chemical is a teratogen in animals. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes, and decreased peripheral vision.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA), urine test for mercury (should be less than 0.02 mg/L). Eye examination. After suspected illness or overexposure, repeat the test above and get a blood test for mercury. Consider chest X-ray after acute overexposure. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing. Evaluation by a qualified allergist. Eye examination. Consider chest X-ray following acute overexposure.

First Aid: Remove victims from exposure. Emergency personnel should avoid self-exposure to mercuric oxide. Evaluate vital signs, including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Remove contaminated clothing as soon as possible. If eye exposure has occurred, remove any contact lenses at once; eyes must be flushed with lukewarm water for at least 15 min. Wash exposed skin areas for 15 min with soap and water. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures in the event of inhalation or ingestion of HgO. Rush to a health-care facility.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor:* NIOSH: *Up to 0.5 mg/m^3:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator*). Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted

canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m³*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*
*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chlorine, hydrogen peroxide, hypophosphorous acid, hydrazine hydrate, magnesium (when heated), disulfur dichloride; hydrogen trisulfide, reducing agents. See also "Incompatibilities."

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for cleanup of mercury are available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but enhances combustion of other substances. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Wear full body protective clothing and self-contained breathing apparatus. Poisonous gases, including mercury fumes and mercury oxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mercuric Oxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Mercuric Oxide*. Trenton, NJ

Mercuric oxycyanide M:0410

Molecular Formula: $C_2Hg_2N_2O$

Common Formula: $Hg(CN)_2 \cdot HgO$

Synonyms: Mercury cyanide oxide; Mercury oxycyanide

CAS Registry Number: 1335-31-5

RTECS® Number: OW1530000

UN/NA & ERG Number: UN1642/151

EC Number: 215-629-8 [*Annex I Index No.:* 080-006-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as mercury-based pesticides, liquid, flammable, toxic, n.o.s.; mercury-based pesticides, liquid, toxic, n.o.s.; mercury-based pesticides, solid, toxic, n.o.s.; mercury compounds, liquid, n.o.s.; mercury compounds, solid, n.o.s.; mercury(I) (mercurous) compounds (pesticides); mercury(II) (mercuric) compounds (pesticides).

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as mercury compounds, n.o.s.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: Hazard Symbol: E, T, N; Risk phrases: R2; R23/24/25; R33; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric oxycyanide is a white crystalline solid. It explodes instead of melting. Molecular weight = 721.9; Specific gravity (water = 1) = 4.43. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 4. Soluble in water.

Potential Exposure: This material has been used in medicine as a topical antiseptic.

Incompatibilities: Mercuric oxycyanide is self reactive. Friction, heat, shock, and careless handling may cause an explosion. Contact with acid or acid mist causes the release of toxic mercury and hydrogen cyanide vapors.

Permissible Exposure Limits in Air

No TEEL available.

As organo mercury compounds

OSHA PEL: 0.01 mg/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3 [skin] Danger of skin sensitization; Carcinogen Category 3.

NIOSH IDLH: 2 mg Hg/m^3.

As cyanides

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

NIOSH IDLH: 25 mg[CN]/m^3.

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for *inorganic* mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: LD$_{50}$ = (oral-rats) 26 mg/kg. Mercuric oxycyanide can affect you when breathed and by passing through skin. Overexposures can cause kidney damage. Mercury poisoning can cause “shakes,” irritability, sore gums, memory loss, increased saliva, personality change, and even permanent brain damage. Skin contact can cause irritation, skin allergy, or a gray skin color. Eye contact causes irritation. Heating or use near acid can release toxic mercury and cyanide vapors. Health effects have been reported below permitted exposure levels.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, and kidney failure. Organic mercury substances have been identified as a teratogen in humans. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes, and decreased peripheral vision.

Points of Attack: Eyes, skin, central nervous system, mucous membrane, peripheral nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye examination. Kidney function tests. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #73-11024.

Respirator Selection: *Up to 0.1 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m^3:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m^3:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercuric oxycyanide is self reactive. Friction, heat, and rough handling may cause an explosion. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Shipping of this material is FORBIDDEN *unless* it is desensitized. The desensitized material requires a shipping label of "POISONOUS/TOXIC MATERIALS." The desensitized material falls in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercuric oxycyanide may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including cyanide gas and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercuric Oxycyanide*. Trenton, NJ

Mercuric sulfate M:0420

Molecular Formula: HgO_4S

Common Formula: $HgSO_4$

Synonyms: Mercury bisulfate; Mercury persulfate; Mercury (2+) sulfate (1:1); Mercury(II) sulfate (1:1); Sulfate mercurique (French); Sulfato mercurico (Spanish); Sulfuric acid, mercury(2+) salt (1:1); Sulfuric acid, mercury(II) salt (1:1)

CAS Registry Number: 7783-35-9

RTECS$^®$ Number: OX0500000

UN/NA & ERG Number: UN1645/151

EC Number: 231-992-5 [*Annex I Index No.:* 080-002-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as mercuric sulphate.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R6; R26; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercuric sulfate is a white, odorless, crystalline solid. Molecular weight = 296.65; Freezing/Melting point = (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Decomposes in water.

Potential Exposure: Mercuric sulfate is used in making other chemicals, as a battery electrolyte, and in extracting gold and silver from rock.

Incompatibilities: Contact with water produces insoluble basic mercuric subsulfate and sulfuric acid. Reacts with acids producing mercury vapors. Violent reaction with gaseous hydrogen chloride above 121°C. Decomposes in heat or on exposure to light, producing toxic fumes of mercury and sulfur oxides. Attacks magnesium, aluminum, zinc, iron, lead, copper.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA *as persulfates.*

Protective Action Criteria (PAC)

TEEL-0: 0.037 mg/m^3

PAC-1: 0.037 mg/m^3

PAC-2: 0.148 mg/m^3

PAC-3: 14.8 mg/m^3

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg [Hg]/m^3, [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg[Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Mercuric sulfate can affect you when breathed in and by passing through skin. Irritates the skin and is corrosive to the eyes and the respiratory tract. Corrosive if ingested. Inhalation of the aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Overexposure can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums, memory loss, increased saliva, personality change, and even permanent brain damage. Heating or contact with acid or acid "mist" causes release of toxic mercury vapors, and lung effects have been reported below permissible exposure levels. The substance may cause effects on the gastrointestinal tract. Very high exposure may result in death.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, and kidney failure. Organic mercury substances have been identified as a teratogen in humans. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes, and decreased peripheral vision.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical examination and history is strongly recommended, with examination of the nervous system including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye examination. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes, and neurobehavioral testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Antidotes and special procedures for medical personnel: The drug NAP (N-acetyl penicillamine) has been used to treat mercury poisoning with limited success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Mercury vapor: NIOSH: *Up to 0.5 mg/m³*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m³*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m³:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m³*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m³:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted

canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*
*End-of-service life indicator (ESLI) required.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, water, and gaseous hydrogen chloride.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agent suitable to surrounding fire. Poisonous gases, including mercury and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercuric Sulfate*. Trenton, NJ

Mercury and inorganic compounds M:0430

Molecular Formula: Hg

Synonyms: Colloidal mercury; Hydragyrum; Kwik; Liquid silver; Mercure (French); Mercury, metallic; Metallic mercury; NCI-C60399; Quecksilber (German); Quicksilver

CAS Registry Number: 7439-97-6; *(alt.)* 8030-64-6; *(alt.)* 51887-47-9; *(alt.)* 92355-34-5; *(alt.)* 92786-62-4; *(alt.)* 123720-03-6

RTECS® Number: OV4550000

UN/NA & ERG Number: UN2809/172

EC Number: 231-106-7 [*Annex I Index No.:* 080-001-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence Group 3, 1993; EPA: Not Classifiable as to human carcinogenicity.

Banned or Severely Restricted (in agriculture) (many countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U151.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.2 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.15; Nonwastewater (mg/L), 0.25 TCLP; Wastewater from retort, N/A; Nonwastewater from retort (mg/L), 0.20 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 7420 (2) as mercury, total dust.

Safe Drinking Water Act: MCL, 0.002 mg/L; MCLG, 0.002 mg/L.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R6; R26; R48/23; R50/53; Safety phrases: S53; S45; S60; S61.

Description: Mercury is a silvery, mobile, odorless liquid. Molecular weight = 200.59; Boiling point = 356−357°C; Freezing/Melting point = −39°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Mercury is used as a catalyst, in dental applications and pharmaceuticals, as a liquid cathode in cells for the electrolytic production of caustic and chlorine. It is used in electrical apparatus (lamps, rectifiers, and batteries) and in control instruments (switches, thermometers and barometers).

Incompatibilities: Heating mercury causes the formation of toxic mercury oxide fumes. Reacts violently with alkali metals, acetylene, azides, ammonia gas, chlorine, chlorine dioxide, many acids, most metals, ground mixtures of sodium carbide, and ethylene oxide. Contact with methyl azide forms shock- and spark-sensitive explosives. Attacks copper and many other metals, forming amalgams.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: (*Hg vapor*): 0.05 mg[Hg]/m^3 TWA [skin]; 0.1 mg[Hg]/m^3 Ceiling Concentration; [skin].

ACGIH TLV®[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week.

Protective Action Criteria (PAC) Mercury*

TEEL-0: 0.025 mg/m^3

PAC-1: 0.25 mg/m^3

PAC-2: **1.7** mg/m^3

PAC-3: **8.9** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: Inappropriate

ERPG-2: 0.25 ppm

ERPG-3: 0.5 ppm

DFG MAK (*elemental and inorganic compounds*): 0.1 mg [Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B.

NIOSH IDLH: 10 mg[Hg]/m^3.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.005 ppm (0.05 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 0.05 mg/m^3, 1993; France: VME 0.05 mg/m^3, [skin] (*vapor*), 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, 2003; Japan: 0.05 mg/m^3, 1999; Norway: TWA 0.05 mg/m^3, 1999; Poland: MAC (TWA) vapors 0.025 mg/m^3, MAC (STEL) vapors 0.2 mg/m^3, 1999; Sweden: NGV 0.05 mg/m^3 (*vapor*), 1999; Switzerland: MAK-W 0.005 ppm (0.05 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.01 mg/m^3, [skin], 1993; Turkey: TWA 0.1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[35, 43] set a MAC of 0.0003 mg/m^3 for ambient air in residential areas. Several states have set guidelines or standards for mercury in ambient air[60] ranging from 0.024 μg/m^3 (Kansas) to 0.01−0.08 mg/m^3 (Montana) to 0.167 μg/m^3 (New York) to 0.2−2.0 μg/m^3 (Connecticut) to 0.24 μg/m^3 (Pennsylvania) to 0.25 μg/m^3 (South Carolina) to 0.5 μg/m^3 (North Dakota) to 0.5−1.0 μg/m^3 (Florida) to 0.8 μg/m^3 (Virginia) to 2.0 μg/m^3 (Nevada) to 3.0 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: A variety of values have been set for mercury in drinking water in various parts of the world. These include[35]: the Czech Republic 0.001 mg/L; Canada 0.001 mg/L maximum acceptable concentration; Germany 0.004 mg/L EEC 0.001 mg/L; Japan 0.0005 mg/L; Mexico 0.005 mg/L; former USSR-UNEP/IRPTC joint project 0.0005 mg/L; USA 0.002 mg/L; WHO 0.001 mg/L. In addition, the US EPA[49] has set a lifetime health advisory at 0.0011 μg/L. And EPA has set a guideline of 0.002 μg/L for drinking water.[62] Beyond that several states have set guidelines for mercury in drinking water[61] including Maine at 2 μg/L and Minnesota at 3 μg/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Exposure to levels below 1 mg/m^3 has been shown to produce nonspecific symptoms, such as shyness, insomnia, anxiety, and loss of appetite. Higher levels (1−3 mg/m^3 for 2−5 h) may cause headache, salivation, metallic taste, chills, cough, fever, tremors, abdominal cramps, diarrhea, nausea, vomiting, tightness in the chest, difficult breathing, fatigue, lung irritation, and possible lung tissue damage. Symptoms may begin several hours after exposure and may last a week. Large doses may result in flu-like symptoms, which, in severe cases, may result in death due to pneumonia. *Lethal blood level in humans:* 0.4−22 mg/mL. *Skin:* Can be absorbed through the skin. Can cause irritation. Prolonged contact with skin can result in symptoms listed above. *Eyes:* Can cause eye irritation. *Ingestion:* Generally does not produce ill effects.

Long Term Exposure: May cause skin allergy. Mercury accumulates in the brain quickly during exposure but is released from the brain very slowly. This will result in a buildup in brain tissue over a long time. The liver and kidneys may also be damaged by mercury accumulation. It may cause headache, dizziness, restlessness, irritability, sleepiness, tremors, defective muscle control, increased salivation, loose teeth, irritation of the gums with a blue line between teeth and gums, loss of appetite, nausea, vomiting, diarrhea, liver damage, changes in urine, raised red areas and blisters of skin, impaired memory and possible permanent brain damage. Repeated exposure (usually more than 5 years) may cause clouding of the eyes, gray skin color. Frequency of complaints and severity of symptoms increase with levels of exposure, most notably above 0.1 mg/m^3. However, many of these symptoms have been reported at levels below recommended limits due to the accumulation of mercury over long term. There is limited evidence that mercury may cause an increase in spontaneous abortions in exposed women.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nervous system (including handwriting test to detect early hand tremor). Urine mercury level (usually less than 0.02 mg/L). Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Mercury vapor: NIOSH: *Up to 0.5 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 mg/m^3*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 mg/m^3:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]* or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).*

*End-of-service life indicator (ESLI) required.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Mercury must be stored to avoid contact with chlorine dioxide, nitric acid, nitrates, ethylene oxide, chlorine, and methylazide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acetylene, ammonia, and nickel.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Wearing protective equipment and clothing, clean up the spill with an industrial vacuum cleaner with a charcoal filter to absorb mercury vapor. For mercury spilled in cracks, cover with zinc dust to form an amalgam, or cover with calcium polysulfide with excess sulfur. Do not sweep or use compressed air to blow mercury droplets as it can increase air concentrations. Store contaminated or waste mercury in tightly covered or vapor-proof containers pending removal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury is not combustible. Use agent suitable for surrounding fire. Poisonous gases, including Hg, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Accumulate for purification and re-use if possible. Mercury vapors may be adsorbed or treated with sulfide solutions and then sent to mercury recovery operations.[22]

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New York State Department of Health. (February 1986). *Chemical Fact Sheet: Mercury (Metallic)*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Mercury*. Trenton, NJ

Mercury alkyl compounds M:0440

Molecular Formula: CH_3ClHg

Common Formula: CH_3HgCl

Synonyms: *Methyl mercury chloride:* Caspan; Chloromethylmercury; Methylmercuric chloride; Methylmercury chloride; MMC; Monomethyl mercury chloride

Dimethyl mercury: Mercury dimethyl

CAS Registry Number: 115-09-3 (methyl mercury chloride); 593-74-8 (dimethyl mercury); 22967-92-6 (methyl mercury ion)

RTECS® Number: OW6320000 (methyl mercury ion); OW1225000 (methyl mercury chloride)

UN/NA & ERG Number: UN2025 (mercury compounds, solid, n.o.s.)/151; UN3024 (mercury compounds, liquid, n.o.s.)/131

EC Number: 204-064-2 (chloromethylmercury); 209-805-3 [*Annex I Index No.:* 080-007-00-3] (dimethylmercury)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1993 (dimethyl mercury); EPA: Possible Human Carcinogen.

Maximum Contaminant Levels (Safe Drinking Water Act).

US EPA Gene-Tox Program, Negative: *In vivo* cytogenetics—mammalian oocyte; Inconclusive: Rodent dominant lethal (dimethyl mercury).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0% (dimethyl mercury).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations (*593-74-8*): Hazard Symbol: T + , N; Risk phrases: R26/27/28; R33; R50/53; Safety phrases: S1/2; S13; S28; S36; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned. *Note*: All other mercury compounds are Hazard Class 3.

Description: Dimethyl mercury is a volatile colorless liquid with faint sweet odor. Molecular weight = 230.67; Boiling point = 96°C. Soluble in water. Methyl mercury chloride is a colorless, crystalline solid. Molecular weight = 251.08; Freezing/Melting point = 170°C. Practically insoluble in water; solubility = <0.1 mg/mL at 21°C.

Potential Exposure: Alkyl mercury compounds have been used as seed disinfectants and for fungicides. They have also been used in organic synthesis.

Incompatibilities: Strong oxidizers, such as chlorine. May be sensitive to light.

Permissible Exposure Limits in Air

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 mg[Hg]/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg[Hg]/m^3 TWA; 0.03 mg[Hg]/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg[Hg]/m^3 STEL [skin].

NIOSH IDLH: 2 mg Hg/m^3.

Dimethyl mercury

Protective Action Criteria (PAC)

TEEL-0: 0.0115 mg/m^3

PAC-1: 0.0345 mg/m^3

PAC-2: 0.046 mg/m^3

PAC-3: 2.3 mg/m^3

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3B.

Australia: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3, [skin], 1993; Austria: MAK 0.01 mg[Hg]/m^3, 1999;

Belgium: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.01 mg[Hg]/m^3, [skin], 1999; Finland: TWA 0.01 mg[Hg]/m^3, [skin], 1999; France: VME 0.01 mg[Hg]/m^3, [skin], 1999; Norway: TWA 0.01 mg[Hg]/m^3, 1999; the Philippines: TWA 0.01 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.01 mg[Hg]/m^3, MAC (STEL) 0.01 mg[Hg]/m^3, 1999; Sweden: NGV 0.01 mg [Hg]/m^3, [skin], 1999; Thailand: TWA 0.01 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Turkey: TWA 0.01 mg[Hg]/m^3, [skin], 1993; United Kingdom: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.01; STEL 0.03 mg/m^3 [skin]. In addition, North Dakota has set guidelines for alkyl mercury compounds in ambient air[60] of 1−3 μg/m^3 (0.0001−0.0003 mg/m^3).

Determination in Air: No method available.

Permissible Concentration in Water: *Methyl mercury: To protect freshwater aquatic life:* 0.016 μg/L as a 24-h average, never to exceed 8.8 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 2.8 μg/L. *To protect human health:* 0.2 μg/L.[6]

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Alkyl mercury compounds can be absorbed through the skin. When deposited on the skin, they give no warning, and if contact is maintained, can cause second-degree burns. Sensitization may occur. Alkyl mercurials have very high toxicity. *Systemic:* The central nervous system, including the brain, is the principal target tissue for this group of toxic compounds. Severe poisoning may produce irreversible brain damage resulting in loss of higher functions. The effects of chronic poisoning with alkyl mercury compounds are progressive. In the early stages, there are fine tremors of the hands; and in some cases, of the face and arms.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. With repeated or continued exposure, tremors may become coarse and convulsive, scanning speech with moderate slurring and difficulty in pronunciation may also occur. The worker may then develop an unsteady gait of a spastic nature which can progress to severe ataxia of the arms and legs. Sensory disturbances including tunnel vision, blindness, and deafness are also common. A late symptom, constriction of the visual fields, is rarely reversible and may be associated with loss of understanding and reason which makes the victim completely out of touch with his environment. Severe cerebral effects have been seen in infants born to mothers who had eaten large amounts of methylmercury-contaminated fish.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: Preplacement and periodic physical examinations should be concerned particularly with the skin, vision, central nervous system, and kidneys. Consideration should be given to the possible effects on the fetus of alkyl mercury exposure in the mother. Constriction of visual fields may be a useful diagnostic sign. Blood and urine levels of mercury have been studied, especially in the case of methylmercury. A precise correlation has not been found between exposure levels and concentrations. They may be of some value in indicating that exposure has occurred, however.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m^3*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m^3:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. These compounds should be stored in a refrigerator or a cool, dry place away from oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Mercury compounds n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases of chlorine and Hg are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Organomercurials*. Rockville, MD, pp. 287−296, 678

US Environmental Protection Agency. (1979). *Mercury: Ambient Water Quality Criteria*. Washington, DC

Mercury thiocyanate M:0450

Molecular Formula: $C_2HgN_2S_2$

Common Formula: $Hg(CNS)_2$

Synonyms: Bis(thyocyanato)-mercury; Mercuric sulfo cyanate, solid; Mercuric sulfocyanate; Mercuric sulfocyanide; Mercury dithiocyanate; Mercury thiocyanate; Tiocianato mercurico (Spanish)

CAS Registry Number: 592-85-8

RTECS$^®$ Number: XL1550000

UN/NA & ERG Number: UN1646/151

EC Number: 209-773-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%; Category D1A.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as mercury-based pesticides, liquid, flammable, toxic, n.o.s.; mercury-based pesticides, liquid, toxic, n.o.s.; mercury-based pesticides, solid, toxic, n.o.s.; mercury compounds, liquid, n.o.s.; mercury compounds, solid, n.o.s.; mercury(I) (mercurous) compounds (pesticides); mercury(II) (mercuric) compounds (pesticides).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mercury thiocyanate is a white, odorless powder. Molecular weight = 316.79; Freezing/Melting point = about 165°C (decomposes). Slightly soluble in cold water.

Potential Exposure: Mercury thiocyanate is used in photography and fireworks.

Incompatibilities: Heat; expands to many times its original volume and then decomposes at freezing/melting point forming toxic fumes of sulfur oxides, mercury cyanide, and nitrogen oxides. Contact with acid or acid fumes causes release of toxic mercury and cyanide vapors.

Permissible Exposure Limits in Air

As organo mercury compounds

OSHA PEL: 0.01 mg/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.0395 mg/m^3

PAC-1: 0.0395 mg/m^3

PAC-2: 0.158 mg/m^3

PAC-3: 15.8 mg/m^3

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3 [skin] Danger of skin sensitization; Carcinogen Category 3.

NIOSH IDLH: 2 mg Hg/m^3.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979−1980.[6] These are the limits for *inorganic* mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45-μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Mercury thiocyanate can affect you when breathed in. High or repeated exposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums, memory loss, increased saliva, metallic taste, personality change, and/or brain damage. Skin and eye contact can cause irritation, allergy, and a gray skin color. Heating or contact with acid or acid "fumes" causes release of toxic mercury or cyanide vapors and lung effects. Health effects may occur below recommended exposure levels.

Long Term Exposure: Repeated or prolonged contact with skin may result in allergy, dermatitis, rash. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. Related mercury compounds may damage the developing fetus and decrease fertility in males and females.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with examination of the nervous system including handwriting. Kidney function tests. Urine test for mercury (should be less than 0.02 mg/L). After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m³:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5* mg/m³*:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m³:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and acids, including fumes.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Restrict persons not wearing protective equipment from area of spill until cleanup is complete. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury thiocyanate may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides, sulfur oxides, mercury and cyanide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Mercury Thiocyanate*. Trenton, NJ

Mesitylene M:0460

Molecular Formula: C_9H_{12}

Common Formula: $C_6H_3(CH_3)_3$

Synonyms: Benzene, 1,3,5-trimethyl-; *sym*-Trimethylbenzene; *symmetrical*-Trimethylbenzene; TMB; 1,3,5-Trimethylbenzene; Trimethyl benzol

CAS Registry Number: 108-67-8

RTECS® Number: OX6825000

UN/NA & ERG Number: UN2325/129

EC Number: 203-604-4 [*Annex I Index No.:* 601-025-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Extremely Hazardous Substance (EPA-SARA, Dropped From Listing in 1988).

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R37; R51/53; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mesitylene is a clear, colorless liquid with a distinctive, aromatic odor. Molecular weight = 120.21; Specific gravity (H_2O:1) = 0.86; Boiling point = 165°C; Freezing/Melting point = −45°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 50°C (cc); Autoignition temperature = 559°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.002%.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Mesitylene is used as raw material in chemical synthesis and as ultraviolet stabilizer; as a paint thinner, solvent, and motor fuel component; as an intermediate in organic chemical manufacture.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers cause a fire and explosion hazard. Violent reaction with nitric acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.92 mg/m³ at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 25 ppm/125 mg/m³ TWA.

ACGIH TLV®[1]: 25 ppm TWA (lists a single CAS number for mixed isomers).

Protective Action Criteria (PAC)*

TEEL-0: 25 ppm

PAC-1: **140** ppm

PAC-2: **360** ppm

PAC-3: **500** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 20 ppm/100 mg/m^3; Pregnancy Risk Group C (all isomers of trimethylbenzene).

Denmark: TWA 25 ppm (120 mg/m^3), 1999; Japan: 25 ppm (120 mg/m^3), 1999; Norway: TWA 20 ppm (100 mg/m^3), 1999; Sweden: NGV 25 ppm (120 mg/m^3), KTV 35 ppm (170 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (125 mg/m^3), 1999; the Netherlands: MAC-TGG 100 mg/m^3; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm.

Determination in Air: Use OSHA Analytical Method PV-2091.

Permissible Concentration in Water: No method available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.41$.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Symptoms of exposure can also include headache, drowsiness, fatigue, dizziness, nausea, a lack of coordination, vomiting, confusion. Acute-lowest toxic concentration for humans is 10 ppm, resulting in central nervous system effects. Liquid deposition in lungs causes chemical pneumonitis. Symptoms of exposure include nervousness, tension, anxiety, asthmatic bronchitis, and skin irritation.

Long Term Exposure: Repeated exposures can cause headaches, tiredness, and a feeling of nervous tension. Can affect the blood cells and the blood's clotting ability, hypochromic anemia. Delayed or chronic health hazard is possible asthmatic bronchitis with coughing and/or shortness of breath. The use of alcoholic beverages enhances the effect. May cause liver damage. The liquid destroys the skin's natural oils, causing drying and cracking.

Points of Attack: Eyes, skin, respiratory system, central nervous system, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Complete blood count and platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 25 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. This chemical must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Mesitylene*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Trimethyl Benzene (mixed isomers)*. Trenton, NJ

Mesityl oxide M:0470

Molecular Formula: $C_6H_{10}O$
Common Formula: $CH_3COCH = C(CH_3)_2$
Synonyms: Isobutenyl methyl ketone; Isopropylideneacetone; Mesityloxid (German); Methyl isobutenyl ketone; 4-Methyl-3-pentene-2-one; 4-Methyl-3-penten-2-on (German); 2-Methyl-2-penten-4-one; 4-Methyl-3-penten-2-one; Oxyde de mesityle (French)
CAS Registry Number: 141-79-7
RTECS® Number: SB4200000
UN/NA & ERG Number: UN1229/129
EC Number: 205-502-5[*Annex I Index No.*: 606-009-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20/21/22; Safety phrases: S2; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Mesityl oxide is a clear, pale yellow, or colorless liquid with a strong peppermint odor. The odor threshold is 0.05 ppm. Molecular weight = 98.16; Specific gravity (H_2O:1) = 0.87; Boiling point = 130°C; Freezing/Melting point = −46.7°C; Vapor pressure = 9 mmHg at 20°C; Flash point = 30.6°C; Autoignition temperature = 343°C. Explosive limits: LEL = 1.4%; UEL = 7.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Slightly soluble in water; solubility = 3%.[NIOSH]

Potential Exposure: Compound Description: Human Data; Primary Irritant. Mesityl oxide is used as a solvent for cellulose esters and ethers and other resins in lacquers and inks. It is used in paint and varnish removers and as an insect repellent.

Incompatibilities: Forms explosive mixture with air. May be able to form explosive peroxides. May react violently with nitric acid, aliphatic amines, alkanolamines, 2-aminoethanol, ethylene diamine, chlorosulfonic acid, oleum (fuming sulfuric acid). Not compatible with oxidizers, strong acids, strong bases, reducing agents, halogens. Dissolves some forms of plastics, resins, and rubber. Attacks copper.

Permissible Exposure Limits in Air

OSHA PEL: 25 ppm/100 mg/m^3 TWA.
NIOSH REL: 10 ppm/40 mg/m^3 TWA.
ACGIH TLV®[1]: 15 ppm/60 mg/m^3 TWA; 25 ppm/100 mg/m^3 STEL.
NIOSH IDLH: 1400 ppm [LEL].

Protective Action Criteria (PAC)
TEEL-0: 25 ppm
PAC-1: 25 ppm
PAC-2: 25 ppm
PAC-3: 1400 ppm

DFG MAK: 5 ppm/20 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D.

Australia: TWA 15 ppm (60 mg/m^3); STEL 25 ppm, 1993; Austria: MAK 25 ppm (100 mg/m^3), 1999; Denmark: TWA 10 ppm (40 mg/m^3), 1999; Finland: TWA 25 ppm (100 mg/m^3); STEL 75 ppm (300 mg/m^3), [skin], 1999; France: VME 15 ppm (60 mg/m^3), 1999; Norway: TWA 10 ppm (40 mg/m^3), 1999; the Netherlands: MAC-TGG 60 mg/m^3, 2003; Poland: MAC (TWA) 20 mg/m^3, MAC (STEL) 100 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-W 15 ppm (60 mg/m^3), 1999; Turkey: TWA 25 ppm (100 mg/m^3), 1993; United Kingdom: TWA 15 ppm (61 mg/m^3); STEL 25 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 25 ppm. Several states have set guidelines or standards for mesityl oxide in ambient air[60] ranging from 0.6 to 1.0 mg/m^3 (North Dakota) to 0.8 mg/m^3 (Connecticut) to 1.0 mg/m^3 (Virginia) to 1.429 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1301 for Ketones (II).[18]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.7$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates and burns the eyes and skin. May cause permanent eye damage. Irritates the respiratory tract causing coughing, wheezing and shortness of breath. Exposure causes headache, sleepiness, dizziness, loss of coordination. Exposure far above OEL may result in narcosis, unconsciousness, coma.

Long Term Exposure: The liquid destroys the skin's natural oils. May affect the liver, kidneys, and lungs. May cause anemia.

Points of Attack: Eyes, skin, respiratory system, blood, liver, kidneys, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Lung function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: Responder™ suits. Also, Viton™/chlorobutyl rubber is among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For more information about engineering controls, see NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *500 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1400 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. See incompatibilities above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*. NIOSH Document No. 78-173. Washington, DC

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Mesityl Oxide*. Trenton, NJ

Metaldehyde M:0480

Molecular Formula: $C_8H_{16}O_4$

Synonyms: Acetaldehyde, tetramer; Antimilace; Ariotox; Cekumeta; Halizan; META; Metacetaldehyde; Metaldehyd (German); Metason; Namekil; Slug-tox; 1,3,5,7-Tetroxocane, 2,4,6,8-tetramethyl-

CAS Registry Number: 108-62-3

RTECS® Number: XF9900000

UN/NA & ERG Number: UN1332/133

EC Number: 203-600-2 [*Annex I Index No.:* 605-005-00-7]

Regulatory Authority and Advisory Bodies

TSCA: 40CFR716.120(d)1 as aldehydes.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R11; R22; Safety phrases: S2; S13; S16; S25; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Metaldehyde is a white crystalline powder with a mild menthol odor. Molecular weight = 176.24; Boiling point = 112−116°C; Freezing/Melting point = 47°C; Flash point = 36°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Insoluble in water.

Potential Exposure: It is used as a poison for slugs and snails, and as a fuel in small heaters.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes, skin, and respiratory tract. Exposure can cause nausea, vomiting, diarrhea, abdominal pain, irritability, sleepiness, muscle twitching, convulsions, coma, and death.

Long Term Exposure: May cause kidney and liver damage. May damage the developing fetus.

Points of Attack: Kidneys, liver.

Medical Surveillance: Kidney function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable storage area. Prior to working with metaldehyde you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Metaldehyde requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Fire may restart after it has been extinguished. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Metaldehyde*. Trenton, NJ

Methacrylic acid M:0490

Molecular Formula: $C_4H_6O_2$

Common Formula: $CH_2 = C(CH_3)COOH$

Synonyms: Acide methacrylique (French); Acido metacrilico (Spanish); Acido α-metacrilico (Spanish); Acrylic acid, 2-methyl-; Glacial methacrylic acid; Methacrylic acid, inhibited; α-Methyl-acrylic acid; Methacrylsaeure (German); 2-Methylpropenoic acid; 2-Methyl-2-propenoic acid; 2-Propenoic acid, 2-methyl-; Propionic acid, 2-methylene

CAS Registry Number: 79-41-4

RTECS® Number: OZ2975000

UN/NA & ERG Number: UN2531 (stabilized)/153

EC Number: 201-204-4 [*Annex I Index No.:* 607-088-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R21/22; R35; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methacrylic acid is a colorless liquid. Molecular weight = 86.10; Specific gravity (H_2O:1) = 1.02 (liquid); Boiling point = 162.8°C; Freezing/Melting point = 16.1°C; Vapor pressure = 0.7 mmHg at 20°C; Flash point = 77°C (oc); 68°C (cc); Autoignition temperature = 68°C. Explosive limits: LEL = 1.6; UEL = 8.8. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2. Soluble in water; solubility = 9% at 25°C.

Potential Exposure: Compound Description: Drug, Mutagen; Human Data. Methacrylic acid is used in preparation of methacrylates and carboxylated polymers, in the production of the material or its alkyl esters, as monomers or comonomers for synthetic resins for the production of plastic sheets, moldings, and fibers.

Incompatibilities: Forms explosive mixture with air. A reducing agent; reacts with oxidizers. Incompatible with strong acids, caustics, ammonia, amines, isocyanates, alkylene oxides, epichlorohydrin. Will polymerize readily from heating above 59°F/15°C, or due to the presence of light, oxidizers (peroxides); or in the presence of traces of hydrochloric acid, with fire or explosion hazard. Attacks metals. *Note:* Typically contains 100 ppm of monomethyl ether hydroquinone (150-76-5) as an inhibitor to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.52 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 20 ppm/70 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 20 ppm/70 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 6.7 ppm

PAC-1: **6.7** ppm

PAC-2: **61** ppm

PAC-3: **220** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 5 ppm/18 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group C.

Australia: TWA 20 ppm (70 mg/m^3), 1993; Austria: MAK 20 ppm (70 mg/m^3), 1999; Belgium: TWA 20 ppm (70 mg/m^3), 1993; Denmark: TWA 20 ppm (70 mg/m^3), 1999; Finland: TWA 20 ppm, 1999; France: VME 20 ppm (70 mg/m^3), 1999; the Netherlands: MAC-TGG 70 mg/m^3, 2003; Russia: STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 20 ppm (70 mg/m^3), KTV 30 ppm (100 mg/m^3), 1999; Switzerland: MAK-W 20 ppm (70 mg/m^3), 1999; United Kingdom: TWA 20 ppm (72 mg/m^3); STEL 40 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 20 ppm. Several states have set guidelines or standards for methacrylic acid in ambient air[60] ranging from 0.7 mg/m^3 (North Dakota) to 1.2 mg/m^3 (Virginia) to 1.4 mg/m^3 (Connecticut) to 1.67 mg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2005.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1.0$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methacrylic acid can affect you when breathed in. A corrosive substance. Exposure can irritate the nose and throat. Methacrylic acid is a corrosive chemical and contact can burn the eyes, causing permanent damage. It can irritate and burn the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: High or repeated exposure may damage the kidneys. Methacrylic acid can cause an allergic skin rash.

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: kidney and liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: butyl rubber gloves, suits, boots; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves, Responder™ suits; Trychem 1000™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 20 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Methacrylic acid should be stored at temperatures below 15°C. Sources of ignition, such as smoking and open flames are prohibited where methacrylic acid is handled, used, or stored. Wherever methacrylic acid is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Inhibited methacrylic acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Using caution, neutralize remainder with aqueous sodium carbonate or lime. Then wash away with plenty of water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Methacrylic Acid*. Trenton, NJ

Methacrylonitrile M:0500

Molecular Formula: C_4H_6N

Common Formula: $CH_2 = CH(CH_3)CN$

Synonyms: AI3-52399; 2-Cyano-1-propene; 2-Cyanopropene-1; 2-Cyanopropene; Isopropene cyanide; Isopropenylnitrile; Metacrilonitrilo (Spanish); α-Methacrylonitrile; α-Methylacrylonitrile; Methyl acrylonitrile; 2-Methylacrylonitrile; 2-Methylpropenenitrile; 2-Methyl-2-propenenitrile; NSC 24145; 2-Propenenitrile, 2-methyl; Usafst-40

CAS Registry Number: 126-98-7

RTECS® Number: UD1400000

UN/NA & ERG Number: UN3079 (stabilized)/131

EC Number: 204-817-5 [*Annex I Index No.:* 608-010-00-2]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); no evidence: mouse, rat; NTP: Toxicity studies, RPT#TOX-47, October 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): U152.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.24; Nonwastewater (mg/kg), 84.

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (5); 8240 (5).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R11; R23/24/25; R43; Safety phrases: S1/2; S9; S16; S18; S29; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methylacrylonitrile is a colorless liquid with an odor like bitter almonds. Odor threshold = 7.0 ppm. It is reported that methacrylonitrile cannot be detected by its smell even at concentrations which are already dangerous for humans. Hence, special attention must be given to ventilation and estimations of the amount of poison present and must be carried out frequently. Molecular weight = 67.10; Specific gravity (H_2O:1) = 0.80; Boiling point = 90.6°C; Freezing/Melting point = −35.8°C; Vapor pressure = 71 mmHg at 25°C; Flash point = 1.1°C (cc). Explosive limits: LEL = 2%; UEL = 6.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water; solubility in water = 3%.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Primary Irritant. This material is used as a monomer in the preparation of polymeric coatings and elastomers.

Incompatibilities: Forms explosive mixture with air. Incompatible with aliphatic amines, alkanolamines, strong acids, strong oxidizers, alkali, light. Polymerization may occur due to elevated temperature, visible light, or contact with a concentrated alkali. Violent reaction with oxidizers. *Note:* Typically contains 50 ppm of monoethyl ether hydroquinone (662-62-8) as an inhibitor to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.74 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/3 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 1 ppm/2.7 mg/m^3 TWA [skin].

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **1.0** ppm

PAC-2: **13** ppm

PAC-3: **25** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 1 ppm (3 mg/m^3), [skin], 1993; Belgium: TWA 1 ppm (2.7 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (3 mg/m^3), [skin], 1999; Finland: TWA 1 ppm (3 mg/m^3); STEL 3 ppm (9 mg/m^3), [skin], 1999; France: VME 1 ppm (3 mg/m^3), [skin], 1999; Norway: TWA 1 ppm (3 mg/m^3), 1999; Switzerland: MAK-W 1 ppm (3 mg/m^3), [skin], 1993; the Netherlands: MAC-TGG 3 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm [skin]. Several states have set guidelines or standards for methacrylonitrile in ambient air[60] ranging from 0.7 mg/m^3 (North Dakota) to 1.2 mg/m^3 (Virginia) to 1.4 mg/m^3 (Connecticut) to 1.667 mg/m^3 (Nevada).

Determination in Air: No measurement method listed.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.7.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Converted to cyanide in the body! A lacrimator (causes tearing); an insidious poison which causes delayed skin reactions. Very readily absorbed through skin. Highly toxic by all routes of exposure. Signs and symptoms of acute exposure to methylacrylonitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood, cardiac arrhythmias, and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) is not a consistent finding. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may also occur. Headache, vertigo (dizziness), agitation, and giddiness may be followed by combative behavior, convulsions, paralysis, protruding eyeballs, dilated and unreactive pupils, and coma. Methylacrylonitrile is irritating to the skin and mucous membranes. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Excessive salivation, nausea, and vomiting may also occur.

Long Term Exposure: May cause liver damage. May cause nervous system damage, causing weakness in the legs.

Points of Attack: Eyes, skin, liver, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nervous system. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential for exposures *over 1 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylacrylonitrile is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methylacrylonitrile should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylacrylonitrile. Wherever methylacrylonitrile is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methacrylonitrile, inhibited, requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: This is a flammable liquid. Use dry chemical, CO_2, water spray, or alcohol foam extinguishers. Methacrylonitrile evolves flammable concentrations of vapor. Thus, at room temperatures, flammable concentrations are liable to be present. Also, the chemical will explode due to its tendency to polymerize violently. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Add alcoholic NaOH, then oxidize with sodium hypochlorite. After reaction, flush to sewer with water.[24]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methacrylonitrile*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Methylacrylonitrile*. Trenton, NJ

Methallyl alcohol M:0510

Molecular Formula: C_4H_8O

Common Formula: $CH_2 = C(CH_3)CH_2OH$

Synonyms: Isopropenyl carbinol; 2-Methyl-2-propen-1-ol; 2-Propen-1-ol, 2-methyl-

CAS Registry Number: 513-42-8

RTECS® Number: UD5250000

UN/NA & ERG Number: UN2614/129

EC Number: 208-161-0

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methallyl alcohol is a colorless liquid with a pungent odor. Molecular weight = 72.12; Boiling point = 114°C; Flash point = 33°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an intermediate in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong acids, caustics, aliphatic amines, isocyanates, DMSO, oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: Use NIOSH Analytical Method (IV) #1402, for Alcohols III.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Methallyl alcohol can affect you when breathed in and by passing through your skin. Exposure to methallyl alcohol can cause irritation to eyes, nose, and throat. Contact can cause skin irritation.

Long Term Exposure: Similar allyl compounds cause liver damage. However, it is not known for certain that this chemical causes the same effects.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to methallyl alcohol, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methallyl alcohol is a flammable liquid. Water may be ineffective. Alcohol foam is the recommended extinguishing agent. Acrid fumes and smoke are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Methallyl Alcohol*. Trenton, NJ

Methamidophos M:0520

Molecular Formula: $C_2H_8NO_2PS$

Common Formula: $CH_3OP(O)(NH_2)SCH_3$

Synonyms: Acephate-met; Bay 71625; Bayer 71628; Chevron 9006; Chevron ortho 9006; *O*,*S*-Dimethyl ester of amide of amidothioate; *O*,*S*-Dimethyl phosphoramidothioate; ENT 27,396; GS-13005; Hamidop; Metamidofos (Spanish); Metamidofos estrella; Monitor; MTD; MTD 600; NSC 190987; Ortho 9006; Pillaron; SRA 5172; Supracide; Tahmabon; Tamaron; Thiophosphorsaeure-*O*,*S*-dimethylesteramid (German)

CAS Registry Number: 10265-92-6

RTECS® Number: TB4970000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 233-606-0 [*Annex I Index No.:* 015-095-00-4]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [methamidophos (soluble liquid formulations of the substance that exceed 600 g active ingredient/l)].

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases R24; R26/28; R50; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methamidophos is an off-white crystalline solid. Molecular weight = 141.12; Freezing/Melting point = 44.5°C; Vapor pressure = 8×10^{-4} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide on vegetables and cotton.

Incompatibilities: Incompatible with strong acids or alkali. Attacks mild steel and copper-containing alloys (technical grade).

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 60 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 165.16992000 ppb (LOW).

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Acute exposure to methamidophos may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may be noted, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. This material is highly toxic; LD_{50} = (oral-rat) 7.5 mg/kg. Human Tox = 7.00000 ppb (HIGH).

Long Term Exposure: The substance may have effects on the nervous system resulting in delayed neuropathy. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 13 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization of an antidote or performance of other invasive procedures. The effects may be delayed. Medical observation recommended.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: This material falls into the class of "Organophosphorus Pesticides, solid, toxic, n.o.s." This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases, including nitrogen oxides, sulfur oxides, and phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methamidophos*. Washington, DC: Chemical Emergency Preparedness Program

Methane M:0530

Molecular Formula: CH_4

Synonyms: Biogas; Fire damp; Marsh gas; Metano (Spanish); Methyl hydride; Natural gas

CAS Registry Number: 74-82-8

RTECS® Number: PA1490000

UN/NA & ERG Number: UN1971 (compressed gas)/115; UN1972 (liquefied gas)/115

EC Number: 200-812-7 [*Annex I Index No.:* 601-001-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F + ; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Methane is an odorless, colorless gas. Molecular weight = 16.05; Boiling point = −162°C; Freezing/Melting point = −183°C; Autoignition temperature = 537°C. Explosive limits: LEL = 5.0%; UEL = 15.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water. Natural gas consists primarily of methane (85%) with lesser amounts of ethane (9%), propane (3%), nitrogen (2%), and butane (1%).

Potential Exposure: Methane is used as a fuel and in the manufacture of organic chemicals, acetylene, hydrogen cyanide, and hydrogen. It may also be a cold liquid. Natural gas is used principally as a heating fuel. It is transported as a liquid under pressure. It is also used in the manufacture of various chemicals including acetaldehyde, acetylene, ammonia, carbon black, ethyl alcohol, formaldehyde, hydrocarbon fuels, hydrogenated oils, methyl alcohol, nitric acid, synthesis gas, and vinyl chloride. Helium can be extracted from certain types of natural gas.

Incompatibilities: Forms explosive mixture with air. Reacts violently with bromine pentafluoride, chlorine dioxide, nitrogen trifluoride, liquid oxygen and oxygen difluoride. In general, avoid contact with oxidizers.

Permissible Exposure Limits in Air Any loss of containment of Methane in a confined area can lower the oxygen content and cause suffocation. Oxygen content should be tested to ensure that it is at least 19% by volume.

OSHA PEL: Simple asphyxiant—inert gas and vapor.

ACGIH TLV®[1]: ACGIH TLV®[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1–C_4).

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 5000 ppm

PAC-3: 200,000 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 10,000 ppm (6700 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: High levels can cause suffocation. Symptoms are due to a decrease in the concentration of oxygen available for breathing and include dizziness, difficult breathing, bluish color of the skin, and loss of consciousness. Any contact with liquid can cause freezing burns.

Long Term Exposure: No effects reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur, employees should be equipped with special clothing designed to prevent freezing of body tissues.

Respirator Selection: Exposure to methane is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments. Chemical cartridge respirators should not be used where methane exposure occurs. For high exposures use air supplied respirators.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methane must be stored to avoid contact with oxidizers (such as oxygen, chlorine, bromine, perchlorates, peroxides, nitrates, and permanganates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where methane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of methane. Wherever methane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. The flame may be invisible. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Incomplete combustion of natural gas may produce carbon monoxide. Use water spray to disperse vapors. *Small fires:* use dry chemical or carbon dioxide extinguishers. *Large fires:* use water spray, fog, or foam. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (flaring).

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Methane.* Albany, Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Methane.* Trenton, NJ

Methidathion M:0540

Molecular Formula: $C_6H_{11}N_2O_4PS_3$

Synonyms: Ciba-geigy GS 13005; *S*-(2,3-Dihydro-5-methoxy-2-oxo-1,4,4-thiadiazol-3-methyl); (*O*,*O*-Dimethyl)-S-[2-

methoxy-1,4,4-thiadiazole-5-(4H)-onyl-(4)-methyl]-dithiophosphat (German); *O*,*O*-Dimethyl *S*-[2-methoxy-1,3,4-thiadiazole-5(4H)-on-4-ylmethyl] phosphorodithioate; *O*, *O*-Dimethyl phosphorodithioate *S*-ester with 4-(mercaptomethyl)-2-methoxy-δ-1,3,4-thiadiazolin-5-one; DMTP (Japan); ENT 27,193; Fisons NC 2964; Geigy 13005; GS-13005; *S*-([5-Methoxy-2-oxo-1,3,4-thiadiazol-3(2H)-yl]methyl) *O*,*O*-dimethyl phosphordithioate; Metidation (Spanish); Somonil; Surpracide; Ultracide

CAS Registry Number: 950-37-8

RTECS® Number: TE2100000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-449-4 [*Annex I Index No.:* 015-069-00-2]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Philippines) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R21; R28; R50/53; Safety phrases: S1/2; S22; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methidathion is a colorless crystalline solid. Molecular weight = 302.34; Freezing/Melting point = 39−40°C; Vapor pressure = 3.4×10^{-6} mmHg at 20°C. Very slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this nonsystemic insecticide.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 400 mg/m^3

Determination in Water: Fish Tox = 0.15019000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This material is poisonous to humans. Its toxic effects are by action on the nervous system. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. Human volunteers ingesting 0.11 mg/kg/day for 6 weeks had no clinical effects. LD_{50} = (oral-rat) 20 mg/kg (highly toxic). Symptoms are similar to parathion poisoning and may include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, dizziness, giddiness, weakness, muscle twitching, difficult breathing, sensation of tightness of chest, blurring or dimness of vision, and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. Human Tox = 1.05000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing

material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, sulfur oxides, and phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Treat with strong alkali, mix with soil and bury in the case of small quantities.[22] For large quantities, use incineration with effluent gas scrubbing.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methidathion*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Methidathion*. Trenton, NJ

Methiocarb M:0550

Molecular Formula: $C_{11}H_{15}NO_2S$

Common Formula: $C_6H_2(SCH_3)(CH_3)_2OCONHCH_3$

Synonyms: AI3-25726; B 37344; Bay 37344; Bay 5024; Bay 9026; Bayer 37344; Carbamic acid, methyl-, 3,5-dimethyl-4-(methylthio)phenyl ester; Carbamic acid, *N*-methyl-, 4-(methylthio)-3,5-xylyl ester; Carbamic acid, methyl-, 4-(methylthio)-3,5-xylyl ester; DCR 736; 3,5-Dimethyl-4-methylmercaptophenyl *N*-methylcarbamate; 3,5-Dimethyl-4-(methylthio)phenol methylcarbamate; 3,5-Dimethyl-4-(methylthio)phenyl methylcarbamate; 3,5-Dimethyl-4-methylthiophenyl *N*-methylcarbamate; Draza; Draza G micropellets; ENT 25,726; H 321; Mercaptodimethur; Mesurol; Methiocarbe; Methyl carbamic acid 4-(methylthio)-3,5-xylyl ester; 4-Methylmercapto-3,5-dimethylphenyl *N*-methylcarbamate; 4-Methylmercapto-3,5-xylyl methylcarbamate; 4-Methylthio-3,5-dimethylphenyl methylcarbamate; 4-(Methylthio)-3,5-xylyl *N*-methylcarbamate; 4-(Methylthio)-3,5-xylyl methylcarbamate; Metiocarb (Spanish); Metmercapturon; OMS-93; PBI Slug Gard; Phenol, 3,5-dimethyl-4-(methylthio)-, methylcarbamate; SD 9228

CAS Registry Number: 2032-65-7

RTECS® Number: FC5775000

UN/NA & ERG Number: UN2757/151

EC Number: 217-991-2 [*Annex I Index No.:* 006-023-00-2]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P199.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as mercaptodimethur.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R50/53; Safety phrases: S1/2; S22; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methiocarb is a colorless crystalline powder. Molecular weight = 225.33; Freezing/Melting point = 117−118°C; Vapor pressure = 0.0001 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this nonsystemic acaricide and insecticide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 15 mg/m^3

Determination in Water: Fish Tox = 0.04597000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the skin and eyes. Inhalation will irritate the respiratory tract. As a carbamate insecticide, this compound is a reversible cholinesterase inhibitor and acts on the nervous system. It is classified as very toxic, and the probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb adult. Symptoms include salivation, slowed heartbeat, spontaneous urination and defecation, labored breathing, headache, blurred vision, tremor, slight paralysis, and muscle twitching. Exposure to carbamate poisoning can also result in nausea, vomiting, diarrhea, abdominal pain, convulsions, coma, and death. Human Tox = 35.00000 ppb (INTERMEDIATE).

Long Term Exposure: The substance may have effects on the nervous system, liver.

Points of Attack: Central nervous system, liver, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: This material may be classified as a Carbamate pesticide, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Remove material with contaminated soil and place in impervious containers. May be incinerated in a pesticide incinerator at the specified temperature/dwell-time combination. Any liquids, sludges, or solid residues generated should be disposed of in accordance with all applicable federal, state, and local pollution control requirements. If appropriate incineration facilities are not available, material may be buried in a chemical waste landfill. May be amenable to biological treatment at a municipal sewage treatment plant (Sax/DPIMR).

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methiocarb.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Mercaptodimethur.* Trenton, NJ

Methomyl M:0560

Molecular Formula: $C_5H_{10}N_2O_2S$

Synonyms: Acetimidic acid, thio-*N*-(methylcarbamoyl) oxy-, methyl ester; Acetimidothioic acid, methyl-*N*-(methylcarbamoyl) ester; Dupont insecticide 1179; ENT 27,341; Ethanimidothic acid, *N*-[(methylamino)carbonyl]; Fram fly kill; Improved blue Malrin sugar bait; Improved golden Malrin bait; Insecticide 1,179; Lannate; Lanox 216; Lanox 90; Mesomile; Methomex; Methyl *N*-([methylamino (carbonyl)oxy]ethanimido)thioate; *S*-Methyl *N*-(methylcarbamoyloxy)thioacetimidate; Methyl *N*-[methyl (carbamoyl) oxy]thioacetimidate; 2-Methylthio-propionaldehyd-*o*-(methylcarbamoyl)oxim (German); Metomilo (Spanish); Nu-bait II; Nudrin; Rentokil fram fly bait; Rentokill; Ridect; SD 14999; Sorex golden fly bait; 3-Thiabutan-2-one, *O*-(methylcarbamoyl) oxime; WL 18236

CAS Registry Number: 16752-77-5

RTECS® Number: AK2975000

UN/NA & ERG Number: UN2757/151

EC Number: 240-815-0 [*Annex I Index No.:* 006-045-00-2]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P066.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 0.14.

Safe Drinking Water Act: Priority List (55 FR 1470).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methomyl is a white crystalline solid with a slight sulfurous odor. A noncombustible solid that may be dissolved in flammable liquids that may alter physical properties listed here. Molecular weight = 162.23; Specific gravity (H_2O:1) = 1.29; Freezing/Melting point = 78−79°C; Vapor pressure: 0.00005 mmHg; also 0.0001 (EPA). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Moderately soluble in water; solubility 6% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Methomyl is a broad-spectrum insecticide used as insecticide in many vegetables, field crops, certain fruit crops, and ornamentals.

Incompatibilities: Keep away from strong bases, strong oxidizers. Heat causes decomposition forming toxic and irritating fumes including nitrogen oxides, sulfur oxides, hydrogen cyanide, methylisocyanate.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 2.5 mg/m^3 TWA.

ACGIH TLV®[1]: 2.5 mg/m^3 TWA not classifiable as a human carcinogen; TLV-BEI$_A$ issued for Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 200 mg/m^3

Australia: TWA 2.5 mg/m^3, 1993; Belgium: TWA 2.5 mg/m^3, 1993; Denmark: TWA 2.5 mg/m^3, [skin], 1999; France: VME 2.5 mg/m^3, [skin], 1999; Norway: TWA 2.5 mg/m^3, 1999; Switzerland: MAK-W 2.5 mg/m^3, [skin], 1999; United Kingdom: TWA 2.5 mg/m^3, 2000; the Netherlands: MAC-TGG 2.5 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for methomyl in ambient air[60] ranging from 25 μg/m^3 (North Dakota) to 40 μg/m^3 (Virginia) to 50 μg/m^3 (Connecticut) to 59.5 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: The US EPA has calculated a no-observed-adverse-effects-level (NOAEL) of 2.5 mg/kg/day from which a lifetime health advisory of 175 μg/L has been calculated. The state of Maine has set a guideline of 50 μg/L for methomyl in drinking water.[61]

Determination in Water: By high-performance liquid chromatography as described in EPA Health Advisory cited below. Fish Tox = 80.25646000 ppb (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 0.63.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Cholinesterase inhibitor. Irritates the eyes. May affect the nervous system resulting in respiratory failure and convulsions. Exposure may result in death. Methomyl has high oral toxicity, moderate inhalation toxicity, and low skin toxicity. The probable oral lethal dose for humans is between 7 drops and 1 teaspoon for a 150-lb adult. Death is due to respiratory arrest. Acute exposure to methomyl usually leads to a cholinergic crisis. Signs and symptoms may include increased salivation, lacrimation (tearing), spontaneous defecation, and spontaneous urination. Pinpoint pupils, blurred vision, tremor, muscle twitching, and loss of muscle coordination may occur. Mental confusion, convulsions, and coma may also be noted. Gastrointestinal effects include nausea, vomiting, diarrhea, and abdominal pain. Bradycardia (slow heart rate) occurs frequently. Dyspnea (shortness of breath), pulmonary edema, and respiratory arrest may also occur. Human Tox = 200.00000 ppb (VERY LOW).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Methomyl may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause anemia.

Points of Attack: Eyes, respiratory system, central nervous system, cardiovascular system, liver, kidneys, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: Tychem 1000™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 2.5 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a pesticide cartridge. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases, strong oxidizers (such as chlorine, bromine and fluorine). Do not store in area where temperature is less than 32°F/0°C.

Shipping: This material may be classified under Carbamate pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep unnecessary people away; isolate hazard areas and deny entry. Stay upwind and keep out of low areas. Do not touch spilled material, or handle broken packages without protective equipment. Do not breathe dust, vapors, or the fumes from burning material. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methomyl does not burn. Use any agent suitable for surrounding fire. Poisonous gases, including nitrogen oxides, sulfur oxides, hydrogen cyanide, methylisocyanate, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Alkaline hydrolysis leads to complete degradation to nontoxic products.[22] May be dissolved in water and sprayed into a furnace with effluent gas scrubbing also. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency. (April 30, 1980). *Methomyl, Health and Environmental Effects Profile No. 125*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report* 2, No. 5, 79−81

US Environmental Protection Agency. (August 1987). *Health Advisory: Methomyl*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methomyl*. DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Methomyl*. Trenton, NJ

Methotrexate M:0570

Molecular Formula: $C_{20}H_{22}N_8O_5$
Synonyms: Amethopterin; 4-Amino-4-deoxy-N^{10}-methylpteroyl glutamate; 4-Amino-4-deoxy-N^{10}-methylpteroylglutamic; 4-Amino-10-methylfolic acid; 4-Amino-N^{10}-methylpteroylglutamic acid; Antifolan; *N*-Bismethylpteroylglutamic acid; CL-14377; L-(+)-*N*-[*p*-([(2,4-Diamino-6-pteridinyl)methyl]methylamino)-benzoyl] glutamic acid; EMT 25,299; Emtexate; HDMTX; Methopterin; Methotextrate; Methylaminopterin; MTX; NCI-C04671; NSC-740; R 9985
CAS Registry Number: 59-05-2
RTECS® Number: MA1225000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 200-413-8
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (ipr); no evidence: mouse, rat.
California Proposition 65 Developmental/Reproductive toxin 1/1/89.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Methotrexate is an orange-brown crystalline powder. Molecular weight = 454.50; Freezing/Melting point = 185−204°C (decomposes). Insoluble in water.
Potential Exposure: Methotrexate is an anti-cancer drug in tablet or injectable liquid form. It is also an insect chemosterilant.
Incompatibilities: Light and oxidizers.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Inhalation, skin and/or eyes.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes.
Long Term Exposure: Methotrexate causes mutations (genetic changes). Such chemicals may have a cancer or reproductive risk. Methotrexate is a probable teratogen in humans. There is limited evidence that methotrexate may affect sperm production in males. When taken as a medical drug, methotrexate can cause nausea, vomiting, loss of appetite, weight loss, bloody diarrhea, sores inside the mouth, hair loss, and skin rash. It can also damage the liver and kidneys. Methotrexate can damage bone marrow causing low blood cell count. It is not known if the effects can occur from work-place exposures.
Points of Attack: Blood, liver, kidneys.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: complete blood count (CBC). Liver and kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles when working with powders or dust, unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to methotrexate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. A regulated, marked area should be established where methotrexate is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from light and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.
Shipping: This material may be classed as Toxic solids, organic, n.o.s. which requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report* 1, No. 4, 82−83

New Jersey Department of Health and Senior Services. (April 1986). *Hazardous Substances Fact Sheet: Methotrexate*. Trenton, NJ

Methoxychlor M:0580

Molecular Formula: $C_{16}H_{15}Cl_3O_2$

Common Formula: $H_3COC_6H_4CH(CCl_3)C_6H_4OCH_3$

Synonyms: Benzene, 1,1′-(2,2,2-trichloroethylidene)bis(4-methoxy-); 2,2-Bis(*p*-anisyl)-1,1,1-trichloroethane; 1,1-Bis (*p*-methoxyphenyl)-2,2,2-trichloroethane; 2,2-Bis(*p*-methoxyphenyl)-1,1,1-trichloroethane; Chemform; Dianisyltrichlorethane; 2,2-Di-*p*-anisyl-1,1,1-trichloroethane; Dimethoxy-DDT; *p*,*p*′-Dimethoxydiphenyltrichloroethane; Dimethoxy DT; Di(*p*-methoxyphenyl)-trichloro methyl methane; *p*,*p*′-DMDT; DMDT; ENT 1,716; Marlate; Marlate 50; Methoxide; Methoxo; *p*,*p*′-Methoxychlor; Methoxy DDT; 2,2-(*p*-Methoxyphenyl)-1,1,1-trichloroethane; Metox; Metoxicloro (Spanish); Moxie; NCI-C00497; 1,1,1-Trichloro-2,2-bis(*p*-anisyl)ethane; 1,1,1-Trichloro-2,2-bis(*p*-methoxyphenol)ethanol; 1,1,1-Trichloro-2,2-bis(4-methoxy-phenyl)aethane (German); 1,1,1-Trichloro-2,2-bis(*p*-methoxyphenyl)ethane; 1,1,1-Trichloro-2,2-di(*p*-methoxyphenyl)ethane; 1,1,1-Trichloro-2,2-di(4-methoxyphenyl)ethane; 1,1-(2,2,2-Trichloroethylidene)bis(4-methoxybenzene)

CAS Registry Number: 72-43-5

RTECS® Number: KJ3675000

UN/NA & ERG Number: UN2761/151

EC Number: 200-779-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; IARC: Human No Adequate Data, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive/dose response: Cell transform.—BALB/c-3T3; Negative: Carcinogenicity—mouse/rat; SHE—clonal assay; Negative: Cell transform—RLV F344 rat embryo; Negative: Histidine reversion—Ames test; Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Banned or Severely Restricted (in agriculture) (several countries) (UN).[13]

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, Permissible Exposure Limits in Air section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U247.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 10.0 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.25; Nonwastewater (mg/kg), 0.18.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL µg/L): 8080 (2); 8270 (10).

Safe Drinking Water Act: MCL, 0.04 mg/L; MCLG, 0.04 mg/L; Regulated chemical (47 FR 9352); Priority List (55 FR 1470).

Reportable Quantity (RQ): 1 lb (0.45 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methoxychlor is a colorless to tan solid with a slight fruity odor. Molecular weight = 345.66; Freezing/Melting point = 89°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Methoxychlor was introduced as an insecticide in 1945. It is a close relative of DDT and has been used as an insecticide of very low mammalian toxicity for home and garden, on domestic animals for fly control, for elm bark-beetle vectors of Dutch elm disease, and for blackfly larvae in streams. Methoxychlor is registered for about 87 crops, alfalfa, nearly all fruits and vegetables, corn, wheat, rice, and other grains, beef and dairy cattle, and swine, goats and sheep, and for agricultural premises and outdoor fogging. Thus, those engaged in manufacture, formulation, and application of the material as well as people in application areas may be exposed.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 (*total dust*) TWA.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 mg/m^3 TWA not classifiable as a human carcinogen.

NIOSH IDLH: potential occupational carcinogen 5000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 15 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(8); Pregnancy Risk Group D.

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 15 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 15 mg/m^3, 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Switzerland: MAK-W 10 mg/m^3, 1999; Thailand: TWA 15 mg/m^3, 1993; United Kingdom: TWA 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for methoxychlor in ambient air[60] ranging from 23.8 μg/m^3 (Kansas) to 35.07 μg/m^3 (Pennsylvania) to 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II (4), Method #S-371; OSHA Analytical Method PV-2038.

Permissible Concentration in Water: The WHO[35] has recommended a limit of 30 μg/L of methoxychlor for drinking water. A US recommendation for bottled water for drinking purposes was 100 μg/L. Mexico[35] has set limits of 4.0 μg/L for methoxychlor in coastal waters, 40.0 μg/L in estuaries, and 35 μg/L in recovery waters used for drinking water supply. The EPA[47] has determined a lifetime health advisory of 340 μg/L for methoxychlor. More recently, EPA has proposed a guideline of 400 μg/L for drinking water.[62] Several states have set guidelines or standards for methoxychlor in drinking water.[61] These range from a standard of 100 μg/L in Arizona and a guideline of 100 μg/L in Maine to a guideline of 340 μg/L for Minnesota.

Determination in Water: By liquid/liquid extraction followed by identification by gas chromatography.[47] Fish Tox: 0.11310000 ppb (EXTRA HIGH). Octanol−water coefficient: Log K_{ow} = >4.4.

Routes of Entry: Inhalation, ingestion, skin and/or eyes. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *Note:* For application, methoxychlor is dissolved in organic or petroleum distillate solvents. These solvents may have poisonous effects in addition to those below. *Inhalation:* The results of accidental exposure and animal studies suggest that high levels may cause irritation to nose and throat and may cause headache, nausea, vomiting, staggering walk, drowsiness, convulsions, coma, and death. *Skin:* Absorbed in significant amounts especially when dissolved in organic solvents. Local irritation and numbing of affected area may be experienced. *Eyes:* May cause irritation. *Ingestion:* Symptoms are similar to those listed under inhalation. Ingestion of 5 oz a day for 6 weeks resulted in no observable symptoms. The least amount causing death has been reported as 1 lb. Exposure can cause anxiety, fatigue, nausea, vomiting, dizziness, confusion, weakness, “pins and needles” in extremities, muscle twitching, and tremor. Higher levels can cause convulsions, unconsciousness, and even death. Human Tox = 40.00000 ppb (INTERMEDIATE).

Long Term Exposure: Experiments with animals suggest that exposure to high levels for prolonged periods may cause excess salivation, tremors, seizures, and convulsions. These will generally go away when exposure stops. Methoxychlor has been shown to affect reproduction and to cause cancer at high exposure levels in some laboratory animals. Whether it does so in humans is not known. A potential occupational carcinogen. (NIOSH). May damage the liver and kidneys. Very high exposures may cause anemia.

Points of Attack: Central nervous system, liver, kidneys. Cancer site in animals: liver and ovaries.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Protect containers from damage. Store in cool, dry area away from fire hazard and out of direct sunlight.

Shipping: This material may be classed under Organochlorine Pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a combustible solid but difficult to ignite. Use agent suitable for surrounding fire. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases, including hydrogen chloride, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report* 7, No. 5, 79−87

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Methoxychlor.* Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methoxychlor.* Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Methoxyethyl acetate M:0590

Molecular Formula: $C_5H_{10}O_3$

Common Formula: $CH_3COOCH_2CH_2OCH_3$

Synonyms: EGMEA; Ethylene glycol monomethyl ether acetate; Glycol monomethyl ether acetate; 2-Methoxyacetate ethanol; 2-Methoxyethyl acetate; 2-Methoxyethyl acrylate; Methyl Cellosolve® acetate; Methyl glycol acetate

CAS Registry Number: 110-49-6

RTECS® Number: KL5950000

UN/NA & ERG Number: UN1189/129

EC Number: 203-772-9 [*Annex I Index No.:* 607-036-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Developmental/Reproductive toxin 1/1/93.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R60; R61; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methoxyethyl acetate is a colorless liquid with a mild, ether-like odor. Odor threshold = 0.33 ppm. Molecular weight = 118.15; Specific gravity (H_2O:1) = 1.01; Boiling point = 145°C; Freezing/Melting point = −65°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 48.9°C (cc); Autoignition temperature = 380°C. Explosive limits: LEL = 1.7%; UEL = 8.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Hormone, Primary Irritant. Methoxyethyl acetate is used as a solvent for resins, oils, greases, and inks. It is also an ingredient of lacquers, paints, and adhesives.

Incompatibilities: Forms explosive mixture with air. Strong oxidants, strong bases, strong acids, and nitrates. May be able to form explosive peroxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.83 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/120 mg/m^3 TWA [skin].

NIOSH REL: 0.1 ppm/0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 ppm/0.5 mg/m^3 TWA [skin]; BEI issued.

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 0.3 ppm

PAC-2: 20 ppm

PAC-3: 200 ppm

DFG MAK: 1 ppm/4.9 mg/m^3 (sum of the concentrations of EGMEA and its acetate in air); Peak Limitation Category II (8) [skin]; Pregnancy Risk Group B.

Australia: TWA 5 ppm (24 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (25 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (24 mg/m^3), [skin], 1993; Denmark: TWA 5 ppm (24 mg/m^3), [skin], 1999; Finland: TWA 25 ppm (120 mg/m^3); STEL 40 ppm (180 mg/m^3), [skin], 1999; France: VME 5 ppm (24 mg/m^3), [skin], 1999; Hungary: TWA 25 mg/m^3; STEL 50 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1.5 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (22 mg/m^3), 1999; the Philippines: TWA 25 ppm (120 mg/m^3), [skin], 1993; Poland: MAC (TWA) 25 mg/m^3, MAC (STEL) 100 mg/m^3, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (25 mg/m^3), KTV 10 ppm (50 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (25 mg/m^3), KZG-W 10 ppm (50 mg/m^3), [skin], 1999; Turkey: TWA 25 ppm (120 mg/m^3), [skin], 1993; United Kingdom: TWA 5 ppm (25 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm [skin]. Several states have set guidelines or standards for methoxyethyl acetate in ambient air[60] ranging from 0.24 mg/m^3 (North Dakota) to 0.4 mg/m^3 (Virginia) to 0.48 mg/m^3 (Connecticut) to 0.571 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1451, Methyl cellosolve acetate; OSHA Analytical methods 53, 79.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.1.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: 2-Methoxyethyl acetate can affect you when breathed in and by passing through your skin. Exposure to the vapor can irritate the eyes. High levels of exposure can cause headache, vomiting, dizziness, fatigue, confusion, lightheadedness, and unconsciousness. Higher exposure can cause irritation of the nose, throat, and lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the blood and central nervous system.

Long Term Exposure: Repeated high exposures can damage the brain and nervous system. May affect the blood, liver and kidneys. May cause low blood count (anemia). *In animals:* narcosis; reproductive, teratogenic effects.

Points of Attack: Eyes, respiratory system, kidneys, brain, central nervous system, peripheral nervous system, reproductive system, hematopoietic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, liver function tests, kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: complete blood count (CBC). Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: butyl rubber gloves, suits, boots; Tychem 1000™ suits. **4 h**: Saranex™ coated suits; 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1 ppm:* Sa (APF = 10) (any supplied-air respirator). *2.5* ppm Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); saF (APF = 50) (any supplied-air respirator with a full face-piece). *100 ppm:* Sa: Pd, Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *200 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Methoxyethyl acetate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong caustics, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where 2-methoxyethyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever 2-methoxyethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Beware of possible presence of peroxides[22] in which case open burning may be used.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: 2-Methoxyethyl Acetate*. Trenton, NJ

Methoxyethylmercuric acetate M:0600

Molecular Formula: $C_5H_{10}HgO_3$

Common Formula: $CH_3OCH_2CH_2HgOOCCH_3$

Synonyms: Acetato(2-methoxyethyl)mercury; Acetoxy(2-methoxyethyl)mercury; Cekusil Universal A®; Landisan®; MEMA; Mercuran; Mercury, acetoxy(2-methoxyethyl)-; Methoxyethylmercury acetate; 2-Methoxyethylmerkuriacetat (German); Panogen®; Panogen® M; Panogen® Metox; Radosan®

CAS Registry Number: 151-38-2

RTECS® Number: OV6300000
UN/NA & ERG Number: UN2777/151
EC Number: 205-790-2
Regulatory Authority and Advisory Bodies
Banned or Severely Restricted (in agriculture) (In UK).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 500 lb (227 kg).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as mercury compounds.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Methoxyethylmercuric acetate is a crystalline solid. Molecular weight = 318.74; Freezing/Melting point = 41°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used as a pesticide in seed treatment for cotton and small grains. It is no longer approved for this use. It exhibits high fungicidal activity against leaf stripe of barley, stinking smut of wheat, snow mold of rye, against seedling diseases in beets and legumes, and for dressing "seed" potatoes, bulbs, and tubers. Not registered as a pesticide in the United States

Incompatibilities: Corrosive to iron and other metals.

Permissible Exposure Limits in Air
OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.
NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 mg/m^3 STEL [skin].
ACGIH TLV®[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg/m^3 STEL [skin].
Protective Action Criteria (PAC)
TEEL-0: 0.0159 mg/m^3
PAC-1: 0.0477 mg/m^3
PAC-2: 0.0477 mg/m^3
PAC-3: 0.0477 mg/m^3
DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3.
NIOSH IDLH: 2 mg[Hg]/m^3.
In addition, North Dakota has set guidelines of 1−3 μg/m^3 (0.0001−0.0003 mg/m^3) for alkyl mercury compounds in ambient air.[60]

Determination in Air: No method available.

Permissible Concentration in Water: Presumably this material is covered in the Priority Toxic Pollutant Category. It is not specifically cited as an organomercurial as is methyl mercury.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45- μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Highly toxic. Target organs are brain and central nervous system. Inhalation can cause lung damage; ingestion can cause kidney damage. Women of childbearing age should avoid exposure. Patients complain of headache; paresthesia of tongue, lips, fingers, and toes; a metallic taste in mouth; gastrointestinal disturbances; gas; and diarrhea. Nervous system symptoms may appear first after a relatively slight exposure or have a latency period: slight loss of coordination, loss of coordination of speech, writing, and gait. Uncoordination may progress to loss of ability to control voluntary movements. Irritability and bad temper may progress to mania. Stupor or coma may develop. Blisters or dermatitis may be present on skin. Symptoms persist for years even in cases of mild exposure.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, and kidney failure. Organic mercury substances have been identified as teratogen in humans. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes, and decreased peripheral vision.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with eye examination. Consider lung function tests for persons with frequent exposure. Examination of the nervous system. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes, and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and special procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m^3:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Mercury-based pesticides, solid, toxic, requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for cleanup of mercury are available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Small fires*: dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Runoff from fire control or dilution water may cause pollution. Poisonous gases, including Hg, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methoxyethylmercuric Acetate*. Washington, DC: Chemical Emergency Preparedness Program

4-Methoxyphenol M:0610

Molecular Formula: $C_7H_8O_2$

Common Formula: $HOC_6H_4OCH_3$

Synonyms: *p*-Guaicol; Hydroquinone monomethyl ether; Hydroquinone monomethyl ether and *p*-hydroxyanisole; 1-Hydroxy-4-methoxybenzene; Mequinol; *p*-Methoxyphenol; MME; Mono methyl ether hydroquinone; Phenol, *p*-methoxy

CAS Registry Number: 150-76-5

RTECS® Number: SL7700000

EC Number: 205-769-8 [*Annex I Index No.:* 604-044-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36; R43; Safety phrases: S2; S24/25; S26; S37/39; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 4-Methoxyphenol is a colorless to white, waxy solid with an odor of caramel and phenol. A combustible solid. Molecular weight = 124.15; Boiling point = 243°C; Freezing/Melting point = 52−53°C; Flash point = 132°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. This compound is used in the manufacture of antioxidants, pharmaceuticals, plasticizers, and dyestuffs. It is used as a stabilizer and UV inhibitor in various polymers.

Incompatibilities: Strong oxidizers, strong bases, acid chlorides, acid anhydrides. Under certain conditions, a dust cloud can probably explode if ignited by a spark or flame.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA.

Protective Action Criteria (PAC).

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3.

Determination in Air: No NIOSH Analytical Method available. See OSHA Analytical Method 32.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: 4-Methoxyphenol can affect you when breathed in and by passing through your skin. Contact can cause severe eye burns and permanent damage. Irritates the skin, nose, throat, upper respiratory system. A central nervous system depressant.

Long Term Exposure: Prolonged contact can cause severe skin burns and scars. Repeated exposure may cause discoloration of the eye and skin. Damage to the vision may occur.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the eyes and vision, including a "slit-lamp" exam. Examination of the central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for exposures over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode; or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Protect containers from physical damage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where 4-methoxyphenol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: A combustible solid, but there are no label requirements or maximum shipping weights specified.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 4-Methoxyphenol may burn but does not readily ignite. Use dry chemical or carbon dioxide extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: 4-Methoxyphenol*. Trenton, NJ

Methyl acetate M:0620

Molecular Formula: $C_3H_6O_2$

Common Formula: CH_3COOCH_3

Synonyms: Acetate de methyle (French); Acetic acid, methyl ester; Devoton; Methylacetat (German); Methyl acetic ester; Methyle (acetate de) (French); Methyl ethanoate; Tereton

CAS Registry Number: 79-20-9

RTECS® Number: AI9100000

UN/NA & ERG Number: UN1231/129

EC Number: 201-185-2 [*Annex I Index No.:* 607-021-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl acetate is a colorless liquid with a fruity odor. Odor threshold = 4.6 ppm. Molecular weight = 74.09; Specific gravity (H_2O:1) = 0.93; Boiling point = 57.2°C; Freezing/Melting point = −98°C; Vapor pressure = 173 mmHg at 20°C; Flash point = −10°C; Autoignition temperature = 455°C. The explosive limits are LEL = 3.1%; UEL = 16%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water; solubility = 25%.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Methyl acetate is used as a solvent in lacquers and paint removers and as an intermediate in pharmaceutical manufacture.

Incompatibilities: Forms explosive mixture with air. A strong reducing agent. Incompatible water, acids, nitrates, strong oxidizers, alkalis. Attacks some plastics. Attacks many metals in presence of water. Reacts slowly with water, forming acetic acid and methanol. Decomposes in heat; on contact with air, bases, strong oxidizers, UV-light, causing fire and explosion hazard.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.03 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/610 mg/m^3 TWA.

NIOSH REL: 200 ppm/610 mg/m^3 TWA; 250 ppm/760 mg/m^3 STEL.

ACGIH TLV®[1]: 200 ppm/606 mg/m^3 TWA; 250 ppm/757 mg/m^3 STEL.

NIOSH IDLH: 3100 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 250 ppm

PAC-2: 500 ppm

PAC-3: 3100 ppm

DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category I(4); Pregnancy Risk Group C.

Australia: TWA 200 ppm (610 mg/m^3); STEL 250 ppm, 1993; Austria: MAK 200 ppm (610 mg/m^3), 1999; Belgium: TWA 200 ppm (610 mg/m^3); STEL 250 ppm (760 mg/m^3), 1993; Denmark: TWA 150 ppm (455 mg/m^3), 1999; Finland: TWA 200 ppm (610 mg/m^3); STEL 250 ppm (765 mg/m^3), 1993; France: VME 200 ppm (610 mg/m^3), VLE 250 ppm (760 mg/m^3), 1999; Hungary: TWA 200 mg/m^3; STEL 500 mg/m^3 [skin] 1993; the Netherlands: MAC-TGG 610 mg/m^3, 2003; Norway: TWA 100 ppm (305 mg/m^3), 1999; the Philippines: TWA 200 ppm (610 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 750 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 100 mg/m^3, 1993; Sweden: TWA 150 ppm (450 mg/m^3); STEL 300 ppm (900 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (610 mg/m^3), KZG-W 400 ppm (1220 mg/m^3), 1999; Turkey: TWA 200 ppm (610 mg/m^3), 1993; United Kingdom: TWA 200 ppm (616 mg/m^3); STEL 250 ppm (770 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm. Several states have set guidelines or standards for methyl acetate in ambient air[60] ranging from 6.1−7.6

mg/m^3 (North Dakota) to 12.2 mg/m^3 (Connecticut) to 14.524 mg/m^3 (Nevada) to 15 mg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) #1458.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 0.2$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl acetate can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. May affect the central nervous system causing dizziness, lightheadedness, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: The liquid destroys the skin's natural oils. Repeated or high exposures may cause methanol poisoning, which can cause headaches, dizziness, coma, and affect the optic nerve, causing blindness. Death can occur.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposures (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Vision examination. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: 4H™ and Silver Shield™ gloves. **4 h**: Teflon™ gloves, suits, boots. Also, butyl rubber is among the recommended protective materials. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator); *3100 ppm:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl acetate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis and nitrates. Sources of ignition, such as smoking and open flames, are prohibited where methyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl acetate.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Methyl Acetate*. Trenton, NJ

Methyl acetylene M:0630

Molecular Formula: C_3H_4

Common Formula: $CH_3C = CH$

Synonyms: Acetylene, methyl-; Allylene; Propine; Propyne

CAS Registry Number: 74-99-7

RTECS® Number: UK4250000

UN/NA & ERG Number: UN1954/115

EC Number: 200-828-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Methyl acetylene is a flammable, colorless gas with a sweet odor. Molecular weight = 40.07; Boiling point = −23.3°C; Freezing/Melting point = −102.8°C; Vapor pressure = 5.2 atm; Relative vapor density (air = 1) = 1.41. Explosive limits: LEL = 1.7%; UEL = 11.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. A fuel that is shipped as a liquefied compressed gas. Practically insoluble in water; solubility 0.4%.

Potential Exposure: Compound Description: Mutagen. This material may be used as a liquid rocket propellent, in admixture with propadiene as an industrial cutting fuel.

Incompatibilities: Forms explosive gas mixture with air. Can form explosive peroxide. Can decompose explosively on heating and at 4.5−5.6 atmospheres of pressure. Strong oxidizers may cause fire and explosions. Forms shock-sensitive compounds with copper, magnesium, silver, and their alloys. Copper or copper alloys containing more than 67% copper should not be used in handling equipment. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor = 1 ppm = 1.64 mg/m^3.

OSHA PEL: 1000 ppm/1650 mg/m^3 TWA.

NIOSH REL: 1000 ppm/1650 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/1640 mg/m^3 TWA.

NIOSH IDLH: 1700 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 1700 ppm

PAC-2: 1700 ppm

PAC-3: 1700 ppm

Australia: TWA 1000 ppm (1650 mg/m^3); STEL 1250 ppm, 1993; Austria: MAK 1000 ppm (1650 mg/m^3), 1999; Belgium: TWA 1000 ppm (1640 mg/m^3); STEL 1250 ppm (2050 mg/m^3), 1993; Denmark: TWA 1000 ppm (1650 mg/m^3), 1999; Finland: TWA 1000 ppm (1650 mg/m^3); STEL 1250 ppm (2065 mg/m^3), 1999; France: VME 1000 ppm (1650 mg/m^3), 1999; the Netherlands: MAC-TGG 1650 mg/m^3, 2003; the Philippines: TWA 1000 ppm (1650 mg/m^3), 1993; Switzerland: MAK-W 1000 ppm (1650 mg/m^3), 1999;

Turkey: TWA 1000 ppm (1650 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000 ppm.

The Federal standard[58], the DFG MAK value[3], and the ACGIH TWA value is 1000 ppm (1650 mg/m^3). Several states have set guidelines or standards for methyl acetylene in ambient air[60] ranging from 16.5−20.4 mg/m^3 (North Dakota) to 30 mg/m^3 (Virginia) to 33 mg/m^3 (Connecticut) to 39.286 mg/m^3 (Nevada).

Determination in Air: Gas collection bag; none; Gas chromatography/Flame ionization detection; NIOSH (II-5), Method #S8.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Rapid evaporation of the liquid may cause frostbite. Exposure can cause headache, dizziness, convulsions, and loss of consciousness.

Long Term Exposure: Can irritate the lungs. May cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Central nervous system, lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1700 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Compressed gases, flammable, n.o.s. require a label of "FLAMMABLE GAS." They fall in Hazard Class 2.1.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Note: Stopping the flow of gas is a better course of action than trying to extinguish the fire.[17] It may be dangerous to extinguish the flame and allow the gas to continue to flow, as an explosive mixture may be formed with air which may cause greater damage than the original fire if allowed to burn.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Methyl Acetylene*, Trenton, NJ

Methyl acetylene−propadiene mixture M:0640

Molecular Formula: C_3H_4

Common Formula: $CH_3C\equiv CH$; $H_2C = C = CH_2$

Synonyms: Allene-methyl acetylene mixture; MAPP gas; Methyl acetylene-allene mixture; Propadiene and methylacetylene mixture; Propyne-allene mixture; Propyne-propadiene mixture

CAS Registry Number: 59355-75-8

RTECS® Number: UK4920000

UN/NA & ERG Number: UN1060 (stabilized)/116

UN/NA & ERG Number: None assigned.

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: This mixture of C_3H_4 isomers is a flammable, colorless gas with a strong, characteristic, foul odor. The odor threshold is 100 ppm. Boiling point = −38 to −20°C; Freezing/Melting point = −136°C; Relative vapor density (air = 1) = 1.48. Explosive limits: LEL = 3.4%; UEL = 10.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 0, Reactivity 0. Insoluble in water. A fuel that is shipped as a liquefied compressed gas mixture containing 60−6.5% methylacetylene and propadiene; the balance is butane and propane.

Potential Exposure: This mixture is used as an industrial cutting fuel.

Incompatibilities: Strong oxidizers, copper alloys. Forms explosive compounds at high pressure in contact with alloys containing more than 67% copper.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.64 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/1800 mg/m^3 TWA.

NIOSH REL: 1000 ppm/1800 mg/m^3 TWA; 1250 ppm/2250 mg/m^3 STEL.

ACGIH TLV®[1]: 1000 ppm/1640 mg/m^3 TWA; 1250 ppm/2050 mg/m^3 STEL.

NIOSH IDLH: 3,400 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 1250 ppm

PAC-2: 1250 ppm

PAC-3: 3400 ppm

Australia: TWA 1000 ppm (1800 mg/m^3); STEL 1250 ppm, 1993; Belgium: TWA 1000 ppm (1640 mg/m^3); STEL 1250 ppm (2050 mg/m^3), 1993; Finland: TWA 1000 ppm (1800 mg/m^3); STEL 1250 ppm (2250 mg/m^3), 1999; the Philippines: TWA 1000 ppm (1800 mg/m^3), 1993; Switzerland: MAK-W 1000 ppm (1800 mg/m^3), 1999; the Netherlands: MAC-TGG 1800 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1250 ppm. In addition, the state of North Dakota has set a guideline[60] of 18−22.5 mg/m^3 for MAPP in ambient air.

Determination in Air: Gas collection bag; none; Gas chromatography/Flame ionization detection; NIOSH II (6), Method #S85.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of the respiratory system, excitement, confusion, anesthesia, liquid: frostbite.

Points of Attack: Respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 3400 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location.

If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Methyl acrylate M:0650

Molecular Formula: $C_4H_6O_2$

Common Formula: $CH_2 = CHCOOCH_3$

Synonyms: Acrilato de metilo (Spanish); Acrylate de methyle (French); Acrylic acid methyl ester; Acrylsaeuremethylester (German); Curithane 103; Methoxycarbonylethylene; Methyl-acrylat (German); Methyl acrylate; Methyl propenate; Methyl 2-propenoate; Methyl propenoate; 2-Propenoic acid, methyl ester; Propenoic acid methyl ester

CAS Registry Number: 96-33-3

RTECS® Number: AT2800000

UN/NA & ERG Number: UN1919 (stabilized)/129

EC Number: 202-500-6 [*Annex I Index No.*: 607-034-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U328.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36; R66; R67; Safety phrases: S2; S16; S26; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methyl acrylate is a clear, colorless liquid with a sharp, fruity odor. Molecular weight = 86.10; Specific gravity (H_2O:1) = 0.96; Boiling point = 80°C; Freezing/Melting point = −76.7°C; Flash point = −3°C (oc); Autoignition temperature = 468°C. Explosive limits: LEL = 2.8%; UEL = 25%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Slightly soluble in water; solubility = 6%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Methyl acrylate is used in production of acrylates, copolymers, barrier resins; surfactants for shampoos; as a monomer in the manufacture of polymers for plastic films, textiles, paper, and leather coating resins. It is also used as a pesticide intermediate and in pharmaceutical manufacture.

Incompatibilities: Forms explosive mixture in air. Incompatible with nitrates, oxidizers, such as peroxides, strong alkalis. Polymerizes easily from heat, light, peroxides; usually contains an inhibitor, such as hydroquinone.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.52 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/35 mg/m^3 TWA [skin].

NIOSH REL: 10 ppm/35 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/7 mg/m^3 TWA [skin]; danger of sensitization.

NIOSH IDLH: 250 ppm.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 2 ppm

PAC-2: 7.5 ppm

PAC-3: 250 ppm

DFG MAK: 5 ppm/18 mg/m^3, Peak Limitation Category I (1) danger of skin sensitization; Pregnancy Risk Group D.

Several states have set guidelines or standards for methyl acrylate in ambient air[60] ranging from 4.8 μg/m^3 (Massachusetts) to 350 μg/m^3 (North Dakota) to 500 μg/m^3 (Virginia) to 700 μg/m^3 (Connecticut) to 833 μg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1459; #2552; OSHA Analytical Method 92.

Permissible Concentration in Water: Russia[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.79$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl acrylate can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Eye and skin contact can cause severe irritation and burns. A lacrimator. Breathing high levels may cause severe lung irritation and may lead to fluid in the lungs (pulmonary edema). This can cause death. Prolonged contact can cause severe damage to the skin and eyes.

Long Term Exposure: Prolonged or repeated exposure to methyl acrylate may cause liver and kidney damage. Exposure may cause skin sensitization and allergy to develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: butyl rubber gloves, suits, boots; Tychem 1000™ suits. **4 h**: Teflon™ gloves, suits, boots. Also, polyvinyl alcohol is among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 100 ppm:* Sa (APF = 10) (any supplied-air respirator). *250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl acrylate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. At temperatures above 20°C a violent reaction could take place. Methyl acrylate should always be used with an inhibitor. Check that the correct concentration of inhibitor is used; if it is not, a violent reaction could occur. Sources of ignition, such as smoking and open flames, are prohibited where methyl acrylate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl acrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl acrylate. Wherever methyl acrylate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl acrylate, inhibited, requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location,

use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: Methyl Acrylate*. Trenton, NJ

Methylal M:0660

Molecular Formula: $C_3H_8O_2$

Common Formula: $CH_3OCH_2OCH_3$

Synonyms: Anesthenyl; Dimethoxymethane; Dimethylacetal formaldehyde; Formal; Formaldehyde dimethyl acetal; Methane, dimethoxy-; Methyl, dimethoxy-; Methylene dimethyl ether; Methyl formal

CAS Registry Number: 109-87-5

RTECS® Number: PA8750000

UN/NA & ERG Number: UN1234/127

EC Number: 203-714-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methylal is a colorless liquid with a pungent odor. Molecular weight = 76.11; Specific gravity (H_2O:1) = 0.86; Boiling point = 43.9°C; Freezing/Melting point = −105°C; Vapor pressure 330 mmHg at 20°C; Flash point = −32°C; Autoignition temperature = 237°C. Explosive limits: LEL = 2.2%; UEL = 13.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Soluble in water; solubility = 33%.

Potential Exposure: Compound Description: Primary Irritant. Methylal is used as a specialty fuel and as a solvent in adhesives and protective coatings.

Incompatibilities: Forms explosive mixture with air. Methylal may be able to form unstable and explosive peroxides. Heating may cause explosion. Strong reaction with strong oxidizers, acids, causing fire and explosion hazard. Hydrolyzes readily in presence of acids to generate aldehydes.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.11 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/3100 mg/m^3 TWA.

NIOSH REL: 1000 ppm/3100 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm; 3110 mg/m^3 TWA.

NIOSH IDLH: 2200 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 2200 ppm

PAC-2: 2200 ppm

PAC-3: 2200 ppm

DFG MAK: 1000 ppm/3200 mg/m^3 TWA; Peak Limitation II(2); Pregnancy Group C.

Australia: TWA 1000 ppm (3100 mg/m^3), 1993; Austria: MAK 1000 ppm (3100 mg/m^3), 1999; Belgium: TWA 1000 ppm (3110 mg/m^3), 1993; Denmark: TWA 1000 ppm (3100 mg/m^3), 1999; Finland: TWA 1000 ppm (3100 mg/m^3); STEL 1250 ppm (3900 mg/m^3), 1999; France: VME 1000 ppm (3100 mg/m^3), 1999; the Netherlands: MAC-TGG 3100 mg/m^3, 2003; the Philippines: TWA 1000 ppm (3100 mg/m^3), 1993; Poland: MAC (TWA) 1000 mg/m^3, MAC (STEL) 3500 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (3100 mg/m^3), 1999; Turkey: TWA 1000 ppm (3100 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (3160 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000 ppm. Several states have set guidelines or standards for methylal in ambient air[60] ranging from 3.875−31.0 mg/m^3 (North Dakota) to 62.0 mg/m^3 (Connecticut) to 73.8 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1611.[18]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylal can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure to high levels may cause you to feel dizzy, lightheaded, and to pass out. Methylal can irritate the eyes, nose, throat and skin. Very high levels may irritate the lungs. High exposure may damage the liver and kidneys.

Long Term Exposure: The liquid removes the skin's natural oils. Repeated exposure may damage the liver and kidneys.

Points of Attack: Skin, eyes, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2,200 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). Unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methylal must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, bromine, nitrates and permanganates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylal is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methylal should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methylal. Wherever methylal is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Concentrated waste containing no peroxides:* discharge liquid at a controlled rate near a pilot flame. *Concentrated waste containing peroxides:* perforation of containers of the waste from a safe distance followed by open burning.

Reference

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methylal.* Trenton, NJ

Methyl alcohol M:0670

Molecular Formula: CH_4O
Common Formula: CH_3OH
Synonyms: Alcohol metilico (Spanish); Alcool methylique (French); Carbinol; Colonial spirit; Columbian spirit; Metanol (Spanish); Methyl alcohol; Methylalkohol (German); Methyl hydroxide; Methylol; Monohydroxymethane; Pyroxylic spirit; Wood alcohol; Wood naphtha; Wood spirit
CAS Registry Number: 67-56-1; *(alt.)* 54841-71-3
RTECS® Number: PC1400000
UN/NA & ERG Number: UN1230/131
EC Number: 200-659-6 [*Annex I Index No.*: 603-001-00-X]
Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: SHE—clonal assay; Cell transform.—SA7/SHE; Negative: *N. crassa—aneuploidy*; *In vitro* SCE—nonhuman.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (Thailand and Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): U154.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/L/TCLP), 0.75.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; Class B2, D1B, D2B.

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R11; R23/24/25; R39/23/24/25; Safety phrases: S1/2; S7; S16; S35/36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl alcohol is a colorless, volatile liquid with a mild odor. Odor threshold = 100 ppm.[41] Molecular weight = 32.04; Specific gravity (H_2O:1) = 0.79; Boiling point = 63.9°C; Freezing/Melting point = −98°C; Vapor pressure = 96 mmHg at 20°C; 127 mmHg at 25°C; Flash point = 12°C; Autoignition temperature = 464°C. Explosive limit: LEL = 6.0%; UEL = 36.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Methyl alcohol is used as a starting material in organic synthesis of chemicals, such as formaldehyde, methacrylates, methyl amines, methyl halides, ethylene glycol, and pesticides, and as an industrial solvent for inks, resins, adhesives, and dyes. It is an ingredient in paint and varnish removers, cleaning and dewaxing preparations, spirit duplicating fluids, embalming fluids, antifreeze mixtures, and enamels, and is used in the manufacture of photographic film, plastics, celluloid, textile soaps, wood stains, coated fabrics, shatterproof glass, paper coating, waterproofing formulations, artificial leather, and synthetic indigo and other dyes. It has also been used as an extractant in many other processes, an antidetonant fuel-injection fluid for aircraft, a rubber accelerator, and a denaturant for ethyl alcohol.

Incompatibilities: Methanol reacts violently with strong oxidizers, causing a fire and explosion hazard.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.31 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/260 mg/m^3 TWA [skin].

NIOSH REL: 200 ppm/260 mg/m^3 TWA; 250 ppm/325 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 200 ppm/262 mg/m^3 TWA; 250 ppm/328 mg/m^3 STEL [skin]; BEI issued (2004).

Protective Action Criteria (PAC)*

TEEL-0: 200 ppm
PAC-1: **530** ppm
PAC-2: **2100** ppm
PAC-3: **7200** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: 200 ppm
ERPG-2: 1000 ppm
ERPG-3: 5000 ppm

DFG MAK: 200 ppm/270 mg/m^3 Peak Limitation Category II(4) [skin]; Pregnancy Risk Group C; BAT: 30 mg/L methanol in urine/end-of-shift; for long-term exposure, after several shifts.

NIOSH IDLH: 6000 ppm.

Arab Republic of Egypt: TWA 200 ppm (260 mg/m^3), [skin], 1993; Australia: TWA 200 ppm (260 mg/m^3); STEL 250 ppm, [skin], 1993; Austria: MAK 200 ppm (260 mg/m^3), [skin], 1999; Belgium: TWA 200 ppm (262 mg/m^3); STEL 250 ppm, [skin], 1993; Denmark: TWA 200 ppm (260 mg/m^3), [skin], 1999; Finland: TWA 200 ppm (260 mg/m^3); STEL 250 ppm, [skin], 1999; France: VME 200 ppm, VLE 1000 ppm, 1999; Hungary: TWA 50 mg/m^3; STEL 100 mg/m^3, [skin], 1993; Japan 200 ppm (260 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 260 mg/m^3, [skin], 2003; Norway: TWA 100 ppm (130 mg/m^3), 1999; the Philippines: TWA 200 ppm (260 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3, MAC (STEL) 300 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 5 mg/m^3, [skin], 1993; Sweden: NGV 200 ppm (250 mg/m^3), KTV 250 ppm (350 mg/m^3), [skin], 1999; Thailand: TWA 200 ppm (260 mg/m^3), 1993; Turkey: TWA 200 ppm (260 mg/m^3), 1993; United Kingdom: TWA 200 ppm (255 mg/m^3); STEL 250 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm [skin]. Russia[43] set a MAC of 1.0 mg/m^3 in ambient air in residential areas on a momentary basis and 0.5 mg/m^3 on a daily average basis. Several states have set guidelines or standards for methanol in ambient air[60] ranging from 0.036 mg/m^3 (Massachusetts) to 0.62 mg/m^3 (Kansas) to 2.6−3.1 mg/m^3 (North Dakota) to 4.3 mg/m^3 (Virginia) to 5.2 mg/m^3 (Connecticut and South Dakota) to 6.19 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2000, Methanol.[18]; #2549 Volatile organic compounds; OSHA Analytical Method 91.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 3600 μg/L based on health effects. Russia[43] set a MAC of 3 mg/L in water bodies used for domestic purposes and of 0.1 mg/L in water bodies used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = (estimated) <-0.77.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* Below 500 ppm symptoms are rarely felt. Can cause headache, vomiting, irritation of the nose and throat, dilation of the pupils, feeling of intoxication, loss of muscle coordination, excessive sweating, bronchitis, and convulsions. Very high exposures may result in stupor, cramps, and visual difficulties, such as spotted vision, sensitivity to light, eye tenderness, and blindness. Recovery is not always complete and symptoms may recur without additional exposure. *Skin:* Can cause dry and cracked skin, irritation, and reddening. Skin absorption can be enough to contribute to symptoms described under inhalation. *Eyes:* Can cause irritation of eyes. *Ingestion:* Symptoms are similar to those under inhalation, plus damage to liver, kidneys, and heart. Nerve damage may occur causing loss of coordination and blindness. Recovery is not always complete. Death may occur. Usual fatal dose is about 100−250 mL but death from ingestion has occurred from as little as 30 mL (about 1 oz).

Long Term Exposure: Exposure to low levels may cause many of the symptoms listed above. Skin contact causes dryness and cracking. May cause liver damage. Because methyl alcohol is slowly eliminated from body, repeated low exposures may buildup to high levels, causing severe symptoms. Recovery is not always complete. Methanol has been found to be a teratogen (changes in the genetic material) in animals. Whether it does in humans is unknown.

Points of Attack: Eyes, skin, respiratory system, central nervous system, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite) pH (Hydrogen ion concentration); whole blood (chemical/metabolite), pre- and postshift; blood plasma, bicarbonate, expired air, liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite) end-of-work-week; urine (chemical/metabolite) prior to next shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: butyl rubber gloves, suits, boots; Teflon™ gloves, suits, boots; Viton™ gloves, suits, Saranex™ coated suits; 4H™ and Silver Shield™ gloves, Responder™ suits, Trellchem™ HPS suits; Trychem 1000™ suits. Also, Viton™/chlorobutyl rubber, polyvinyl acetate, styrene/butadiene rubber, Viton™/Neoprene™, butyl/Neoprene™, and chlorinated polyethylene are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa (APF = 10) (any supplied-air respirator). *5000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *6000 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine). Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl alcohol is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl alcohol.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including formaldehyde, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Methyl Alcohol*, NIOSH Document No. 76-148. Washington, DC

US Environmental Protection Agency. (July 11, 1977) (Revised 1979). *Chemical Hazard Information Profile: Methanol*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Methyl Alcohol: Health and Environmental Effects Profile No. 126*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report,* 5, No. 5, 58−64

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Methyl alcohol*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Methyl alcohol*. Trenton, NJ

Methylamine M:0680

Molecular Formula: CH_5N

Common Formula: CH_3NH_2

Synonyms: Aminomethane; Carbinamine; Mercurialin; Methanamine; Methylamine; Metilamino (Spanish); Monomethylamine

CAS Registry Number: 74-89-5

RTECS® Number: PF6300000

UN/NA & ERG Number: UN1061 (anhydrous)/118; UN1235 (aqueous solution)/132

EC Number: 200-820-0 [*Annex I Index No.:* 612-001-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F + , Xn; Risk phrases: R12; R20; R37/38; R41; Safety phrases: S2; S16; S26; S39. (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methylamine is a colorless gas with a fish- or ammonia-like odor; at low concentrations a fishy odor. Shipped as a liquefied compressed gas. The odor threshold is 3.2 ppm. Molecular weight = 31.07; Specific gravity (H_2O:1) = 0.7 (liquid); Boiling point = −6°C; Freezing/Melting point = −94°C; Relative vapor density (air = 1) = 1.08; Vapor pressure = 3 atm; Flash point = flammable gas; Autoignition temperature = 430°C. Explosive limits: LEL = 4.9%; UEL = 20.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Natural Product; Primary Irritant. Methylamine is used in organic synthesis; a starting material for *N*-oleyltaurine, a surfactant; and *p*-*N*-methylaminophenol sulfate, a photographic developer. It has possible uses in solvent extraction systems in separation of aromatics from aliphatic hydrocarbons. It is also used in the synthesis of many different pharmaceuticals, pesticides, and rubber chemicals.

Incompatibilities: A medium strong base. Reacts violently with strong acids; mercury, strong oxidizers, nitromethane. Corrosive to copper, zinc alloys, aluminum, and galvanized surfaces.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.27 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/12 mg/m^3 TWA.

NIOSH REL: 10 ppm/12 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/6.4 mg/m^3; 15 ppm/19 mg/m^3 STEL.

Protective Action Criteria (PAC)*

TEEL-0: 10 ppm

PAC-1: **15** ppm

PAC-2: **64** ppm

PAC-3: **350** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 10 ppm/13 mg/m^3 TWA; Peak Limitation Category I(1); a momentary value of 10 mL/m^3/13 mg/m^3 should not be exceeded; Pregnancy Risk Group D.

NIOSH IDLH: 100 ppm.

Australia: TWA 10 ppm (12 mg/m^3), 1993; Austria: MAK 10 ppm (12 mg/m^3), 1999; Belgium: TWA 10 ppm (13 mg/m^3), 1993; Denmark: TWA 10 ppm (12 mg/m^3), [skin], 1999; Finland: STEL 10 ppm (12 mg/m^3), [skin], 1999; France: VLE 10 ppm (12 mg/m^3), 1999; Japan: 10 ppm (13 mg/m^3), 1999; the Netherlands: MAC-TGG 6.4 mg/m^3, 2003; Norway: TWA 10 ppm (12 mg/m^3), 1999; the Philippines: TWA 10 ppm (12 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 15 mg/m^3, 1999; Russia: TWA 10 ppm; STEL 1 mg/m^3, [skin], 1993; Sweden: NGV 10 ppm (13 mg/m^3), KTV 20 ppm (25 mg/m^3), [skin], 1999; United Kingdom: TWA 10 ppm (13 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm. Several states have set guidelines or standards for methylamine in ambient air[60] ranging from 28.6 μg/m^3 (Kansas) to 40.0 μg/m^3 (New York) to 120 μg/m^3 (Florida and North Dakota) to 200 μg/m^3 (Virginia) to 240 μg/m^3 (Connecticut) to 286 μg/m^3 (Nevada) to 300 μg/m^3 (South Carolina).

Determination in Air: Use OSHA Analytical Method 40.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for drinking purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.69$.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylamine can affect you when breathed and by passing through your skin. Contact with the liquid can cause frostbite and severe burns of the eyes and skin. The vapor can irritate the eyes, nose, throat, and lungs. Higher levels can cause a buildup of fluid (pulmonary edema). This can cause death.

Long Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking. May cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h:** Responder™ suits; Trychem 1000™ suits. **4 h**: Teflon™ gloves, suits, boots. Also, nitrile rubber, Styrene-butadiene rubber, Neoprene™, Silvershield™, and PVC are among the recommended protective materials. Prevent possible skin freezing from direct liquid contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid. Wear gas-proof chemical goggles and face shield when working with the gas, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methylamine must be stored to avoid contact with mercury, flammable materials, and strong oxidizers, (such as chlorine dioxide, or bromine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylamine is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylamine. Wherever methylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Methylamine, *anhydrous*, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1. Methylamine, *aqueous solution*, requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Alternatively, spread heavily with sodium bisulfate and sprinkle with water. Then drain into a sewer (see next sentence) with a large amount of water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylamine is a flammable liquid or gas. If you are dealing with gas, stop the flow of gas if it can be done safely. Use water to keep fire-exposed containers cool and to protect people attempting shut-off. For water solutions, use water spray, CO_2, dry chemical, and alcohol foam extinguishers. Poisonous gases, including oxides of nitrogen, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

US Environmental Protection Agency. (May 1, 1978). *Chemical Hazard Information Profile: Methylamines*. Washington, DC

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report,* 5, No. 4, 48−50

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methylamine*. Trenton, NJ

Methyl *n*-amyl ketone M:0690

Molecular Formula: $C_7H_{14}O$

Common Formula: $CH_3COC_5H_{11}$

Synonyms: Amyl-methyl-cetone (French); Amyl methyl ketone; Butyl acetone; Methyl amyl ketone; Methyl-amyl-cetone (French); 2-Heptanone; 2-Ketoheptane; Methyl pentyl ketone; Pentyl methyl ketone

CAS Registry Number: 110-43-0

RTECS® Number: MJ5075000

UN/NA & ERG Number: UN1110/127

EC Number: 203-767-1 [*Annex I Index No.:* 606-024-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: risk phrases: R10; R20/22; Safety phrases: S2; S22/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl amyl ketone is a clear colorless liquid with a mild, banana-like odor. Molecular weight = 114.21; Specific gravity (H_2O:1) = 0.81; Boiling point = 151.7°C; Freezing/Melting point = −35.6°C; Vapor pressure = 3 mmHg at 20°C; Flash point = 39°C; Autoignition temperature = 393°C. Explosive limits: LEL = 1.1% at 66°C; UEL = 7.9% at 121°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Poor solubility in water; solubility = 0.4%.

Potential Exposure: Compound Description: Primary Irritant. Methyl amyl ketone is used as a solvent in metal roll coatings and in synthetic resin finishes; as a solvent for nitrocellulose in lacquers and as a relatively inert reaction medium.

Incompatibilities: Forms explosive mixture with air. Strong acids, alkalis, oxidizers. Attacks some forms of plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.67 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/465 mg/m^3 TWA.

NIOSH REL: 100 ppm/465 mg/m^3 TWA.

ACGIH TLV®[1]: 50 ppm/233 mg/m^3 TWA.

NIOSH IDLH: 800 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 750 ppm

PAC-3: 800 ppm

Australia: TWA 50 ppm (235 mg/m^3), 1993; Belgium: TWA 50 ppm (233 mg/m^3), 1993; Denmark: TWA 50 ppm (230 mg/m^3), 1999; Finland: TWA 50 ppm (230 mg/m^3); STEL 75 ppm (345 mg/m^3), 1999; France: VME 50 ppm (235 mg/m^3), 1999; Norway: TWA 25 ppm (115 mg/m^3), 1999; Sweden: TWA 25 ppm (120 mg/m^3); STEL 50 ppm (250 mg/m^3), 1999; the Netherlands: MAC-TGG 233 mg/m^3, 2003; United Kingdom: LTEL 50 ppm (240 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for methyl *n*-amyl ketone in ambient air[60] ranging from 2.35−4.65 mg/m^3 (North Dakota) to 3.9 mg/m^3 (Virginia) to 4.7 mg/m^3 (Connecticut) to 5.595 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #1301; #2553, Ketones II.[18]

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl *n*-amyl ketone can affect you when breathed in and by passing through your skin. Irritates the eyes and the respiratory tract. May affect the central nervous system. Breathing the vapor can cause dizziness and lightheadedness and can make you pass out.

Long Term Exposure: Causes skin irritation with cracking and drying; destroys the skin's natural oils. May cause liver and kidney damage. May affect the nervous system.

Points of Attack: Eyes, skin, respiratory system, central nervous system, peripheral nervous system.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests, examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **4 h**: 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: *800 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl (*n*-amyl) ketone must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, chlorates, nitrites, and permanganates, since violent reaction occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Sources of ignition, such as smoking and open flames, are prohibited where methyl (*n*-amyl) ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to

fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methyl n-Amyl Ketone*. Trenton, NJ

N-Methylaniline M:0700

Molecular Formula: C_7H_9N

Common Formula: $C_6H_5NH(CH_3)$

Synonyms: Anilinomethane; Benzenenamine, *N*-methyl-; MA; (Methylamino)benzene; *N*-Methylaminobenzene; Methyl aniline; Methylaniline (mono); *N*-Methylbenzenamine; 4,4′-Methylene-bis-(*N,N*-dimethylaniline)*;* *N*-Methylphenylamine; Methylphenyl amine; *N*-Monomethylaniline; Monomethyl aniline; *N*-Phenylmethylamine

CAS Registry Number: 100-61-8

RTECS® Number: BY4550000

UN/NA & ERG Number: UN2294/153

EC Number: 202-870-9 [*Annex I Index No.:* 612-015-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: *N*-Methylaniline is a yellow to light brown oily liquid with a weak, ammonia-like odor. Turns reddish-brown if left standing. The odor threshold is 1.7 ppm. Molecular weight = 107.17; Specific gravity (H_2O:1) = 0.99; Boiling point = 195.6°C; Freezing/Melting point = −57.2°C; Vapor pressure = 0.3 mmHg at 20°C; Flash point = 79.4°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Mutagen. The material is used as an intermediate in organic synthesis, as a solvent and as an acid acceptor.

Incompatibilities: Reacts violently with strong acids, acid chlorides, acid anhydrides, strong oxidizers. Attacks some plastic.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.38 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 2 ppm/9 mg/m^3 [skin] TWA.

NIOSH REL: 0.5 ppm/2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 ppm/2.2 mg/m^3 TWA [skin].

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 2 ppm

PAC-2: 2 ppm

PAC-3: 100 ppm

DFG MAK: 0.5 ppm/2.2 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D.

Arab Republic of Egypt: TWA 2 ppm (9 mg/m^3), [skin], 1993; Australia: TWA 0.5 ppm (2 mg/m^3), [skin], 1993; Austria: MAK 0.5 ppm (2 mg/m^3), [skin], 1999; Belgium: TWA 0.5 ppm (2.2 mg/m^3), [skin], 1993; Denmark: TWA 0.5 ppm (2.25 mg/m^3), [skin], 1999; France: VME 0.5 ppm (2 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Poland: MAC (TWA) 2 mg/m^3, 1999; Turkey: TWA 2 ppm (9 mg/m^3), [skin], 1993; United Kingdom: TWA 0.5 ppm (2.2 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm [skin]. Russia[43] set a MAC of 0.04 mg/m^3 (40 μg/m^3) in ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for *n*-methylaniline in ambient air[60] ranging from 20 μg/m^3 (North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 47.6 μg/m^3 (Nevada).

Determination in Air: Bubbler; sodium hydroxide; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #3511.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.69.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylaniline can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Exposure to methylaniline can interfere with the ability of the blood to carry oxygen (methemoglobinemia). This can cause headaches, weakness, dizziness, dyspnea (breathing difficulty), cyanosis, a bluish color of the lips and nose. Higher exposure can cause shortness of breath, collapse, and even death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can damage the bladder, causing bloody urine.

Long Term Exposure: Repeated exposures may cause liver and kidney damage, and a low blood count (anemia). Repeated or prolonged contact may cause skin sensitization.

Points of Attack: Respiratory system, liver, kidneys, blood, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin, complete blood count, urinalysis (routine). Also, if symptoms develop or overexposure is suspected, the following may be considered: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm:* Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *25 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Methylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic, or thermal device.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methylaniline*. Trenton, NJ

Methyl benzoate M:0710

Molecular Formula: $C_8H_8O_2$

Synonyms: Benzoato de metilo (Spanish); Benzoic acid, methyl ester; Essence of niobe; Methyl benzenecarboxylate; Niobe oil; Oil of niobe

CAS Registry Number: 93-58-3

RTECS® Number: DH3850000

UN/NA & ERG Number: UN2938/152

EC Number: 202-259-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl Benzoate is a colorless, oily, transparent, liquid with a pleasant odor. Molecular weight = 136.16; Specific gravity (H_2O:1) = 1.09; Boiling point = 198.8°C; Freezing/Melting point = −13°C; Flash point = 83°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Used as food additive and as a solvent for cellulose esters and ethers, resins, and rubber.

Incompatibilities: Incompatible with strong acids, strong bases, nitrates, oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 ppm

PAC-1: 6 ppm

PAC-2: 40 ppm

PAC-3: 75 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. Swallowing the liquid may cause chemical pneumonia.

Long Term Exposure: May cause skin sensitization and allergy. May cause an asthma-like allergy. Can affect the nervous system causing tremors and muscle weakness.

Points of Attack: Skin, lungs, nervous system.

Medical Surveillance: Evaluation by a qualified allergist. Lung function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: Bronchodialators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl benzoate you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, strong bases, oxidizers, nitrates. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl benzoate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Methyl Benzoate*. Trenton, NJ

Methyl bromide M:0720

Molecular Formula: CH_3Br

Synonyms: Bromomethane; Brom-*o*-gas; Dawson 100; Dowfume; EDCO; Embafume; Halon 1001; Iscobrome; Kayafume; Methane, bromo-; Methogas; M-B-C fumigant; Monobromomethane; R 40BL; Rotox; Terabol; Terr-*o*-gas 100; Zytox

CAS Registry Number: 74-83-9

RTECS® Number: PA4900000

UN/NA & ERG Number: UN1062/123

EC Number: 200-813-2 [*Annex I Index No.:* 602-002-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse; EPA: Not Classifiable as to human carcinogenicity; NIOSH: Potential occupational carcinogen.

Carcinogenicity: (Animal Suspected) IARC[9]: DFG[3]: (ACGIH)[1] (suspected occupational carcinogen, NIOSH).

Toxic Chemical (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 0.7.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U029.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (20); 8240 (10).

Safe Drinking Water Act: Priority List (55 FR 1470).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B). Only as methyl bromide and ethylene dibromide mixture, liquid.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Developmental/Reproductive toxin (methyl bromide, as a structural fumigant) 1/1/93.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/25; R36/37/38; R48/20; R50; R59; R68;

Safety phrases: S1/2; S15; S27; S36/39; S38; S45; S59; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methyl bromide is a colorless gas with a chloroform-like odor at high concentrations. A liquid below 3.3°C. Shipped as a liquefied compressed gas. Molecular weight = 94.95; Specific gravity (H_2O:1) = 1.73; Boiling point = 3.3°C; Freezing/Melting point = −93.7°C; Relative vapor density (air = 1) = 3.36; Vapor pressure = 1.9 atm; Flash point = practically nonflammable except in presence of a high-energy ignition sources; Autoignition temperature = 537°C. Explosive limits: LEL = 10.0%; UEL = 16.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: Methyl bromide is used in fire extinguishers, as a fumigant in pest control, as a methylation agent in industry, and as an insect fumigant for soil, grain, warehouses, mills, ships, etc. It is also used as a chemical intermediate and a methylating agent, a refrigerant, a herbicide, a low-boiling solvent in aniline dye manufacture, for degreasing wool, for extracting oils from nuts, seeds, and flowers, and in ionization chambers. It is used as an intermediate in the manufacture of many drugs.

Incompatibilities: Attacks aluminum to form *spontaneously* flammable aluminum trimethyl. Incompatible with strong oxidizers, aluminum, dimethylsulfoxide, ethylene oxide, water. Attacks zinc, magnesium, alkali metals, and their alloys. Attacks some rubbers and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.89 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm/80 mg/m^3 Ceiling Concentration [skin].

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 1 ppm/3.9 mg/m^3 [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 250 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: 30 ppm

PAC-2: **210** ppm

PAC-3: **740** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin], Carcinogen Category 3B.

Arab Republic of Egypt: TWA 5 ppm (20 mg/m^3), [skin] 1993; Australia: TWA 5 ppm (20 mg/m^3), [skin], 1993; Austria: Suspected: carcinogen, 1999; Denmark: TWA 5 ppm (20 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (20 mg/m^3); STEL 10 ppm (40 mg/m^3), [skin], 1999; France: VME 5 ppm (20 mg/m^3), 1999; Hungary: TWA 10 mg/m^3; STEL 20 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003; Norway: TWA 5 ppm (20 mg/m^3), 1999; the Philippines: TWA 20 ppm (80 mg/m^3), [skin], 1993; Poland: MAC (TWA) 5 mg/m^3, MAC (STEL) 40 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: NGV 5 ppm (19 mg/m^3), KTV 10 ppm (40 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (20 mg/m^3), KZG-W 10 ppm (40 mg/m^3), [skin], 1999; Thailand: TWA 20 ppm (80 mg/m^3), 1993; Turkey: TWA 20 ppm (80 mg/m^3), 1993; United Kingdom: TWA 5 ppm (20 mg/m^3); STEL 15 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The Czech Republic: MAC 1.0 mg/m^3. Russia has set MAC value of 0.02 mg/m^3 for the ambient air in residential areas on a momentary basis and 0.01 mg/m^3 on a daily average basis. Several states have set guidelines or standards for methyl bromide in ambient air[60] ranging from 2.6 μg/m^3 (Massachusetts) to 47.6 μg/m^3 (Kansas) to 100 μg/m^3 (South Carolina) to 200 μg/m^3 (North Dakota) to 350 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 476 μg/m^3 (Nevada) to 480 μg/m^3 (Pennsylvania).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method 2520;[18] OSHA Analytical Method PV-2040.

Permissible Concentration in Water: *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 1.9 μg/L.[6] States which have set guidelines for methyl bromide in drinking water[61] include Arizona at 2.5 μg/L and Kansas at 0.19 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = 1.2.

Routes of Entry: Inhalation, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl bromide irritates the respiratory tract. Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the central nervous system causing psychological disturbances. Signs and symptoms of acute exposure to methyl bromide may be severe and include tremors, convulsions, brain hemorrhage, paralysis, coma, and permanent brain damage. Respiratory effects include cough, tachypnea (rapid respiratory rate), pulmonary edema, and respiratory collapse. Cyanosis (blue tint to the skin and mucous membranes), pallor, ventricular fibrillation, and circulatory collapse may also occur. Lethargy, profound weakness; headache, dizziness, mental confusion, slurring of speech, staggering gait, and blurred or double vision are often found. Gastrointestinal signs and symptoms include nausea, vomiting, abdominal pain, and anorexia. Oliguria (scanty urination), anuria (lack of urine formation), kidney hemorrhage, and kidney failure may occur. Contact with methyl bromide may cause dermatitis (red, inflamed skin) and conjunctivitis (red, inflamed eyes). *Inhalation:* A level of 35 ppm can cause nausea, vomiting, loss of appetite, headache, dizziness, drowsiness, and dimming of vision. These effects go away soon after exposure ceases. Headaches, dizziness, and weakness can be felt at 100 ppm and can last for months after exposure. Higher levels have caused coughing, nose and throat irritation, disturbed speech and walk, visual disturbances, twitching, numbness, paralysis, convulsions, and permanent nerve damage. Symptoms are often delayed 24−48 h. Exposures of 10,000 ppm for a few minutes can cause death. Can cause abdominal cramps and respiratory failure resulting in death. *Skin:* Contact with liquid can cause burning or tingling sensation, itching, redness, and swelling. Large amounts can cause blisters, numbness, or aching pain. Methyl bromide can be absorbed through the skin and cause symptoms described under inhalation. Death has occurred from skin absorption. *Eye:* Can cause irritation, tearing, reddening, or burning pain.

Ingestion: Can cause throat and stomach irritation as well as symptoms described under inhalation.

Note: Do not wear *ordinary rubber gloves* or *adhesive bandages* while using methyl bromide. It can dissolve rapidly through rubber or adhesive tape and cause severe symptoms.

Long Term Exposure: Levels between 20 and 35 ppm can cause symptoms as described under short-term inhalation. Symptoms can last months or years, or can be permanent. Repeated or prolonged contact with skin may cause dermatitis, lung damage, and broncho-spasms. Methyl bromide may affect the central nervous system causing paralysis, poor vision, psychological disorders, hallucinations, numbness in the arms and legs, and brain damage. May cause liver and kidney damage. Methyl bromide is a mutagen and may have a cancer risk. May damage the testes.

Points of Attack: Eyes, skin, respiratory system, central nervous system, brain. Cancer site in animals: lung, kidney, and fore-stomach.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; chest X-ray, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); urine (chemical/metabolite). Evaluate the central nervous system; respiratory tract, and skin in preplacement and periodic examinations. Blood test for bromides (unexposed persons usually have serum levels of 5 mg/L or below). Kidney function tests. Evaluation for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 h:** Responder™ suits; Trychem 1000™ suits. **4 h**: butyl rubber gloves, suits, boots; Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots. Also, Saranex™ and styrene-butadiene rubber are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Poison gas. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in well-ventilated area away from direct sunlight. Maintain temperature below 40°C; avoid heat sources. Protect against physical damage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Methyl bromide requires a shipping label of "POISON GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Fire Extinguishing: This chemical is a flammable gas but only in presence of a high energy ignition source. Nonflammable at room temperature. Poisonous gases, including hydrogen bromide and carbon monoxide, are produced in fire. Establish forced ventilation to keep levels below explosive limit. If liquid is spilled, evacuate area of spill; absorb liquid in vermiculite, dry sand, earth, or similar material and deposit in sealed containers for later disposal. If gas is leaked, do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. The recommended disposal procedure is to spray the gas into the fire box of an incinerator equipped with an afterburner and scrubber (alkali).[22]

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Bromomethane: Health and Environmental Effects Profile No. 29*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (February 20, 1985). *Chemical Hazard Information Profile: Methyl Bromide*. Washington, DC: Office of Toxic Substances

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Bromide*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Methyl Bromide.* Version 3. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report,* 5, No. 6, 37−40

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: Methyl Bromide*. Trenton, NJ

Methyl-*tert*-butyl ether M:0730

Molecular Formula: $C_5H_{12}O$
Synonyms: Ether, *tert*-butyl methyl-; 2-Methoxy-2-methylpropane; Methyl 1,1-dimethylethyl ether; Methyl *tert*-butyl ether; MTBE; Propane, 2-methoxy-2-methyl-
CAS Registry Number: 1634-04-4
RTECS® Number: KN5250000
UN/NA & ERG Number: UN2398/127
EC Number: 216-653-1 [*Annex I Index No.*: 603-181-00-X]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
European/International Regulations: Hazard Symbol: T; Risk phrases: R10; R48/23; R62; R67; Safety phrases: S1/2; S36/37; R45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Methyl-*tert*-butyl ether is a colorless liquid. Molecular weight = 88.17; Boiling point = 54°C; Freezing/Melting point = −109°C; Flash point = −10°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Used as an organic solvent, as an octane booster in unleaded gasolines, in making other chemicals, and in medicine to dissolve gall stones.
Incompatibilities: Forms explosive mixture with air. May be able to form unstable peroxides. Much less likely to form peroxides than other ethers. Incompatible with strong acids. Violent reaction with strong oxidizers. May accumulate static electrical charges and cause ignition of its vapors.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: None.
ACGIH TLV®[1]: 50 ppm/180 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC)*
TEEL-0: 50 ppm
PAC-1: **50** ppm
PAC-2: **570** ppm
PAC-3: **5300** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 50 ppm/180 mg/m^3 TWA; Peak Limitation Category I(1.5); Carcinogen Category 3B; Pregnancy Risk Group C.
Russia: STEL 100 mg/m^3, 1993; Sweden: TWA 50 ppm (180 mg/m^3); STEL 75 ppm (250 mg/m^3), 1999; United Kingdom: TWA 25 ppm (92 mg/m^3); STEL 75 ppm (275 mg/m^3), 2000; the Netherlands: MAC-TGG 180 mg/m^3, 2003.
Determination in Air: Use NIOSH Analytical Method #1615, MTBE.
Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause difficulty concentrating and thinking. Higher levels can cause headache, nausea, dizziness, weakness and lightheadedness.
Long Term Exposure: May cause kidney damage.
Points of Attack: Kidneys.
Medical Surveillance: Kidney function tests. The use of alcoholic beverages should be avoided before or during use.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Do not drink any alcoholic beverages before or during use.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with MTBE you should be trained on its

proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl *tert*-butyl ether requires a shipping label of " FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Solid streams of water may spread fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: Methyl-tert-Butyl Ether*. Trenton, NJ

Methyl *n*-butyl ketone M:0740

Molecular Formula: $C_6H_{12}O$

Common Formula: $CH_3CO(CH_2)_3CH_3$

Synonyms: *n*-Butyl methyl ketone; Butyl methyl ketone; 2-Hexanone; Hexanone-2; Ketone, butyl methyl; MBK; Methyl butyl ketone; MNBK; Propylacetone

CAS Registry Number: 591-78-6

RTECS® Number: MP1400000

UN/NA & ERG Number: UN1224/127

EC Number: 209-731-1 [*Annex I Index No.:* 606-030-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Developmental/ Reproductive toxin (male) 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R10; R48/23; R62; R67; Safety phrases: S1/2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: MNBK is a colorless liquid with an acetone-like odor. The odor threshold is 0.08 ppm. Molecular weight = 100.18; Specific gravity (H_2O:1) = 0.81; Boiling point = 127.8°C; Freezing/Melting point = −57°C; Vapor pressure = 11 mmHg at 20°C; Flash point = 25°C (cc); Autoignition temperature = 423°C. Explosive limits: LEL = 1.2%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: The material is used as a solvent.

Incompatibilities: Violent reaction with oxidizers. May form unstable peroxides. Attacks plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.10 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/410 mg/m^3 TWA.

NIOSH REL: 1 ppm/4 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/20 mg/m^3 TWA; 10 ppm/40 mg/m^3 STEL [skin].

DFG MAK: 5 ppm/21 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; BAT: 5 mg [hexane-2,5-dione +4,5-dihydroxy-2-hexanone]/L in urine at end-of-shift.

NIOSH IDLH: 1600 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm
PAC-1: 10 ppm
PAC-2: 1500 ppm
PAC-3: 1600 ppm
Australia: TWA 5 ppm (20 mg/m^3), 1993; Austria: MAK 5 ppm (21 mg/m^3), 1999; Belgium: TWA 5 ppm (20 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (4 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (20 mg/m^3); STEL 10 ppm (40 mg/m^3), [skin], 1999; France: VME 5 ppm (20 mg/m^3), VLE 8 ppm (35 mg/m^3), 1999; Hungary: TWA 20 mg/m^3; STEL 40 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 1 ppm (4 mg/m^3), 1999; the Philippines: TWA 100 ppm (410 mg/m^3), 1993; Poland: MAC (TWA) 10 mg/m^3, MAC (STEL) 50 mg/m^3, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 1 ppm (4 mg/m^3), KTV 2 ppm (8 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (410 mg/m^3), 1993; United Kingdom: TWA 5 ppm (21 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm [skin]. Several states have set guidelines or standards for MBK in ambient air[60] ranging from 54 μg/m^3 (Massachusetts) to 80 μg/m^3 (Connecticut) to 200 μg/m^3 (North Dakota) to 350 μg/m^3 (Virginia) to 476 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300, Ketones, #2555; OSHA Analytical Method PV-2031.[18]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.4$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl-*n*-butyl ketone can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. May affect the nervous system. Exposure may result in unconsciousness. Overexposure can cause you to feel dizzy and lightheaded and to pass out.

Long Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking. Exposure can damage the nerves, causing numbness and weakness, especially in the hands and feet. The vapor can irritate eyes, nose, and throat. There is limited evidence that this chemical may have reproductive effects. It may damage the male reproductive system. Handle with extreme caution. Exposure to other aliphatic monoketones (e.g., methyl ketone, methyl propyl ketone, methyl amyl ketone, hexyl ketone, etc.) may exacerbate the nerve damage caused by this chemical.

Points of Attack: Eyes, skin, respiratory system, central nervous system, peripheral nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: examination of the nervous system. Complete blood count. If symptoms develop or overexposure has occurred, the following may be useful: Nerve conduction tests should be considered. For men who suspect any problems conceiving a child, semen analysis and sperm count may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex™ is recommended in the literature. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *10 ppm:* Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1600 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained

on its proper handling and storage. Methyl *n*-butyl ketone must be stored to avoid contact with strong oxidizers (such as peroxides, chlorates, perchlorates, permanganates, and nitrates) because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, and flames. Sources of ignition, such as smoking and open flames, are prohibited where methyl *n*-butyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gallons or more of methyl *n*-butyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl *n*-butyl ketone.

Shipping: Ketones, liquid, n.o.s. must be labeled "FLAMMABLE LIQUID." This chemical falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methyl n-Butyl Ketone*. Trenton, NJ

Methyl chloride M:0750

Molecular Formula: CH_3Cl

Synonyms: Artic; Chlor-methan (German); Chloromethane; Chlorure de methyle (French); Methylchlorid (German); Monochloromethane; Methane, chloro-

CAS Registry Number: 74-87-3

RTECS® Number: PA6300000

UN/NA & ERG Number: UN1063/115

EC Number: 200-817-4 [*Annex I Index No.:* 602-001-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 15,000 lb.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U045.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: Priority List (55 FR 1470).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.19; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin 3/10/00; male 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R12; R40; R48/20; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methyl chloride is a colorless gas with a faint, sweet odor which is not noticeable at dangerous concentrations. The odor threshold is 10 ppm. Shipped as a liquefied compressed gas. Molecular weight = 50.49; Specific gravity (H_2O:1) = 0.92; Boiling point = −24.4°C; Freezing/Melting point = −97.8°C; Relative vapor density (air = 1) = 1.78; Vapor pressure = 5.0 atm; Flash point = flammable gas; Autoignition temperature = 632°C. Explosive limits: LEL = 8.1%; UEL = 17.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water (reaction); solubility 0.5%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Methyl chloride is used as a methylating and chlorinating agent in organic chemistry and in the production of silicones and tetramethyl lead. In petroleum refineries it is used as an extractant for greases, oils, and resins. Methyl chloride is also used as a solvent in the synthetic rubber industry, as a refrigerant, and as a propellant in polystyrene foam production. In the past it has been used as a local anesthetic (freezing). It is an intermediate in drug manufacture.

Incompatibilities: Violent reaction with chemically active metals, such as potassium, powdered aluminum, zinc, and magnesium. Reaction with aluminum trichloride, ethylene. Reacts with water (hydrolyzes) to form hydrochloric acid. Attacks many metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 300 ppm [5 min max peak in any 3 h] [skin].

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 50 ppm/103 mg/m^3 TWA; 100 ppm/207 mg/m^3 STEL; [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: **910** ppm

PAC-3: **3000** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 50 ppm/100 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group B; Carcinogen Category 3.

NIOSH IDLH: 2000 ppm [Ca].

Arab Republic of Egypt: TWA 50 ppm (105 mg/m^3), 1993; Australia: TWA 50 ppm (105 mg/m^3); STEL 100 ppm, 1993; Austria: MAK 50 ppm (105 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (103 mg/m^3); STEL 100 ppm (207 mg/m^3), 1993; Denmark: TWA 50 ppm (105 mg/m^3), 1999; Finland: TWA 50 ppm (105 mg/m^3); STEL 75 ppm (160 mg/m^3), 1999; France: VME 50 ppm (105 mg/m^3), VLE 100 ppm, carcinogen, 1999; the Netherlands: MAC-TGG 52 mg/m^3, 2003; Japan: 50 ppm (100 mg/m^3), 1999; Norway: TWA 25 ppm (50 mg/m^3), 1999; the Philippines: TWA 100 ppm (210 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; STEL 160 mg/m^3, 1999; Russia: TWA 50 ppm; STEL 5 mg/m^3, 1993; Sweden: NGV 50 ppm (100 mg/m^3), KTV 100 ppm (200 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (105 mg/m^3), KZG-W 100 ppm (210 mg/m^3); Thailand: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; Turkey: TWA 100 ppm (210 mg/m^3), 1993; United Kingdom: TWA 50 ppm (105 mg/m^3); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, IN New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm [skin]. Several states have set guidelines or standards for methyl chloride in ambient air[60] ranging from 1.6 μg/m^3 (Michigan) to 74.12 μg/m^3 (Kansas) to 1050−2050 μg/m^3 (North Dakota) to 1750 μg/m^3 (Virginia) to 2100 μg/m^3 (Connecticut and New York) to 2500 μg/m^3 (Nevada) to 2520 μg/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method (IV) #1001.

Permissible Concentration in Water: *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 1.9 μg/L.[6] In addition, several states have set guidelines for methyl chloride in drinking water[61] ranging from 0.19 μg/L (Kansas) to 0.50 μg/L (Arizona).

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography and mass spectrometry (EPA Method #624). Octanol−water coefficient: Log $K_{ow} = 0.9$.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Illness has been reported at concentrations of 500 ppm. 10,000 ppm for 30 min has caused death. Can cause nausea, vomiting, painful neck, loss of appetite. More severe exposure may result in the above symptoms plus headache, diarrhea, dizziness, loss of coordination, tremors of hands and lips, drooping eyelids, and eye twitch. Very severe exposure may include the above plus burning sensation in mouth and throat, mustard-like taste, difficulty in swallowing, hallucinations, loss of memory, cold and clammy skin, rapid breathing, unconsciousness, coma and death. Onset of symptoms may be delayed several hours after exposure. Effects may last weeks or months. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Contact with liquefied gas may cause freezing of skin, burns and permanent damage. Other symptoms are muscular pain, anemia, muscle weakness and fever. *Eyes:* Contact with the liquid can cause frostbite and severe burns, leading to permanent damage. May cause dimness of sight and abnormally dilated pupils. *Ingestion:* Ingestion of liquefied gas will cause freezing of mouth and throat.

Long Term Exposure: Long-term exposure may affect the testes, causing decreased production of male hormones and sperm. There is limited evidence that methyl chloride causes kidney cancer in animals. May damage the liver and kidneys. May cause brain damage. May cause blurred or double vision, and "drunken" behavior.

Points of Attack: Central nervous system, liver, kidneys, brain, reproductive system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Kidney function tests. Liver function tests. Examination for brain effects. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 h***:* Viton™ gloves, suits, Saranex™ coated suits, Barricade™ coated suits; Responder™ suits, Trellchem™ HPS suits; Trychem 1000™ suits. **4 h**: Teflon™ gloves, suits, boots. Prevent possible skin freezing from direct liquid contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl chloride must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates) or chemically active metals (such as sodium, potassium, powdered aluminum, zinc, and magnesium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and direct sunlight. Sources of ignition, such as smoking and open flames, are prohibited where methyl chloride is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever methyl chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases, including hydrogen chloride, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration with adequate scrubbing and ash disposal facilities.

References

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*, Report PB-296, 797. Washington, DC

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Methyl Chloride*. Report PB-276-678. Rockville, MD, pp. 29−36

US Environmental Protection Agency. (April 30, 1980). *Chloromethane: Health and Environmental Effects Profile No. 48*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Methyl Chloride*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 76−78

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Methyl Chloride*. Trenton, NJ

Methyl 2-chloroacrylate M:0760

Molecular Formula: $C_4H_5ClO_2$

Common Formula: $CH_2Cl = CHCOOCH_3$

Synonyms: 2-Chloroacrylate de méthyle (French); 2-Chloroacrylic acid, methyl ester; 2-Chloropropenoic acid, methyl ester; 2-Chloro-2-propenoic acid methyl ester; 2-Cloroacrilato de metilo (Spanish); Methyl-α-chloroacrylate

CAS Registry Number: 80-63-7

RTECS® Number: AS6380000

UN/NA & ERG Number: UN2924 (Flammable liquid, corrosive, n.o.s)/132

EC Number: 201-298-7

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: Hazard Symbol: C; Risk Phrases: R10; R34; Safety phrases: S9; S16; S25; S28; S33; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl 2-chloroacrylate is a colorless liquid. Molecular weight = 120.54; Boiling point = 52°C at 51 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = <1 mg/mL at 22°C.

Potential Exposure: Used to make acrylic high polymer with properties closely resembling those of polymethylmethacrylate. Monomer for specialty polymers (e.g., aircraft glazing).[EPA] Corrosive. Lacrimator.

Incompatibilities: May hydrolyze upon contact with moisture. Incompatible with nitrates. May be a polymerization hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.05 ppm

PAC-1: 0.15 ppm

PAC-2: 1.01 ppm

PAC-3: 7.5 ppm

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive and a lacrimator. It is a skin, eye, and lung irritant. A trace on skin causes large blisters. Inhalation of high concentrations may cause rapid breathing, headache, nausea, lethargy, convulsions, and death. Also, high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This material requires a label of "FLAMMABLE LIQUID." It falls into Hazard Class 3(8), Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl 2-Chloroacrylate*. Washington, DC: Chemical Emergency Preparedness Program

Methyl chloroformate M:0770

Molecular Formula: $C_2H_3ClO_2$

Synonyms: Carbonochloridic acid, methyl ester; Chlorameisensaeure methylester (German); Chlorocarbonate de methyle (French); Chlorocarbonic acid methyl ester; Chloroformic acid methyl ester; MCF; Methoxycarbonyl chloride

CAS Registry Number: 79-22-1

RTECS® Number: FG3675000

UN/NA & ERG Number: UN1238/155

EC Number: 201-187-3 [*Annex I Index No.:* 607-019-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): U156.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R11; R21/22; R26; R34; Safety phrases: S1/2; S14; S26; S28; S36/37/39; S45; S46; S63 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methyl chloroformate is a colorless liquid with an unpleasant, acrid odor. This is a highly corrosive and flammable material. Molecular weight = 94.50; Specific gravity (H_2O:1) = 1.22; Boiling point = 71°C; Freezing/Melting point = −61°C; Flash point = 17°C; Autoignition temperature = 504°C. Flammability Limits: LEL = 6.7%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Human Data. Used in synthesis of pharmaceuticals; herbicides, plastics, and other organic chemicals; as a solvent in the photographic industry; as a chemical intermediate in the production of other chemicals. In WWI it was used as military tear-producing warfare agent.

Incompatibilities: Forms explosive mixture with air. Violent reaction with alkali metals, ethers. Incompatible with strong acids, strong bases, alcohols, oxidizers, dimethylsulfoxide, dimethyl formamide. Contact with water or moisture produces corrosive and poisonous hydrogen chloride gas. Corrodes metals in the presence of moisture. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: 0.3 ppm

PAC-2: **2.2** ppm

PAC-3: **6.7** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.2 ppm/0.78mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Determination in Air: No method available.

Determination in Water: No criteria have been established.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Highly corrosive, contact can irritate and burn the skin and eyes, with possible permanent damage. Inhalation irritates the respiratory tract causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. A concentration of 190 ppm has been lethal in 10 min.

Long Term Exposure: Can cause sensitization and skin allergy. Can cause lung irritation and bronchitis. After 2−3 inhalations, brief initial irritation may occur followed by massive symptoms (heavy cough) after 36 h. Relapse may occur in the following days with eventual recovery.

Points of Attack: Skin, lungs.

Medical Surveillance: Lung function tests. Examination by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl chloroformate you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture, oxidizers, strong acids, strong bases. See incompatibilities for other materials to avoid. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl chloroformate requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 6.1. Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 1.6/2.5

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. *Do not use water*. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Methyl Chloroformate*. Trenton, NJ

Methyl chlorosilane M:0780

Molecular Formula: CH_5ClSi
Common Formula: CH_3SiH_2Cl
Synonyms: Chloromethylsilane
CAS Registry Number: 993-00-0
RTECS® Number: VV2150000
UN/NA & ERG Number: UN2534/119
EC Number: 213-600-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥45.00% concentration).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl chlorosilane is a colorless liquid. Flash point = −9°C. NJDHSS (New Jersey Department of Health and Senior Services) Hazard Rating: Health 3, Flammability 4, Reactivity 2W. Reacts with water.

Potential Exposure: Methyl chlorosilane is rarely used as a raw material, but it is released during the manufacture of silicones or siloxanes.

Incompatibilities: May form explosive gases with air. Contact with water, steam, or moisture, forms toxic and corrosive hydrogen chloride gas. Not compatible with strong bases, strong acids, oxidizers. Attacks metals, plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.6 ppm

PAC-1: **1.8** ppm

PAC-2: **22** ppm

PAC-3: **100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: No method available.

Harmful Effects and Symptoms

Short Term Exposure: Methyl chlorosilane can affect you when breathed in. Methyl chlorosilane is a corrosive chemical and can cause severe eye and skin burns. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyl chlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Methyl chlorosilane must be stored to avoid contact with water, steam, and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames, are prohibited where methyl chlorosilane is handled, used, or stored.

Shipping: Methylchlorosilane requires a shipping label of "POISON GAS, FLAMMABLE GAS, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water* or wet method. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Ventilate and wash area (after neutralizing with sodium bicarbonate) after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 2.7/4.3/4.3

Fire Extinguishing: This chemical is a flammable and corrosive liquid. Poisonous gases, including chlorine and phosgene, are produced in fire. *Do not use water.* Use dry chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Methyl Chlorosilane*. Trenton, NJ

Methyl cyanoacrylate M:0790

Molecular Formula: $C_5H_5NO_2$
Common Formula: $CH_2 = C(CN)COOCH_3$

Synonyms: Acrylic acid, 2-cyano-, methyl ester; Adhere®; 2-Cyanoacrylic acid methyl ester; Eastman 910 monomer®; Mecrylate; 2-Propenoic acid, 2-cyano-, methyl ester; Super Bonder®; Super Glue®

CAS Registry Number: 137-05-3

RTECS® Number: AS7000000

UN/NA & ERG Number: UN3334 (Aviation regulated liquid, n.o.s.)/171 (ICOA/IATA)

EC Number: 205-275-2 [*Annex I Index No.:* 607-235-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S2; S23; 24/25; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl cyanoacrylate is a thick, clear liquid adhesive. The odor threshold is 2.2 ppm. Molecular weight = 111.11; Specific gravity (H_2O:1) = 1.10 at 27°C; Boiling point = 47−49°C at 1.8 mmHg; Vapor pressure = 0.2 mmHg at 20°C; Flash point = 78.9°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Primary Irritant. Methyl 2-cyanoacrylate is used in production of coatings and textiles; in the manufacture of quick-setting, high-strength, adhesive cements. Often found around the home; bonds eyes and skin in seconds. *Keep out of the reach of children.*

Incompatibilities: Reacts violently with water, bases, and peroxides. Contact with alcohols, water, amines, and alkalis can cause rapid polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.54 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 2 ppm/8 mg/m^3 TWA; 4 ppm/16 mg/m^3 STEL.

ACGIH TLV®[1]: 0.2 ppm/1 mg/m^3 TWA.

Protective Action Criteria (PAC)
TEEL-0: 0.2 ppm
PAC-1: 4 ppm
PAC-2: 12.5 ppm
PAC-3: 12.5 ppm

DFG MAK: 2 ppm/9.2 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Australia: TWA 2 ppm (8 mg/m^3); STEL 4 ppm, 1993; Austria: MAK 2 ppm (8 mg/m^3), 1999; Belgium: TWA 2 ppm (9.1 mg/m^3); STEL 4 ppm (18 mg/m^3), 1993; Denmark: TWA 2 ppm (8 mg/m^3), 1999; Finland: TWA 2 ppm (9 mg/m^3); STEL 4 ppm (18 mg/m^3), [skin], 1993; France: VME 2 ppm (8 mg/m^3), VLE 4 ppm (16 mg/m^3), 1999; Norway: TWA 2 ppm (8 mg/m^3), 1999; Sweden: NGV 2 ppm (9 mg/m^3), KTV 4 ppm (18 mg/m^3), 1999; Switzerland: MAK-W 2 ppm (9 mg/m^3), 1999; United

Kingdom: STEL 0.3 ppm (1.4 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 ppm. Several states have set guidelines or standards for methyl cyanoacrylate in ambient air[60] ranging from 48 μg/m^3 (Nevada) to 80−160 μg/m^3 (North Dakota) to 130 μg/m^3 (Virginia) to 160 μg/m^3 (Connecticut).

Determination in Air: Use OSHA Analytical Method 55.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl 2-cyanoacrylate can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation of vapor may cause an asthmatic reaction. Contact can irritate the eyes and skin. Capable of instantly gluing skin tissue.

Long Term Exposure: Methyl 2-cyanoacrylate may cause a skin allergy to develop. Once an allergy has developed, even very small future exposures will cause rash and itching. Repeated exposure may affect the liver and kidneys. May be able to cause lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with plenty of soap and water. Remove cured adhesive with hot soapy water. Do not pull or scrape off adhesive as skin can also come off. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA approve self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Methyl 2-cyanoacrylate must be stored to avoid contact with water, alkaline materials or peroxides, since violent reactions occur. Store in original containers under refrigerated conditions at 2−8°C. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: AVIATION REGULATED LIQUID N.O.S. (Cyanoacrylate ester) Air: Packaging instructions (passenger or cargo): 906. Hazard Class 9.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including cyanide and nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Avoid water unless you can flood the area. Water causes methyl 2-cyanoacrylate to polymerize and possibly to ignite spontaneously. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Methyl 2-Cyanoacrylate*. Trenton, NJ

Methylcyclohexane M:0800

Molecular Formula: C_7H_{14}

Common Formula: $C_6H_{11}CH_3$

Synonyms: Cyclohexane, methyl-; Cyclohexylmethane; Heptanaphthene; Hexahydrotoluene; MCH; Sextone B; Toluene hexahydride

CAS Registry Number: 108-87-2

RTECS® Number: GV6125000

UN/NA & ERG Number: UN2296/128

EC Number: 203-624-3 [*Annex I Index No.:* 601-018-00-7]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Xn, N; Risk phrases: R11; R38; R51/53; R38; R65; R67; Safety phrases: S2; S9; S16; S33; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methylcyclohexane, an alkene, is a colorless liquid with a faint benzene-like odor. The odor threshold is 630 ppm (this is above the OEL). Molecular weight = 98.21; Specific gravity (H_2O:1) = 0.77; Boiling point = 101°C; Freezing/Melting point = −127°C; Vapor pressure = 37 mmHg at 20°C; Flash point = −3.9°C (cc), −5.9°C (oc); Autoignition temperature = 258°C. Explosive limits: LEL = 1.2%; UEL = 6.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. Methylcyclohexane is used as a solvent for cellulose derivatives particularly with other solvents and as an organic intermediate in organic synthesis. A component of jet fuel.

Incompatibilities: Forms explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 500 ppm/2000 mg/m^3 TWA.
NIOSH REL: 400 ppm/1600 mg/m^3 TWA.
ACGIH TLV®[1]: 400 ppm/1610 mg/m^3 TWA.
NIOSH IDLH: 1200 ppm [LEL].
Temporary Emergency Exposure Limits (DOE
TEEL-0: 500 ppm
PAC-1: 1200 ppm
PAC-2: 1200 ppm
PAC-3: 1200 ppm

DFG MAK: 200 ppm/810 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 400 ppm (1600 mg/m^3), 1993; Belgium: TWA 400 ppm (1610 mg/m^3), 1993; Denmark: TWA 200 ppm (805 mg/m^3), 1999; Finland: TWA 400 ppm (1600 mg/m^3); STEL 500 ppm (2000 mg/m^3), 1999; France: VME 400 ppm (1600 mg/m^3), 1999; Japan: 400 ppm (1600 mg/m^3), 1999; the Netherlands: MAC-TGG 1600 mg/m^3, 2003; the Philippines: TWA 500 ppm (2000 mg/m^3), 1993; Poland: MAC (TWA) 500 mg/m^3, MAC (STEL) 2000 mg/m^3, 1999; Russia: TWA 400 ppm; STEL 50 mg/m^3, 1993; Switzerland: MAK-W 400 ppm (1600 mg/m^3), KZG-W 800 ppm (3200 mg/m^3), 1999; Turkey: TWA 500 ppm (2000 mg/m^3), 1993; United Kingdom: LTEL 400 ppm (1600 mg/m^3); STEL 500 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 400 ppm. Several states have set guidelines or standards for methyl cyclohexane in ambient air[60] ranging from 16−20 mg/m^3 (North Dakota) to 27 mg/m^3 (Virginia) to 32 mg/m^3 (Connecticut) to 38.095 mg/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36−126°C.[18]

Permissible Concentration in Water: Vermont has set a guideline of 28.6 mg/L for drinking water.[61]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylcyclohexane can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. May affect the central nervous system; exposure may cause dizziness, lightheadedness. High levels may act as an anesthetic. Unconsciousness and death may occur at higher levels. Ingesting the liquid may cause chemical pneumonitis.

Long Term Exposure: Prolonged or repeated skin contact can cause cracking and drying of exposed areas. May affect the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys, liver.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1200 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Methylcyclohexane must be stored to avoid contact with strong oxidizers, (such as chlorine, bromine, chlorine oxide, nitrates and permanganates), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylcyclohexane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methylcyclohexane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylcyclohexane.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Methylcyclohexane*. Washington, DC

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methyl Cyclohexane*. Trenton, NJ

Methylcyclohexanol M:0810

Molecular Formula: $C_7H_{14}O$
Common Formula: $H_3CC_6H_{10}OH$
Synonyms: Hexahydrocresol; Hexahydromethyl phenol; Methylcyclohexanol; Methylcyclohexane
CAS Registry Number: 25639-42-3
RTECS® Number: GW0175000
UN/NA & ERG Number: UN2617/129
EC Number: 247-152-6
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2-Methylcyclohexanol is a straw-colored liquid with a weak, menthol-like odor. The odor threshold is 490 ppm (higher than the OEL). Molecular weight = 114.21; Specific gravity (H_2O:1) = 0.92; Boiling point = 155−180°C (technical grade); Freezing/Melting point = −50°C; Vapor pressure = 2 mmHg at 30°C; Flash point = 65−68°C; Autoignition temperature = 296°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Human Data. Methylcyclohexanol is used as a lacquer solvent, as a blending agent in textile soaps, and as an antioxidant in lubricants.

Incompatibilities: Forms explosive mixture with air. Contact with strong oxidizers may cause fire and explosions. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.67 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 100 ppm/470 mg/m^3 TWA.
NIOSH REL: 50 ppm/235 mg/m^3 TWA.
ACGIH TLV®[1]: 50 ppm/234 mg/m^3 TWA.
NIOSH IDLH: 500 ppm*
*The odor threshold is 490 ppm.
No TEEL available.
DFG MAK: MAK 50 ppm/235 mg/m^3.
Australia: TWA 50 ppm (235 mg/m^3), 1993; Belgium: TWA 50 ppm (234 mg/m^3), 1993; Denmark: TWA 50 ppm (235 mg/m^3), 1999; Finland: TWA 50 ppm (235 mg/m^3); STEL 75 ppm (355 mg/m^3), 1993; France: VME 50 ppm (235 mg/m^3), 1999; Japan: 50 ppm (230 mg/m^3), 1999; Norway: TWA 25 ppm (115 mg/m^3), 1999; the Netherlands: MAC-TGG 50 mg/m^3, [skin], 2003; the Philippines: TWA 100 ppm (470 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3, MAC (STEL) 350 mg/m^3, 1999; Russia: TWA 50 ppm, 1993; Switzerland: MAK-W 50 ppm (235 mg/m^3), KZG-W 100 ppm (470 mg/m^3), 1999; Turkey: TWA 100 ppm (470 mg/m^3), 1993; United Kingdom: LTEL 50 ppm (235 mg/m^3); STEL 75 ppm, 1993; United Kingdom: TWA 50 ppm (237 mg/m^3); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for methyl cyclohexanol in ambient air[60] ranging from 2.35−3.5 mg/m^3 (North Dakota) to 3.9 mg/m^3 (Virginia) to 4.7 mg/m^3 (Connecticut) to 5.595 mg/m^3 (Nevada).

Determination in Air: Charcoal tube; CH_2C_{12}; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1404. See also NIOSH: Methylcyclohexanol Method #S374.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylcyclohexanol can affect you when breathed in and by passing through your skin. Irritates the eyes and the skin. High levels of the vapor may cause irritation of eyes and upper respiratory tract. Repeated or prolonged exposure can cause headaches, irritation of the eyes, nose, and throat, and can also cause a skin rash. High exposures from skin contact or inhalation may cause damage to the heart, liver, kidneys, and lungs, and may result in death.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin rash. Animal studies have shown this chemical to cause liver and kidney damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys, liver.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Methylcyclohexanol must be stored to avoid contact with strong oxidizers (such as peroxides, chlorates, perchlorates, nitrates, and permanganates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where methylcyclohexanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Methyl Cyclohexanol*. Trenton, NJ

2-Methylcyclohexanone M:0820

Molecular Formula: $C_7H_{12}O$

Common Formula: $H_3CC_6H_9O$

Synonyms: Methyl anone; *o*-Methyl-cyclohexanon (German); Methylcyclohexanone; *o*-Methylcyclohexanone; 1-Methylcyclohexan-2-one

CAS Registry Number: 583-60-8

RTECS® Number: GW1750000

UN/NA & ERG Number: UN2297/128

EC Number: 209-513-6 [*Annex I Index No.:* 606-011-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20; Safety phrases: S2; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: *o*-Methylcyclohexanone is a colorless liquid with a weak peppermint-like odor (also reported to be acetone-like). Molecular weight = 112.19; Specific gravity (H_2O:1) = 0.93; Boiling point = 162.7°C; Freezing/Melting point = −13.9°C; Flash point = 47.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Methylcyclohexanone is used as a solvent in making varnish, plastics, and as a rust remover. Also used in the leather industry.

Incompatibilities: Reacts violently with aldehydes, strong oxidizers, strong acids. Contact with peroxides may form unstable heat- and shock-sensitive explosives.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.59 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/460 mg/m^3 TWA [skin].

NIOSH REL: 50 ppm/230 mg/m^3 TWA; 75 ppm/345 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 50 ppm/229 mg/m^3 TWA; 75 ppm/344 mg/m^3 STEL [skin].

NIOSH IDLH: 600 ppm.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 75 ppm

PAC-2: 125 ppm

PAC-3: 600 ppm

DFG MAK: 50 ppm/230 mg/m^3 [skin].

Australia: TWA 50 ppm (230 mg/m^3); STEL 75 ppm, [skin], 1993; Austria: MAK 50 ppm (230 mg/m^3), [skin], 1999; Belgium: TWA 50 ppm (229 mg/m^3); STEL 75 ppm (344 mg/m^3), [skin], 1993; Denmark: TWA 50 ppm (230 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (230 mg/m^3); STEL 75 ppm (345 mg/m^3), [skin], 1999; France: VME 50 ppm (230 mg/m^3), [skin], 1999; Japan: 50 ppm (230 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 230 mg/m^3, [skin], 2003; Norway: TWA 25 ppm (115 mg/m^3), 1999; the Philippines: TWA 100 ppm (460 mg/m^3), [skin], 1993; Poland: MAC (TWA) 50 mg/m^3, MAC (STEL) 340 mg/m^3, 1999; Russia: TWA 50 ppm, 1993; Switzerland: MAK-W 50 ppm (230 mg/m^3), KZG-W 100 ppm (470 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (460 mg/m^3), [skin], 1993; United Kingdom: TWA 50 ppm (237 mg/m^3); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 75 ppm [skin]. Several states have set guidelines or standards[60] for methylcyclohexanone in ambient air ranging from 2.3−3.45 mg/m^3 (North Dakota) to 3.9 mg/m^3 (Virginia) to 4.6 mg/m^3 (Connecticut) to 5.476 mg/m^3 (Nevada).

Determination in Air: Collection in an adsorption tube, workup with acetone; analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #2521.[18]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *o*-Methylcyclohexanone can affect you when breathed in and by passing through your skin. It can irritate the skin, eyes, nose, and throat. Breathing the vapor can cause headaches, dizziness, or lightheadedness. Contact can strongly irritate and even damage the eyes.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis to develop with thickening and cracking. May affect the liver, kidneys, and lungs.

Points of Attack: Skin, respiratory system, liver, kidneys, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* Sa (APF = 10) (any supplied-air respirator). *600 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. *o*-methylcyclohexanone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where *o*-Methylcyclohexanone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material, and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: o-Methylcyclohexanone*. Trenton, NJ

Methyl cyclopentane M:0830

Molecular Formula: C_6H_{12}
Common Formula: $C_5H_9CH_3$
Synonyms: Cyclopentane, methyl-; MCP; Methylcyclopentane; Methylpentamethylene
CAS Registry Number: 96-37-7
RTECS® Number: GY4640000
UN/NA & ERG Number: UN2298/128
EC Number: 202-503-2
Regulatory Authority and Advisory Bodies
WGK (German Aquatic Hazard Class): No value assigned.
Description: Methyl cyclopentane is a colorless liquid with a sweet gasoline-like odor. Molecular weight = 84.18; Boiling point = 72°C; Freezing/Melting point = −142°C; Flash point = −7°C; Autoignition temperature = 258°C. Explosive limits: LEL = 1.0%; UEL = 8.35%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0.
Potential Exposure: This material is used as a solvent, as a fuel, and in chemical synthesis.
Incompatibilities: Strong oxidizers; strong acids.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH: 100 ppm/350 mg/m^3 TWA; STEL 510 ppm/1800 mg/m^3 [15 min]
ACGIH TLV®[1]: 500 ppm/1760 mg/m^3 TWA; 1000 ppm/3500 mg/m^3 STEL
Protective Action Criteria (PAC)
TEEL-0: 4 ppm
PAC-1: 12.5 ppm
PAC-2: 75 ppm
PAC-3: 4000 ppm
DFG MAK: 500 ppm/1800 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.
Determination in Air: Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1500, for Hydrocarbons, BP 36−126°C.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl cyclopentane can affect you when breathed in. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Higher levels can cause death. Exposure can irritate the eyes, nose, and throat. Contact can irritate the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Can cause central nervous system excitement followed by depression.

Long Term Exposure: May cause damage to the nervous system.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to liquid methyl cyclopentane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl cyclopentane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) and strong acids, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where methyl cyclopentane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl cyclopentane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl cyclopentane. Wherever methyl cyclopentane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl cyclopentane is a flammable liquid. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Water may be ineffective on fire. Poisonous gases are produced in fire. Establish forced ventilation to keep levels below explosive limit. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Methyl Cyclopentane*. Trenton, NJ

Methyl dichlorosilane M:0840

Molecular Formula: CH_4Cl_2Si

Common Formula: CH_3SiHCl_2

Synonyms: Dichloromethylsilane; Monomethyl-dichlorosilane; Silane, dichloromethyl-

CAS Registry Number: 75-54-7

RTECS® Number: VV3500000

UN/NA & ERG Number: UN1242/139

EC Number: 200-877-1

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl dichlorosilane is a clear, straw-colored liquid. Molecular weight = 115.04; Boiling point = 41°C; Freezing/Melting point = −91°C; Flash point = −9°C; Autoignition temperature = 316°C. Explosive limits: LEL = 6.0%; UEL = 55.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: This material is used to make siloxanes and other silicone polymer (polysiloxane) materials.

Incompatibilities: Forms explosive mixture with air. Reacts violently with water producing corrosive hydrochloric acid. Methyl dichlorosilane may spontaneously ignite on contact with air (even under inert gas) and on contact with potassium permanganate, lead(II) oxide, copper oxide, silver oxide. Violent reaction with oxidizers. Decomposes on contact with hot surfaces or flames producing toxic and corrosive fumes including silicon oxides, hydrogen chloride, and phosgene. Decomposes on contact with alkaline compounds producing highly flammable hydrogen gas. Corrodes many metals in presence of water. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.3 ppm
PAC-1: **0.90** ppm
PAC-2: **11** ppm
PAC-3: **50** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl dichlorosilane is a corrosive chemical and contact can cause severe eye and skin burns leading to permanent damage. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death.

Long Term Exposure: May cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyl dichlorosilane, use a NIOSH/MSHA- or

European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl dichlorosilane must be stored to avoid contact with water, since violent reactions occur once hydrogen chloride is produced. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl dichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl dichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl dichlorosilane. Wherever methyl dichlorosilane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl dichlorosilane requires a shipping label of “DANGEROUS WHEN WET, CORROSIVE, FLAMMABLE LIQUID.” It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in dry lime, dry sand, soda ash, or a similar material and deposit in sealed containers. Following cleanup, neutralize spill area by flushing with large quantities of water and then treat spill area with sodium bicarbonate. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

When spilled in water

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.6/2.5

Fire Extinguishing: Methyl dichlorosilane is a flammable liquid and may ignite in air. Use dry chemical or CO_2 extinguishers. *Do not use water*. Fire may restart after it has been extinguished. Poisonous gases, including hydrogen chloride, silicon oxides, and phosgene, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See “Spill Handling.”

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Methyl Dichlorosilane*. Trenton, NJ

4,4′- Methylenebis (2-chloroaniline)
M:0850

Molecular Formula: $C_{13}H_{12}Cl_2N_2$

Common Formula: $(C_6H_3ClNH_2)CH_2(C_6H_3ClNH_2)$

Synonyms: Aniline, 4,4′-methylenebis(2-chloro-); Benzenamine, 4,4′-methylenebis(2-chloro-); Bis amine; Bis (4-amino-3-chlorophenyl)methane; Bis(3-chloro-4-aminophenyl) methane; BOCA; Cuamine MT; Curalin M; Curene 442; Cyanaset; DACPM; Diamet KH; Di-(4-amino-3-chlorophenyl)methane; 4,4′-Diamino-3,3′-dichlorodiphenylmethane; 3,3′-Dichloro-4,4′-diaminodiphenylmethan (German); 3,3′-Dichloro-4,4′-diaminodiphenylmethane; MBOCA; Methylenebis(3-chloro-4-aminobenzene); *p,p*′-Methylenebis (α-chloroaniline); *p,p*′-Methylenebis(*o*-chloroaniline); 4,4′-Methylene(bis)-chloroaniline; 4,4′-Methylenebis(*o*-chloroaniline); Methylene-4,4′-bis(*o*-chloroaniline); 4,4′-Methylenebis-2-chlorobenzenamine; 4,4′-Methylenebis (2-chloro-benzeneamine); Methylenebis(*o*-chloroaniline); *p,p*′-Metilenbis(*o*-cloroanilina) (Spanish); Millionate M; MOCA; Quodorole

CAS Registry Number: 101-14-4; *(alt.)* 29371-14-0; *(alt.)* 51065-07-7; *(alt.)* 78642-65-6

RTECS® Number: CY1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-918-9 [*Annex I Index No.*: 612-078-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, Group 2A, 1993; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; Mammalian micronucleus; Positive: Histidine reversion—Ames test; Positive/dose response: Cell transform.—BALB/c-3T3.

Banned or Severely Restricted (Sweden) (UN).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U158.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.50; Nonwastewater (mg/kg), 30.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 7/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4,4′-Methylenebis (2-chloroaniline) is a yellow to light gray-tan pellet and is also available in liquid form. Molecular weight = 267.17; Specific gravity (H_2O:1) = 1.44; Freezing/Melting point = 99−110°C; Vapor pressure = 0.00001 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. 4,4′-Methylenebis(2-chloroaniline) is used as a curing agent in the polyurethane industry for isocyanate containing polymers and in the production of solid elastomeric parts. Other uses are in the manufacture of cross-linked urethane foams used in automobile seats and safety padded dashboards; it is also used in the manufacture of gun mounts, jet engine turbine blades, radar systems, and components in home appliances.

Incompatibilities: Reacts with chemically active metals (e.g., potassium, sodium, magnesium, and zinc). May ignite on contact with cellulose nitrate of high-surface area. Incompatible with acrolein, acrylonitrile, *tert*-butyl nitroacetylene, ethylene oxide, isopropyl chlorocarbonate, maleic anhydride, triisobutylaluminum.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.003 mg/m^3 TWA [skin]; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 ppm/0.11 mg/m^3 TWA; Suspected Human Carcinogen [skin] BEI issued.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 1 ppm

PAC-2: 7.5 ppm

PAC-3: 40 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 0.02 ppm (0.22 mg/m^3), [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.02 ppm (0.22 mg/m^3), [skin], carcinogen, 1993; Finland: TWA 0.02 ppm (0.2 mg/m^3); STEL 0.06 ppm, [skin], 1993; Finland: TWA 0.02 ppm (0.2 mg/m^3); STEL 0.06 ppm, carcinogen, 1999; France: VME 0.02 ppm (0.22 mg/m^3), carcinogen, 1999; Japan: 0.005 mg/m^3, [skin], 2A carcinogen, 1999; the Netherlands: MAC-TGG 0.02 mg/m^3, 2003; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.0 mg/m^3, carcinogen, 1999; United Kingdom: TWA 0.005 mg/m^3, [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for MOCA in ambient air[60] ranging from zero (Nevada and North Dakota) to 0.015 $\mu g/m^3$ (Connecticut) to 0.55 $\mu g/m^3$ (Pennsylvania) to 1.0 $\mu g/m^3$ (Rhode Island) to 2.2 $\mu g/m^3$ (Virginia).

Determination in Air: Use NIOSH Analytical Method #8302, MBOCA in urine; OSHA Analytical Method 24; ID-71.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.94.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: 4,4′-Methylenebis(2-chloroaniline) can affect you when breathed in and by passing through your skin. 4,4′-Methylenebis(2-chloroaniline) is a carcinogen; handle with extreme caution. Exposure can interfere with the ability of the blood to carry oxygen causing headaches, dizziness, nausea, and a bluish color to the skin and lips. High levels can cause trouble breathing, collapse, and death. Contact can irritate the eyes. High or repeated exposures may affect the kidneys, cause a low blood count, and cause bloody urine.

Long Term Exposure: May cause methemoglobinemia, anemia, kidney irritation. A potential occupational carcinogen. May affect the kidneys.

Points of Attack: Liver, blood, kidneys. Cancer site in animals: liver, lung, and bladder tumors.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level. Complete blood count. Kidney function tests. Preplacement and periodic examinations should include a history of exposure to other carcinogens, alcohol and smoking habits, use of medications, and family history. Special attention should be given to liver size and function and to any changes in lung symptoms or X-rays.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: Saranex™ coated suits, Barricade™ coated suits. **4 h**: 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. 4,4′-Methylenebis(2-chloroaniline) must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of “POISONOUS/TOXIC MATERIALS.” They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including chlorine and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Lunch, A. L., O'Connor, G. B., Barnes, J. R., Killian, A. S., Jr., & Neeld, W. E., Jr. (1971). Methylene-bis-ortho-chloroaniline (MOCA): Evaluations of hazards and exposure control. *American Industrial Hygiene Association Journal*, 32, 802

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: 4,4′-Methylenebis(2-Chloroaniline)*. Trenton, NJ

Methylenebis(4-cyclohexyl isocyanate) M:0860

Molecular Formula: $C_{15}H_{22}N_2O_2$

Common Formula: $OCNC_6H_{10}CH_2C_6H_{10}NCO$

Synonyms: Bis(4-isocyanatocyclohexyl)methane; Dicyclohexylmethane 4,4′-diisocyanate; DMDI; HMDI; Hydrogenated MDI; Nacconate H 12; Reduced MDI; Saturated MDI

CAS Registry Number: 5124-30-1

RTECS® Number: NQ9250000

UN/NA & ERG Number: Not regulated

EC Number: 225-863-2 [*Annex I Index No.*: 615-009-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23; R36/37/39; R42/43; Safety phrases: S1/2; S26; S28; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: DMDI is a clear, colorless to light-yellow liquid. Molecular weight = 262.39; Specific gravity (H_2O:1) = 1.07 at 25°C; Freezing/Melting point = 19−23°C; Vapor pressure = 0.001 mmHg at 20°C; Flash point ≥202°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water; reactive.

Potential Exposure: Compound Description: Primary Irritant. Those involved in the manufacture of this compound or its use in the production of light-stable, non-yellowing polyurethane resins.

Incompatibilities: Violent reaction with alcohols, glycols. May slowly polymerize if heated above 122°F/50°C. Incompatible with moisture, heat, air, amines, amides, strong alkalis, and chemically active metals. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.73 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.01 ppm/0.11 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.005 ppm/0.054 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.005 ppm

PAC-1: 0.005 ppm

PAC-2: 0.01 ppm

PAC-3: 0.15 ppm

Belgium: TWA 0.005 ppm (0.054 mg/m^3), 1993; Denmark TWA 0.005 ppm (0.054 mg/m^3), 1999; Norway: TWA 0.005 ppm (0.05 mg/m^3), 1999; Sweden: TWA 0.005 ppm; STEL 0.01 ppm, 1999; United Kingdom: TWA 0.02 mg (NCO)/m^3; STEL 0.07 mg[NCO]/m^3, 2000; the Netherlands: MAC 0.1 1 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.005 ppm. Several states have set guidelines or standards for ambient air[60] ranging from 0.8 μg/m^3 (Virginia) to 1.1 μg/m^3 (North Dakota) to 0−3.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5525; OSHA Analytical Method PV-2092.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylene bis(4-cyclohexylisocyanate) can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs, causing a buildup of fluid (pulmonary edema). This can cause death. Contact can irritate and burn the eyes, causing permanent damage. Skin contact can cause blisters.

Long Term Exposure: Methylenebis(4-cyclohexylisocyanate) can cause an asthma-like allergy to develop. Future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Repeated exposures may permanently damage the lungs.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal at first if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.1 ppm:* Sa (APF = 10) (any supplied-air respirator).* *Up to 0.25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode.)* *Up to 0.5 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Methylene bis(4-cyclohexylisocyanate) must be stored to avoid contact with alcohols, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, heat, air, amines, strong bases, and chemically active metals.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Dampen spilled solid material with 60−70% ethanol to avoid airborne dust. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material, and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylene bis(4-cyclohexylisocyanate) may burn, but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers. Poisonous gases, including hydrogen cyanide, ammonia, nitriles, and oxides of nitrogen, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Methylene bis(4-Cyclohexylisocyanate)*. Trenton, NJ

4,4′-Methylenebis(*N,N*-dimethyl) aniline M:0870

Molecular Formula: $C_{17}H_{22}N_2$

Common Formula: $(CH_3)_2N\text{-}C_6H_4\text{-}CH_2\text{-}C_6H_4\text{-}N(CH_3)_2$

Synonyms: Aniline, 4,4′-methylenebis(*N,N*-dimethyl)-; Arnold's base; *tetra* Base; Benzenamine, 4,4′-methylenebis-(*N,N*-dimethyl-); *p,p*′-Bis(dimethylamino)diphenylmethane; 4,4′-Bis(dimethylamino)diphenylmethane; 4,4′-Bis(dimethylaminophenyl)methane; Bis[*p*-(*N,N*-dimethylamino)phenyl] methane; Bis[*p*-(dimethylamino)-phenyl]methane; Bis[4-(*N,N*-dimethylamino)-phenyl]methane; Bis[4-(dimethylamino) phenyl]methane; 4,4′-Methylene bis(*N,N*-dimethylaniline); Michler's base; Michler's hydride; Michler's methane; NCII-C01990; Reduced Michler's ketone; *N,N,N*′,*N*′-Tetramethyl-*p,p*′-diaminodiphenyl-methane; *N,N,N*′,*N*′-Tetramethyl-4,4′-diaminodiphenyl-methane; *p,p*′-Tetramethyldiamino-diphenylmethane; 4,4′-Tetramethyldiaminodiphenylmethane; Tetramethyldiamino-diphenylmethane

CAS Registry Number: 101-61-1

RTECS® Number: BY5250000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 202-959-2 [*Annex I Index No.*: 612-201-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/81.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4,4′-Methylenebis(*N,N*-dimethyl)benzenamine is a yellow crystalline compound. Molecular weight = 254.41; Boiling point = 390°C; Freezing/Melting point = 90−91°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: 4,4′-methylenebis(N,N-dimethyl) benzenamine is used as an intermediate in dye manufacture and as an analytical reagent in the determination of lead.

Incompatibilities: Strong acids, oxidizers, acid chlorides, acid anhydrides.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: Carcinogen Category 2.

The state of North Dakota has set a guideline of zero concentration for ambient air.[60]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: 4,4′-Methylenebis(*N,N*′-dimethyl) aniline can affect you when breathed in and by passing through your skin. 4,4′-Methylenebis(*N,N*-dimethyl)aniline is a carcinogen; handle with extreme caution. High exposure can interfere with the ability of the blood to carry oxygen (a condition called methemoglobinemia). This can cause headaches, dizziness, weakness, and a bluish color to the skin and lips. Higher levels can cause trouble breathing, collapse, and death.

Long Term Exposure: May be a carcinogen. It has been shown to cause liver and thyroid cancer in animals.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Methylenebis(*N,N*-dimethyl)benzenamine. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Respirator Selection: At any exposure level, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air-respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. 4,4′-Methylenebis(*N*,*N*-dimethyl)benzenamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s. require the label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group 1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol, or polymer foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: 4,4′-Methylenebis(N,N-Dimethyl)Benzenamine*. Trenton, NJ

Methylenebis(phenyl-isocyanate)

M:0880

Molecular Formula: $C_{15}H_{10}N_2O_2$
Common Formula: $OCNC_6H_4CH_2C_6H_4NCO$

Synonyms: AI3-15256; Benzene, 1,1′-methylenebis(4-isocyanato-); Bis(*p*-isocyanatophenyl)methane; Bis(1,4-isocyanatophenyl)methane; Bis(4-isocyanatophenyl) methane; Caradate 30; Desmodur 44; 4,4′-Diisocyanatodiphenylmethane; Di-(4-isocyanatophenyl)methane; *p*,*p*′-Diphenylmethane diisocyanate; 4,4′-Diphenylmethane diisocyanate; Diphenyl methane diisocyanate; Diphenylmethane *p*,*p*′-diisocyanate; Diphenylmethane 4,4′-diisocyanate; Diphenylmethane diisocyanate; Hylene M-50; Isocyanic acid, ester with diphenylmethane; Isocyanic acid, methylenedi-*p*-phenylene ester; Isonate 125M; Isonate 125 MF; MDI; MDR; Methyl bisphenylisocyanate; 1,1′-Methylenebis(4-isocyanatobenzene); 1,1-Methylenebis(4-isocyanatobenzene); Methylenebis(4-isocyanatobenzene); Methylenebis(*p*-phenylene isocyanate); Methylenebis(4-phenylene isocyanate); *p*,*p*′-Methylenebis (phenylisocyanate); 4,4′-Methylenebis(phenylisocyanate); Methylene bis(4-phenylisocyanate); Methylene bisphenylisocyanate; Methylenebis(*p*-phenylisocyanate); Methylenebis (4,4′-phenylisocyanate); Methylenebis(4-phenylisocyanate); 4,4′-Methylenedi(phenyldiisocyanate); 4,4′-Methylenedi-*p*-phenylene diisocyanate; Methylenedi(*p*-phenylene diisocyanate); Methylenedi-*p*-phenylene diisocyanate; 4,4′-Methylenedi(phenylene isocyanate); Methylene di(phenylene isocyanate); Methylenedi(*p*-phenylene isocyanate); Methylenedi-*p*-phenylene isocyanate; 4,4′-Methylene diphenylisocyanate; Metilenbis(fenilisocianato) (Spanish); Nacconate 300; NCI-C50668; Rubinate 44

CAS Registry Number: 101-68-8

RTECS® Number: NQ9350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; 3082/171

EC Number: 202-966-0 [*Annex I Index No.:* 615-005-01-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Data, animal No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20; R36/37/38; R40;R42/43; R48/20; Safety phrases: S1/2; S23; S23; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MDI is a white to light-yellow, odorless flakes. A liquid above 37°C. Molecular weight = 250.27; Specific gravity (H_2O:1) = 1.23 (solid at 25°C); 1.19 (liquid at 50°C); Boiling point = 313.9°C at 5 mmHg; Freezing/

Melting point = 37.2°C; Vapor pressure = 0.0000005 mmHg at 20°C; Flash point = 198.9°C (cc); Autoignition temperature = 240°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Slightly soluble in water (reaction).

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. MDI is used in the production of polyurethane foams and plastics, polyurethane coatings, elastomers, and thermoplastic resins.

Incompatibilities: Violent reaction with oxidizers, strong alkalis, acids, alcohols, ammonia, amines, amides, glycols, caprolactum. Unstable above 100°F/38°C. Polymerizes at temperatures above 204°C. Reacts readily with water to form insoluble polyureas. Attacks some plastics, rubber, and coatings. Reacts with moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.24 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.02 ppm/0.2 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.005 ppm/0.05 mg/m^3 TWA; 0.2 mg/m^3/ 0.020 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 0.005 ppm TWA, measured as inhalable fraction and vapor [skin]; BEI_A issued as Acetylcholinesterase-inhibiting pesticides.

NIOSH IDLH: 75 mg/m^3.

Protective Action Criteria (PAC)*

TEEL-0: 0.051 mg/m^3

PAC-1: **0.2** mg/m^3

PAC-2: **2** mg/m^3

PAC-3: **2.5** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.05 mg/m^3, inhalable fraction; danger of sensitization of the airways and skin; Peak Limitation Category I(1); a momentary value of 0.1 mg/m^3 should not be exceeded; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 10 μg[4,4′-Diaminodiphenylmetane]/dL creatinine in urine/end-of-shift.

Austria: MAK 0.005 ppm (0.05 mg/m^3), Suspected: carcinogen, 1999; Belgium TWA 0.005 ppm (0.051 mg/m^3); STEL 0.02 ppm, 1993; Denmark TWA 0.005 ppm (0.05 mg/m^3), 1999; France: VME 0.01 ppm (0.1 mg/m^3), VLE 0.02 ppm (0.2 mg/m^3), 1999; Hungary TWA 0.05 mg/m^3; STEL 0.1 mg/m^3, 1993; Japan 0.05 mg/m^3, 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, 2003; the Philippines: TWA 0.02 ppm (0.2 mg/m^3), 1993; Poland: MAC (TWA) 0.05 mg/m^3, MAC 0.2 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3 [skin] 1993; Sweden: NGV 0.005 ppm, TGV 0.01 ppm, 1999; Switzerland: MAK- week 5 ppm (15 mg/m^3); STEL 25 ppm (75 mg/m^3), 1999; Thailand TWA 0.02 ppm (0.2 mg/m^3), 1993; United Kingdom TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.005 ppm. Several states have set guidelines or standards for MDI in ambient air[60] ranging from 0.2 μg/m^3 (Rhode Island) to 0.67 μg/m^3 (New York) to 1.0 μg/m^3 (Connecticut) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (North Dakota and South Carolina) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5521, #5522, #5525; OSHA Analytical Method 18, 33, 47.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* A lacrimator. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Vapors are irritating at 0.001−0.026 ppm and may cause shortness of breath, asthma, sore throat, coughing, wheezing, chest tightness, depression, headache, nasal discharge, and insomnia. May cause allergic respiratory reactions. Symptoms may be delayed up to 8 h after exposure. *Skin:* Causes irritation, redness, and pain. May cause a rash. Irritation begins at levels of 0.05−0.1 ppm. May adhere firmly to skin. Attempts to remove it may increase or produce irritation. *Eyes:* Irritation at 0.05−0.1 ppm causing redness, pain, and blurred vision. *Ingestion:* Causes abdominal spasms and vomiting.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated or prolonged inhalation exposure may cause asthma-like allergy. Prolonged exposure may lead to permanent breathing or respiratory problems.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); red blood cells/count; sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Evaluation by a qualified allergist. Preplacement and periodic medical examinations should include chest X-ray, pulmonary function tests, and an evaluation of any respiratory disease or history of allergy. Periodic pulmonary function tests may be useful in detecting the onset of pulmonary sensitization.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Responder™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *0.5 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBA (any self-contained breathing apparatus). *1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *2.5 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *75 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store at temperatures indicated on labels, separately from acids, bases, amines, alcohols and ammonia, and with ventilation along the floor. Since MDI will react with moisture in the air, the storage area should be a dry place, away from all sources of fire or ignition.

Shipping: Toxic solids, organic, n.o.s. compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use carbon dioxide, dry chemical, or halons. In case of large fires, water spray may be used to cool drums, taking care to prevent direct contact between water and MDI. Poisonous gases, including nitrogen oxides and hydrogen cyanide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

New York State Department of Health. (May 1986). *Chemical Fact Sheet 4,4′-Methylene Diphenyl Diisocyanate*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency. (June 28, 1984). *Chemical Hazard Information Profile: Methylene Diphenyl Diisocyanate*. Washington, DC: Office of Toxic Substances

Methylene bromide M:0890

Molecular Formula: CH_2Br_2

Synonyms: Bromuro de metileno (Spanish); Dibromomethane; Methane, dibromo-; Methylene dibromide

CAS Registry Number: 74-95-3

RTECS® Number: PA7350000

UN/NA & ERG Number: UN2664/160

EC Number: 200-824-2 [*Annex I Index No.:* 602-003-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U068.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 15.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (15); 8240 (5).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20; R52/53; Safety phrases: S2; S24; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methylene bromide is a colorless liquid with a sweet, pleasant odor. Molecular weight = 173.85; Boiling point = 96−97°C; Freezing/Melting point = −53°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Mutagen; Human Data. Methylene bromide is used as a solvent and as a chemical intermediate.

Incompatibilities: Mixture with potassium forms a shock-sensitive explosive. Incompatible with oxidizers, aluminum, magnesium. The substance decomposes on contact with hot surfaces producing hydrogen bromide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 30 ppm

PAC-2: 200 ppm

PAC-3: 1250 ppm

Russia: STEL: 10 mg/m^3, 1993.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Methylene bromide can affect you when breathed in. Contact can irritate the eyes and skin. May affect the nervous system and blood, resulting in impaired functions and formation of carboxyhemoglobinemia. Exposure can cause you to feel dizzy, lightheaded and to pass out. High levels can cause death. Methylene bromide can cause the heart to beat irregularly or stop. This can cause death.

Long Term Exposure: Repeated skin contact can cause dryness and itching; removal of the skin's natural oils. May cause liver and kidney damage.

Points of Attack: Blood, kidneys, liver, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Serum bromine level. Carboxyhemoglobin level. Holter monitor (a special 24-h EKG to look for irregular heartbeat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methylene bromide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed container in a well-ventilated area away from potential high heat sources. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a

hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylene bromide may burn but does not readily ignite. Poisonous gases, including bromine and bromide, are produced in fire. Use dry chemical, carbon dioxide, alcohol, or polymer foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report,* 7, No. 2, 48–50

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methylene Bromide*. Trenton, NJ

Methylene chloride M:0900

Molecular Formula: CH_2Cl_2

Synonyms: Aerothene MM; Chlorure de methylene (French); Cloruro de metileno (Spanish); DCM; Dichloromethane; Diclorometano (Spanish); Freon 30; Methane, dichloro-; Methane dichloride; Methylene bichloride; Methylene dichloride; Narkotil; NCI-C50102; R 30; Solaesthin; Solmethine

CAS Registry Number: 75-09-2

RTECS$^{®}$ Number: PA8050000

UN/NA & ERG Number: UN1593/160

EC Number: 200-838-9 [*Annex I Index No.:* 602-004-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Positive: Histidine reversion—Ames test; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; Negative: *D. melanogaster* sex-linked lethal; OSHA Regulated carcinogen; NIOSH suspected human carcinogen; See *NIOSH Pocket Guide*, Appendix A.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U080.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Safe Drinking Water Act: Regulated chemical (47 FR 9352); MCL, 0.005 mg/L; MCLG, zero.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.089; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 4/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R40; Safety phrases: S2; S23; S24/25; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Methylene chloride is a nonflammable, colorless liquid with a chloroform-like odor. A gas above 40°C/104°F. The odor is noticeable at 250 ppm. However, this level substantially exceeds the OSHA STEL and must not be relied upon as an adequate warning of unsafe concentrations. Molecular weight = 84.93; Specific gravity (H_2O:1) = 1.33; Boiling point = 40°C; Freezing/Melting point = −95°C; Relative vapor density (air = 1) = 2.91; Vapor pressure = 350 mmHg; Autoignition temperature = 556°C. Explosive limits: LEL = 13%; UEL = 23%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive

Effector; Human Data; Primary Irritant. Methylene chloride is used mainly as a low-temperature extractant of substances which are adversely affected by high temperature. It can be used as a solvent for oil, fats, waxes, bitumen, cellulose acetate, and esters. It is also used as a paint remover, as a degreaser, and in aerosol propellants.

Incompatibilities: Incompatible with strong oxidizers, caustics, chemically active metals, such as aluminum, magnesium powders, potassium, lithium, and sodium, and concentrated nitric acid causing fire and explosion hazard. Contact with hot surfaces or flames causes decomposition producing fumes of hydrogen chloride and phosgene gas. Attacks some forms of plastics, rubber, and coatings. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.47 mg/m^3 at 25°C & 1 atm.

OSHA PEL 25 ppm TWA; 125 ppm STEL, a potential occupational carcinogen, see 29CFR1910.1052; for Construction see 56FR57036.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 50 ppm/174 mg/m^3 TWA; BEI: 0.2 mg [dichloromethane]/L in urine/end-of-shift; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: potential occupational carcinogen, 2300 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 25 ppm

PAC-1: **200** ppm

PAC-2: **560** ppm

PAC-3: **6900** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 100 ppm/350 mg/m^3; BAT: 5% [CO-Hb] in blood, at end-of-shift; 1 mg[dichloromethane]/L in blood/end-of-shift; Carcinogen Category 3A.

Australia: TWA 100 ppm (350 mg/m^3), carcinogen, 1993; Austria: MAK 100 ppm (360 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (174 mg/m^3), carcinogen, 1993; Denmark: TWA 35 ppm (122 mg/m^3), [skin], 1999; Finland: TWA 100 ppm (350 mg/m^3); STEL 250 ppm (870 mg/m^3), 1999; France: VME 50 ppm (180 mg/m^3), VLE 100 ppm, continuous carcinogen, 1999; Hungary: STEL 10 mg/m^3, carcinogen, 1993; the Netherlands: MAC-TGG 350 mg/m^3, 2003; Norway: TWA 35 ppm (125 mg/m^3), 1999; the Philippines: TWA 500 ppm (1740 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; STEL 50 mg/m^3, 1999; Russia: TWA 100 ppm; STEL 50 mg/m^3, 1993; Sweden: NGV 35 ppm (120 mg/m^3), KTV 70 ppm (250 mg/m^3), [skin] 1999; Switzerland: MAK-W 100 ppm (360 mg/m^3), KZG-W 500 ppm (1800 mg/m^3), 1999; Thailand: TWA 500 mg/m^3; STEL 1000 mg/m^3, 1993; Turkey: TWA 500 ppm (1740 mg/m^3), 1993; United Kingdom: TWA 100 ppm (350 mg/m^3); STEL 300 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans; the Czech Republic: TWA 500 mg/m^3; Standards for methylene chloride in ambient air in residential areas have been set by Russia[43] at 8.8 mg/m^3 on a momentary basis and by the Czech Republic[35] at 3.0 mg/m^3 on a momentary basis and 1.0 mg/m^3 on a daily average basis. Several states have set guidelines or standards for methylene chloride in ambient air[60] ranging from 0.2 μg/m^3 (Rhode Island) to 2.4 μg/m^3 (Massachusetts and North Carolina) to 55.55 μg/m^3 (Kansas) to 1,167 μg/m^3 (New York) to 3500 μg/m^3 (South Dakota) to 3500−17,400 μg/m^3 (North Dakota) to 58,000 μg/m^3 (Virginia) to 7000 μg/m^3 (Connecticut) to 8333 μg/m^3 (Pennsylvania) to 8700 μg/m^3 (Indiana) to 8750 μg/m^3 (South Carolina).

Determination in Air: *Use* NIOSH Analytical Method #1005, Methylene chloride; #3800, Organic and Inorganic Gases, #2549, Volatile organic compounds; OSHA Analytical Methods 59 and 80.

Permissible Concentration in Water: *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L.[6] A lifetime health advisory could not be calculated by EPA.[48] Several states have set standards and guidelines for methylene chloride in drinking water[61] ranging from standards of 2 μg/L (New Jersey) to 100 μg/L (New Mexico) and guidelines of 4.7 μg/L (Arizona) to 25 μg/L (Connecticut) to 40 μg/L (California) to 48 μg/L (Minnesota and Vermont) to 50 μg/L (Kansas) to 150 μg/L (Maine). Russia set a MAC[35] of 7.5 mg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography, plus mass spectrometry (EPA Method #624). Octanol−water coefficient: Log K_{ow} = 1.25

Routes of Entry: Inhalation of vapors, percutaneous absorption of liquid, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the blood, causing the formation of methemoglobin and carboxyhemoglobin. Exposure can cause irregular heartbeat or cause heart to stop. This can cause death. *Inhalation:* Levels of 300−700 ppm for 3−5 hours has caused slight loss of muscle control and coordination. Effects of high concentrations include headaches, stupor, dizziness, fatigue, drunken behavior, chest pain, arm and leg pains, loss of feeling, loss of appetite, hot flashes and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Contact is painful and highly irritating if confined on the skin by gloves or clothing. Absorbed slowly through the skin to cause symptoms listed under inhalation. *Eyes:* May cause pain, irritation, burns, and permanent damage. *Ingestion:* The liquid may cause chemical pneumonitis. Accidental ingestion of paint removers containing methylene chloride as the main ingredient have reportedly caused headache, nausea, vomiting, visual disturbance, presence of blood in the urine, and unconsciousness.

Note: Methylene chloride is changed to carbon monoxide in the human body. This is a particularly hazardous condition for those who have a history of heart trouble or those who are also exposed to carbon monoxide. See "Carbon monoxide" Fact Sheet. These persons should take extra precautions.

Long Term Exposure: Repeated or prolonged skin contact may cause drying and cracking. May be carcinogenic to humans. It has been shown to cause liver and lung cancer in animals. May affect the central nervous system and liver, causing degenerative brain disease and enlargement of the liver. See symptoms as above. Prolonged exposure can cause changes in blood, hallucinations, and decreased response to visual and auditory stimulation. Most of the effects will disappear after exposure stops. Methylene chloride caused genetic effects in certain bacteria and caused birth defects in chickens. In laboratory studies, methylene chloride has also been shown to cause tumors in mice and rats. Whether methylene chloride causes birth defects or tumors in humans is not known.

Points of Attack: Eyes, skin, cardiovascular system, central nervous system. Cancer site in animals: lung, liver, salivary and mammary gland.

Medical Surveillance: OSHA mandates the following tests: laboratory surveillance; carboxyhemoglobin; electrocardiogram (resting); hematocrit; liver function tests; cholesterol level. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), carboxyhemoglobin; whole blood (chemical/metabolite), carboxyhemoglobin, end-of-shift; whole blood (chemical/metabolite), carboxyhemoglobin, prior to next shift; whole blood (chemical/metabolite), end-of-shift; complete blood count; expired air, expired air, end-of-shift; liver function tests; urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heartbeat. Blood carboxyhemoglobin (this must be done within a few hours after exposure). Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves, Responder™ suits, Trellchem™ HPS suits; Trychem 1000™ suits. **4 h**: Teflon™ gloves, suits, boots; Barricade™ coated suits 4,4′-Methylenedianiline 101-77-9 Prevent skin contact. **8 h**: 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methylene chloride must be stored to avoid contact with strong oxidizers (such as perchlorates, peroxides, chlorates, nitrates, or permanganates), strong caustics, and chemically active metals (such as aluminum, magnesium powder, sodium, potassium, or lithium) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is not combustible, but may form a flammable mixture with air. Use an extinguishing agent suitable for surrounding fire. Poisonous gases, including carbon monoxide, hydrogen chloride, and phosgene, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Methylene Chloride*. NIOSH Document No. 76-138

US Environmental Protection Agency. (1980). *Halomethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Dichloromethane, Health and Environmental Effects Profile No. 74*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report,* 1, No. 2, 45−47 (1980) and 6, No. 5, 51−52 (1986)

US Public Health Service. (December 1987). *Toxicological Profile for Methylene Chloride*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Methylene Chloride*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Methylene Chloride*. Trenton, NJ

Methyl ethyl ether M:0910

Molecular Formula: C_3H_8O

Synonyms: Ether, ethyl methyl; Ethane, methoxy-; Ethyl methyl ether; Methane, ethoxy; Methoxyethane

CAS Registry Number: 540-67-0

RTECS® Number: KO0260000

UN/NA & ERG Number: UN1039/115

EC Number: None found.

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl Ethyl Ether is a colorless liquid or gas at room temperature. Molecular weight = 60.11; Boiling point = 11°C; Flash point = − 37°C; Autoignition temperature = 190°C. Explosive limits: LEL = 2.0%; UEL = 10.1%; Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1. Soluble in water.

Potential Exposure: Used as a medicine and as an anesthetic.

Incompatibilities: Violent reaction with strong oxidizers, sulfuric and nitric acids. May be able to form explosive peroxides on standing.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the skin, eyes, and nose. Inhalation can cause lightheadedness and can reduce concentration. Higher levels of exposure may cause unconsciousness and even death.

Long Term Exposure: Repeated contact may cause skin dryness and cracking. Prolonged high exposure may affect the brain.

Points of Attack: Brain, skin.

Medical Surveillance: Evaluate for brain effect, such as memory, concentration, sleeping patterns and mood, headache, and fatigue. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with methyl ethyl ether you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Ethyl methyl ether requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Liquid:* This chemical is a combustible liquid. Poisonous gases are produced in fire. Use alcohol foam extinguishers. Water may not be effective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methyl Ethyl Ether*. Trenton, NJ

Methyl ethyl ketone M:0920

Molecular Formula: C_4H_8O

Common Formula: $CH_3COCH_2CH_3$

Synonyms: Acetone, methyl-; Aethylmethylketon (German); Butanone; 2-Butanone; Butanone 2 (French); Ethyl methyl cetone (French); Ethyl methyl ketone; MEK; Methyl acetone; Methyl ketone; Ketone, ethyl methyl; Meetco; Metil etil cetona (Spanish)

CAS Registry Number: 78-93-3

RTECS® Number: EL6475000

UN/NA & ERG Number: UN1193/127

EC Number: 201-159-0 [*Annex I Index No.:* 606-002-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.; US EPA Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U159.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 200.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.28; Nonwastewater (mg/kg), 36.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (10); 8240 (100).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313: Removed from the TRI list 2004 as a result of a court decision.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36; R66; R67; Safety phrases: S2; S9; S16 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MEK is a clear, colorless liquid with a fragrant, mint-like, moderately sharp odor. The odor threshold in air is 5.4 ppm. Molecular weight = 72.12; Specific gravity (H_2O:1) = 0.81; Boiling point = 79.4°C; Freezing/Melting point = −86.1°C; Vapor pressure = 78 mmHg at 20°C; Flash point = −9°C (cc); Autoignition temperature = 505°C. Explosive limits: LEL = 1.4% at 93°C; UEL = 11.4% at 93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water; solubility = 28%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. MEK is used as a solvent in nitrocellulose coating and vinyl film manufacture; in smokeless powder manufacture; in cements and adhesives; and in the dewaxing of lubricating oils. It is also an intermediate in drug manufacture.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers, amines, ammonia, inorganic acids, caustics, isocyanates, pyridines. Incompatible with potassium *tert*-butoxide, 2-propanol, chlorosulfonic acid, oleum. Attacks some plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.95 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/590 mg/m^3 TWA.

NIOSH REL: 200 ppm/590 mg/m^3 TWA; 300 ppm/885 mg/m^3 STEL.

ACGIH TLV®[1]: 200 ppm/590 mg/m^3 TWA; 300 ppm/885 mg/m^3 STEL.

NIOSH IDLH: 3000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 200 ppm.

PAC-1: 200 ppm.

PAC-2: 2700 ppm.

PAC-3: 4000 ppm.

DFG MAK: 200 ppm/590 mg/m^3 [skin]; Peak Limitation Category I(1); Pregnancy Risk Group C; BAT: 5 mg/m^3 in urine, at end-of-shift.

Australia: TWA 150 ppm (445 mg/m^3); STEL 300 ppm, 1993; Austria: MAK 200 ppm (590 mg/m^3), 1999; Belgium: TWA 200 ppm (590 mg/m^3); STEL 300 ppm (885 mg/m^3), 1993; Denmark: TWA 50 ppm (145 mg/m^3), [skin], 1999; Finland: STEL 100 ppm, 1993; France: VME 200 ppm (600 mg/m^3), 1999; Hungary: TWA 200 mg/m^3; STEL 600 mg/m^3, 1993; India: TWA 200 ppm (590 mg/m^3); STEL 300 ppm (885 mg/m^3), 1993; the Netherlands: MAC-TGG 590 mg/m^3, [skin], 2003; Norway: TWA 75 ppm (220 mg/m^3), 1999; the Philippines: TWA 200 ppm (590 mg/m^3), 1993; Poland: MAC (TWA) 200 mg/m^3, MAC (STEL) 850 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 200 mg/m^3, 1993; Sweden: NGV 50 ppm (150 mg/m^3), KTV 100 ppm (300 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (590 mg/m^3), KZG-V 400 ppm (1180 mg/m^3), 1999; Turkey: TWA 200 ppm (590 mg/m^3), 1993; United Kingdom: TWA 200 ppm (600 mg/m^3), STE 300 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 300 ppm. The Czech Republic: (ambient air in residential areas) have been set[35] at 0.3 mg/m^3 on a momentary and a daily average basis; Russia (in ambient air in residential areas): 0.1 mg/m^3 on a momentary basis. Several states have set guidelines or standards for methyl ethyl ketone in ambient air[60] ranging from 0.16 mg/m^3 (Massachusetts) to 1.967 mg/m^3 (New York) to 3.7−88.5 mg/m^3 (North Carolina) to 5.9 mg/m^3 (Florida) to 5.9−8.85 mg/m^3 (North Dakota) to 9.8 mg/m^3 (Virginia) to 11.8 mg/m^3 (Connecticut and South Dakota) to 14.048 mg/m^3 (Nevada) to 14.75 mg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #2500, Methyl ethyl ketone; #2555; #3800; #8002 in blood; #2549 Volatile organic compounds; OSHA Analytical Methods 16, 84, and 1004.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes. The EPA[48] has set a lifetime health advisory at 170 μg/L. Several states have set guidelines for methyl ethyl ketone in drinking water[61] ranging from 60 μg/L (Massachusetts) to 170 μg/L (Arizona) to 172 μg/L (Minnesota) to 270 μg/L (New Jersey)[59] to 750 μg/L (Maine) to 1000 μg/L (Connecticut).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.29$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and the respiratory tract. May affect the central nervous system. *Inhalation:* Human exposures to levels of 350 ppm caused irritation of the nose and throat. Exposure can cause dizziness, lightheadedness, headache, nausea, blurred vision. Numbness in fingers, arms, and legs, accompanied by headache, nausea, vomiting, and fainting have occurred after exposure to levels of 300−600 ppm. *Skin:* Contact can irritate the skin causing rash and burning feeling. Liquid is absorbed readily and may cause numbing of fingers and arms. *Eyes:* Contact can irritate and cause burns and permanent damage. Exposure to levels of 200 ppm produced irritation. *Ingestion:* Can cause irritation of the mouth, throat, and stomach, the severity of which will be dependent upon amount swallowed. Symptoms of poisoning include nausea, vomiting, stomach pain, and diarrhea. Death can occur from ingestion of as little as 1 oz.

Long Term Exposure: Repeated exposure can cause drying and cracking of the skin. Has been implicated in certain nervous system and brain disorders characterized by weakness, fatigue, sleep disturbances, reduced coordination, heaviness in chest, and numbness of hands and feet. These symptoms may develop after 1 year of exposure to vapor concentrations of 50−200 ppm. Improvement is gradual and may take years after exposure is discontinued. Animal tests show that this chemical is a teratogen in animals and possibly causes toxic effects upon human reproduction.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift. If symptoms develop, or overexposure is suspected, examination of the nervous system is recommended. Special tests for nerve damage, called nerve conduction studies, may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber and chlorobutyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: *Up to 3000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrOv (APF = 10) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions: NIOSH*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl ethyl ketone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flame. Sources of ignition, such as smoking and open flames, are prohibited where methyl ethyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of methyl ethyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl ethyl ketone.

Shipping: This compound requires a shipping label: "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.[22]

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

US Environmental Protection Agency, Methyl Ethyl Ketone. (April 30, 1980). *Health and Environmental Effects Profile No. 128*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 85−87

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 2-Butanone*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Methyl Ethyl Ketone*. Trenton, NJ

Methyl ethyl ketoneperoxide M:0930

Molecular Formula: $C_8H_{16}O_4$
Synonyms: 2-Butanone, peroxide; Butanox®; Hi-Point 90; Ketonox; Luperox®; Lupersol; MEKP; MEK peroxide; Methyl ethyl ketone hydroperoxide; NCI-C55447; Peroxido de metil etil cetona (Spanish); Quickset extra; Sprayset MEKP; the rmacure
CAS Registry Number: 1338-23-4
RTECS® Number: EL9450000
UN/NA & ERG Number: UN3101/146; UN3105/145; UN3107/145
EC Number: 215-661-2

Regulatory Authority and Advisory Bodies
Highly Reactive Substance and Explosive (World Bank).[15]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).
US EPA Hazardous Waste Number (RCRA No.): U160.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MEKP, an organic peroxide, is a colorless liquid. Molecular weight = 176.24; Specific gravity (H_2O:1) = 1.12 at 15°C; Boiling point = (decomposes) 117.8°C; Freezing/Melting point = about 60°C. Flash point = 52−93°C (oc) 60% MEKP.[52] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Human Data; Primary Irritant. MEKP is used as a curing agent for thermosetting polyester resins and as a crosslinking agent and catalyst in the production of other polymers.

Incompatibilities: Forms explosive mixture with air (flash point varies). MEKP may exist in several different structures; decomposition temperatures may vary. Pure substance is shock-sensitive. Explosive decomposition above 176°F/80°C (also reported at 230°F/110°C). Keep away from sources of ignition, heat, sunlight. A strong oxidizer. Violent reaction with strong acids, strong bases, reducing agents, combustible substances, organic materials, chemical accelerants, oxides of heavy metals, salts, trace contaminants, amines. May accumulate static electrical charges and cause ignition of its vapors. Commercial product is diluted with 40% dimethyl phthalate, cyclohexane peroxide, or diallyl phthalate to reduce sensitivity to shock.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 7.21 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 0.2 ppm/1.5 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 0.2 ppm/1.5 mg/m^3 Ceiling Concentration.
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 3 ppm
PAC-2: 20 ppm
PAC-3: 20 ppm
DFG MAK: Produces very severe skin effects. See Section X(a).
Australia: TWA 0.2 ppm (1.5 mg/m^3), 1993; Belgium: STEL 0.2 ppm (1.5 mg/m^3), 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: STEL 0.2 ppm (1.5 mg/m^3), [skin], 1999; France: VLE 0.2 ppm (1.5 mg/m^3), 1999; Norway: TWA 1 mg/m^3, 1999; the Netherlands: MAC 1.5 mg/m^3, 2003; Switzerland: MAK-W 0.2 ppm (1.5 mg/m^3), 1999; United Kingdom: STEL 0.2 ppm (1.5 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.2 ppm. Several states have set guidelines or standards for MEK peroxide in ambient air[60] ranging from 11.0 μg/m^3 (Virginia) to 15.0 μg/m^3 (North Dakota) to 30.0 μg/m^3 (Connecticut and South Dakota) to 36.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3508; OSHA Analytical Method 77.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Methyl ethyl ketone peroxide can affect you when breathed in and by passing through your skin. Contact can irritate the skin, and can cause burn and permanently damage the eyes. Exposure can irritate the nose and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Methyl ethyl ketone peroxide may affect the liver and kidneys. May cause lung irritation and bronchitis. May cause skin allergy.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function test. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber, Neoprene, and Viton™ are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.2 ppm*, use an NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use an NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive mode.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Methyl ethyl ketone peroxide must be stored to avoid contact with heat, shock, and organics since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from organics. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl ethyl ketone peroxide. Sources of ignition, such as smoking and open flames, are prohibited where methyl ethyl ketone peroxide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever methyl ethyl ketone peroxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Shipment of methyl ethyl ketone peroxide, in solution, with >9% by mass active oxygen is FORBIDDEN by any means. Solutions containing less than 9% active oxygen require a shipping label of "ORGANIC PEROXIDE." They fall in DOT Hazard Class 5.2 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. MEKP may be destroyed by adding 20% NaOH solution slowly in a quantity about 10 times the weight of MEKP. Incineration is recommended if NaOH treatment is not used. See the Sax (1985) reference cited below for details.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Methyl Ethyl Ketone Peroxide*. Washington, DC

Na. Inst. for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Methyl Ethyl Ketone Peroxide*, Report PB-276,678. Rockville, MD, pp. 37−41

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 35−37 (1982) and 5, No. 4, 50−55 (1985)

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: Methyl Ethyl Ketone Peroxide*. Trenton, NJ

2-Methyl-5-ethyl pyridine M:0940

Molecular Formula: $C_8H_{11}N$
Synonyms: Aldehydecollidine; Aldehydine; Collidine, aldehydecollidine; 3-Ethyl-6-methylpyridine; 5-Ethyl-2-methylpyridine; 5-Ethyl-2-picoline; MEP; 6-Methyl-3-ethylpyridine; Methyl ethyl pyridine; 2-Methyl-5-ethylpyridine
CAS Registry Number: 104-90-5
RTECS® Number: TJ6825000
UN/NA & ERG Number: UN2300/153
EC Number: 203-250-0
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: 2-Methyl-5-ethyl pyridine is a colorless liquid with a sharp, aromatic odor. Molecular weight = 121.20; Boiling point = 128°C; Flash point = 39°C; also listed at 68°C; Autoignition temperature = 538°C. Explosive limits: LEL = 1.1%; UEL = 6.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water.
Potential Exposure: In the manufacture of nicotinic acid, vinylpyridine monomer; as intermediates for insecticides, germicides, and textile chemicals.
Incompatibilities: Strong oxidizers, strong acids, aldehydes, strong bases, acid chlorides, chloroformates, isocyanates, phenols, cresols.
Permissible Exposure Limits in Air
No TEEL available.
Russia: MAC 2 mg/m^3.[43]
Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, nausea, vomiting, and diarrhea. Moderately toxic by oral and dermal routes.
Long Term Exposure: May affect the central nervous system causing muscle weakness, loss of coordination, and loss of consciousness.
Points of Attack: Lungs, nervous system.
Medical Surveillance: Consider chest X-ray following acute overexposure. Examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be

equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 54−55 and 3, No. 6, 48−49 (1983)

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: 2-Methyl-5-Ethylpyridine*. Trenton, NJ

Methyleugenol M:0945

Molecular Formula: $C_{11}H_{14}O_2$

Synonyms: 4-Allyl-1,2-dimethoxybenzene; 1-Allyl-3,4-dimethoxybenzene; 4-Allylveratrole; Benzene, 4-Allyl-1,2-dimethoxy-; Chavibetol methyl ether; 1,2-Dimethoxy-4-allylbenzene; 3,4-Dimethoxyallylbenzene; 1-(3,4-Dimethoxyphenyl)-2-propene; 3-(3,4-Dimethoxyphenyl) propene; 1,2-Dimethoxy-4-(2-propenyl)benzene; Eugenol methyl ether; 1,3,4-Eugenol methyl ether; Eugenyl methyl ether; Methyl eugenol ether; *o*-Methyleugenol; Veratrole, 4-allyl-; Veratrole methyl ether

CAS Registry Number: 93-15-2

RTECS$^{®}$Number: CY2450000

UN/NA & ERG Number: UN2810

EC Number: 202-223-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical: Cancer 11/16/2001.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R36/38; R40; R42/43; Safety phrases: S2; S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Clear colorless to pale yellow liquid. Spicy, earthy odor. Bitter burning taste. This chemical is combustible. Molecular weight = 178.23; Specific gravity = 1.0396 at 20°C; Vapor density = >1.0; Boiling point = 249°C; 254.7°C at 760 mmHg; Melting point = −4°C; Vapor pressure = 0.02 mmHg at 20°C; 1 mmHg at 85°C; Flash point = 99°C; 109°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability 1; Reactivity 0. Practically insoluble in water; solubility = <1 mg/mL at 66°F; 500 mg/L.

Potential Exposure: Agricultural Chemical and Pesticide; Tumorigen; Mutagen; Primary Irritant. Methyleugenol is a naturally occurring substance found in the essential oils of several plant species. Methyleugenol is used as a flavoring agent in jellies, baked goods, nonalcoholic beverages, chewing gum, candy, pudding, relish, and ice cream. Methyleugenol has been used as an anesthetic in rodents. It is also used as an insect attractant in combination with insecticides.[NTP 2000]

Incompatibilities: When heated to decomposition, it emits acrid smoke, irritating fumes, and toxic fumes of carbon monoxide and carbon dioxide. Methyleugenol is incompatible with strong oxidizers; contact with reducing agents may cause the release of hydrogen gas.

Permissible Exposure Limits in Air: No OELs or TEEL available.

Determination in Air: No NIOSH or OSHA method available.

Permissible Concentration in Water: Not found.

Determination in Water: Bluegill (*Lepomis macrochirus*) $LC_{50} = 8233\ \mu g/L$, Moderately Toxic; Rainbow trout, donaldson trout (*Oncorhynchus mykiss*) $LC_{50} = 6450\ \mu g/L$, Moderately Toxic; octanol−water partition coefficient: Log $K_{ow} = 3.0-3.5$. Organic carbon−water partition coefficient: Log $K_{oc} = 2.7$.

Routes of Entry: Skin, eyes, inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: This compound is a primary irritant and sensitizer and may cause contact dermatitis. Symptoms of exposure to this compound include nausea, vomiting, diarrhea, circulatory collapse, dizziness, rapid and shallow breathing, unconsciousness, convulsions, abdominal burning, dysuria, hematuria, tachycardia, bronchial irritation, anuria, pulmonary edema, bronchial pneumonia, and renal damage. LD_{50} = (oral-rat) 810 mg/kg; LC_{50} = (inhal.-rat) = >4800 mg/m^3.

Long Term Exposure: This compound may be irritating to the skin and eyes.

Points of Attack: Liver, kidneys, skin, respiratory tract.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin or respiratory tract allergy.

First Aid: *Eyes*: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin or respiratory tract allergy.

Personal Protective Methods: Wear protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Recommended gloves: Ansell 5.109 (Latex); thickness: 0.18 mm; Breakthrough time: *15 min*; Edmont 29-870 (Neoprene); thickness: 0.51 mm; Breakthrough time: *135 min*; North Model F-091 (Viton); thickness: 0.41 mm; Breakthrough time: *480 min*.

Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA- or European Standard EN 149-approved respirator; or follow regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA- or European Standard EN 149-approved respirator; or use an approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas, and SO_2) with a dust/mist filter.

Storage: Color Code—Green: General storage may be used. You should protect this material from exposure to light, and store it under ambient temperatures.

Shipping: Not regulated.

Spill Handling: First remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. All contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Wear a self-contained breathing apparatus in pressure-demand, NIOSH/MSHA- or European Standard EN 149-approved respirator, and full protective gear. During a fire or heated to decomposition, irritating and highly toxic gases may be generated and it emits acrid smoke, irritating fumes, and toxic fumes of carbon monoxide and carbon dioxide. Use water spray to keep fire-exposed containers cool. Containers may explode in the heat of a fire. Extinguishing media; cool containers with flooding quantities of water until well after fire is out. Fires involving this material can be controlled with a dry chemical, carbon dioxide, or Halon extinguisher. A water spray may also be used.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

Hazardous Substances Data Bank [HSDB], US National Library of Medicine, TOXNET. *Eugenol*. <http://toxnet.nlm.nih.gov>

Methyl formate M:0950

Molecular Formula: $C_2H_4O_2$

Common Formula: $HCOOCH_3$

Synonyms: Formiate de methyle (French); Formiato de metilo (Spanish); Formic acid, methyl ester; Methyle (formiate de) (French); Methylformiat (German); Methyl methanoate

CAS Registry Number: 107-31-3

RTECS® Number: LQ8925000

UN/NA & ERG Number: UN1243/129

EC Number: 203-481-7 [*Annex I Index No.*: 607-014-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R12; R20/22; R36/37; Safety phrases: S2; S9; S16; S24; S26; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl formate is a colorless liquid with a pleasant odor. Odor threshold = 2000 ppm. Molecular weight = 60.06; Specific gravity (H_2O:1) = 0.98; Boiling point = 3.7°C; Freezing/Melting point = − 100°C; Vapor pressure = 476 mmHg at 20°C; Flash point = − 18.9°C; Autoignition temperature = 449°C. Explosive limits: LEL = 4.5%; UEL = 23.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Soluble in water; solubility = 30%.

Potential Exposure: Compound Description: Agricultural Chemical. Methyl formate is used as a solvent, as an intermediate in pharmaceutical manufacture, and as a fumigant.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers. Reacts slowly with water to form methanol and formic acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.46 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/250 mg/m^3 TWA.

NIOSH REL: 100 ppm/250 mg/m^3 TWA; 150 ppm/375 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm/246 mg/m^3 TWA; 150 ppm/368 mg/m^3 STEL.

NIOSH IDLH: 4500 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 150 ppm

PAC-2: 750 ppm

PAC-3: 4500 ppm

DFG MAK: 50 ppm/120 mg/m^3 TWA; Peak Limitation Category II(4); [skin]; Pregnancy Risk Group C.

Australia: TWA 100 ppm (250 mg/m^3); STEL 150 ppm, 1993; Austria: MAK 100 ppm (250 mg/m^3), 1999; Belgium: TWA 100 ppm (246 mg/m^3); STEL 150 ppm (369 mg/m^3), 1993; Denmark: TWA 100 ppm (250 mg/m^3), 1999; Finland: TWA 100 ppm (250 mg/m^3); STEL 150 ppm (375 mg/m^3), 1999; France: VME 100 ppm (250 mg/m^3), 1999; the Netherlands: MAC-TGG 250 mg/m^3, 2003; Sweden: TWA 100 ppm (250 mg/m^3); STEL 150 ppm (350 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (250 mg/m^3), KZG-W 200 ppm (500 mg/m^3), 1999; Turkey: TWA 100 ppm (250 mg/m^3), 1993; United Kingdom: TWA 100 ppm (250 mg/m^3); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 150 ppm. Several states have set guidelines or standards for methyl formate in ambient air[60] ranging from 2.50−3.75 mg/m^3 (North Dakota) to 4.2 mg/m^3 (Virginia) to 5.0 mg/m^3 (Connecticut) to 5.952 mg/m^3 (Nevada).

Determination in Air: Use NIOSH (II-5) Method #S-291. OSHA Analytical Method PV-2041.

Determination in Water: Octanol−water coefficient: Log $K_{\mathrm{ow}} = -0.2$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Methyl formate can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs and cause a buildup of fluid (pulmonary edema). This can cause death. High levels attack the nervous system and cause you to become dizzy, lightheaded; and may cause unconsciousness and death.

Long Term Exposure: Prolonged or repeated contact can cause cracking and drying of the skin. Repeated exposure can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Eyes, lungs, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* Sa (APF = 10) (any supplied-air respirator). *2500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *4500 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl formate must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, chlorine dioxide, nitrates, and permanganates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl formate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl formate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl formate. Wherever methyl formate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; atomizing in a suitable combustion chamber.

Reference

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Methyl Formate*. Trenton, NJ

Methyl hydrazine M:0960

Molecular Formula: CH_6N_2

Common Formula: CH_3NHNH_2

Synonyms: Hydrazine, methyl-; Hydrazomethane; *N*-Methyl hydrazine; 1-Methyl hydrazine; Metilhidrazina (Spanish); MMH; Monomethylhydrazine

CAS Registry Number: 60-34-4

RTECS® Number: MV5600000

UN/NA & ERG Number: UN1244/131

EC Number: 200-471-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Carcinogenicity: NIOSH: Suspected occupational carcinogen.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test; TRP reversion; Positive/limited: Carcinogenicity—mouse/rat; Negative: Rodent dominant lethal; *In vitro* UDS—human fibroblast; Negative: *S. cerevisiae* gene conversion.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

US EPA Hazardous Waste Number (RCRA No.): P068.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer (methyl hydrazine and its salts) 7/1/92.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl hydrazine is a fuming, colorless liquid with an ammonia-like odor. The odor threshold is 1.3−1.7 ppm. Molecular weight = 46.09; Specific gravity (H_2O:1) = 0.87 at 25°C; Boiling point = 87.8°C; Freezing/Melting point = −52.2°C; Vapor pressure = 38 mmHg at 20°C; Flash point = −8.3°C; Autoignition temperature = 194°C. Explosive limits: LEL = 2.5%; UEL = 92.0%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. MMH has been used as the propellant in liquid propellant rockets; it is also used as a solvent and as an organic intermediate.

Incompatibilities: Forms explosive mixture with air. Highly reactive reducing agent and a medium strong base. May explode if heated or when in contact with metal oxides. Violent reaction with strong oxidizers, such as fluorine, chlorine, combustibles, nitric acid, hydrogen peroxide. Incompatible with acids, alcohols, glycols, isocyanates, phenols, cresols, porous materials, such as earth, asbestos, wood, and cloth. Oxides of iron or copper, manganese, lead, copper, or their alloys can lead to fire and explosions. Attacks cork, some plastics, coatings, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.89 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.2 ppm/0.35 mg/m^3 Ceiling Concentration [skin].

NIOSH REL: 0.04 ppm/0.08 mg/m^3 [120 min] Ceiling Concentration; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 ppm/0.019 mg/m^3 [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: potential occupational carcinogen 20 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.01 ppm

PAC-1: 0.2 ppm

PAC-2: **0.9** ppm

PAC-3: **2.7** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] danger of skin sensitization.

Australia: TWA 0.2 ppm (0.35 mg/m^3), [skin], carcinogen, 1993; Belgium: STEL 0.2 ppm (0.38 mg/m^3), [skin], Carcinogen 1993; Denmark: TWA 0.04 ppm (0.08 mg/m^3), [skin], 1999; Finland: STEL 0.2 ppm (0.35 mg/m^3), [skin], 1999; France: VME 0.2 ppm (0.35 mg/m^3), 1999; Norway: TWA 0.08 mg/m^3, 1999; the Netherlands: MAC 0.35 mg/m^3, [skin], 2003; Poland: MAC (TWA) 0.02 mg/m^3, MAC (STEL) 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.2 ppm (0.35 mg/m^3), [skin], 1999; Thailand: TWA 0.2 ppm (0.35 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for methyl hydrazine in ambient air[60] ranging from zero (Maryland, North Dakota, and Texas) to 0.88 μg/m^3 (Pennsylvania) to 1.17 μg/m^3 (New York) to 1.75 μg/m^3 (South Carolina) to 3.5 μg/m^3 (Virginia) to 8.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3510.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} = −1.03.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, respiratory tract; and if ingested, may cause permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the central nervous system, liver, and blood, causing excitability, vomiting, tremors, convulsions, formation of methemoglobin, and death. Exposure at high concentrations may result in death. The effects may be delayed. Symptoms of acute exposure to methyl hydrazine may include facial numbness, facial swelling, and increased salivation. Headache, twitching, seizure, convulsions, and coma may also occur. Gastrointestinal signs and symptoms include anorexia, nausea, and vomiting. Methyl hydrazine is toxic to the liver, ruptures red blood cells; and may cause kidney damage. Methyl hydrazine vapors are extremely toxic and the liquid is corrosive to skin. Methyl hydrazine is the strongest convulsant and the most toxic of methyl-substituted hydrazine derivatives. It is more toxic than hydrazine. At high doses, it is a strong central nervous system poison.

Long Term Exposure: May damage the liver, kidneys, and blood, resulting in formation of methemoglobin. This substance causes liver cancer in animals and is possibly carcinogenic to humans.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, blood, cardiovascular system. Cancer site in animals: lung, liver, blood vessels, and intestine.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; pulmonary function tests. Before beginning employment and at regular times after that, the following is recommended: complete blood count. If symptoms develop or overexposure has occurred, the following may be useful: consider lung function tests, especially if lung symptoms are present. Test for kidney and liver function. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: Responder™ suits; Trychem 1000™ suits. Also, Viton™, chlorobutyl rubber, and CR-39® may offer some protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl hydrazine must be stored to avoid contact with oxides of iron and copper; manganese, lead, and copper alloys; porous materials (such as earth, asbestos, wood, and cloth); oxidizers (such as perchlorates, hydrogen peroxide, chlorates, nitrates, permanganates); and fuming nitric acid since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Sources of ignition, such as smoking and open flames, are prohibited where methyl hydrazine is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl hydrazine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl hydrazine. Wherever methyl hydrazine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 1.5/2.4

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. For small fires, use dry chemical, carbon dioxide, water spray, and alcohol foam. For large fires, use water spray, fog, or foam. Keep unnecessary people away and isolate the hazardous area. Stay upwind and keep out of low-lying areas. Fire exposed containers should be kept cool with water. Use water spray to disperse vapors and protect responders attempting to stop a leak which has not ignited. Move container from fire area if it can be done without risk. Wear positive pressure breathing apparatus and special (full) protective clothing. No skin surface should be exposed. See "Isolation Distances" above. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. There are two alternatives[24]: Dilute with water, neutralize with sulfuric acid, then flush to sewer with large volumes of water or incinerate with added flammable solvent in furnace equipped with afterburner and alkaline scrubber.

References

Nat. Inst. for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines*, NIOSH Document No. 78-172. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 86−90 (1982) and 5, No. 4, 55−59 (1985)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Hydrazine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Methyl Hydrazine*. Trenton, NJ

Methyl iodide M:0970

Molecular Formula: CH_3I

Synonyms: Halon 10001; Iodomethane; Iodure de methyle (French); Jod-methan (German); Methyljodid (German); Methane, iodo-; Yoduro de metilo (Spanish)

CAS Registry Number: 74-88-4

RTECS® Number: PA9450000

UN/NA & ERG Number: UN2644/151

EC Number: 200-819-5 [*Annex I Index No.:* 602-005-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: L5178Y cells *In vitro*—TK test; *E. coli* polA without S9; Positive: *S. cerevisiae*—homozygosis.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U138.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.19; Nonwastewater (mg/kg), 65.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (40); 8240 (5).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 4/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R21; R23/25; R37/38;R40; Safety phrases: S1/2; S36/37; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl iodide is a colorless liquid with a pungent, ether-like odor. Turns yellow, red, or brown on exposure to light and moisture. Molecular weight = 141.94; Specific gravity (H_2O:1) = 2.28; Boiling point = 42.8°C; Vapor pressure = 400 mmHg; Freezing/Melting point = − 66.7°C. It is noncombustible. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 1%.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Methyl iodide is used in fire extinguishers; as an intermediate in the manufacture of pharmaceuticals and some pesticides.

Incompatibilities: Violent reaction with strong oxidizers, strong bases, trialkylphosphines, silver chlorite, oxygen, sodium. Decomposes at 270°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.80 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/28 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/10 mg/m^3 TWA [skin]; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/12 mg/m^3 TWA [skin].

NIOSH IDLH: potential occupational carcinogen 100 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 25 ppm

PAC-2: 50 ppm

PAC-3: 125 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 2 ppm (10 mg/m^3), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 2 ppm (12 mg/m^3), [skin], Carcinogen 1993; Denmark: TWA 1 ppm (5.6 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (28 mg/m^3); STEL 10 ppm (56 mg/m^3), [skin], 1999; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 10 mg/m^3, [skin], 2003; Poland: MAC (TWA) 10 mg/m^3; MAC (STEL) 30 mg/m^3, 1999; Sweden: NGV 1 ppm (6 mg/m^3), KTV 5 ppm (30 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-W 0.3 ppm (2 mg/m^3), [skin], carcinogen, 1999; United Kingdom: TWA 2 ppm (12 mg/m^3), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin].

Determination in Air: Use NIOSH Analytical Method #1014.[18]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.63.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Methyl iodide can affect you when breathed in and by passing through your skin. Methyl iodide is a carcinogen; handle with extreme caution. Contact can irritate the eyes and cause severe skin burns. It can cause brain damage leading to disorientation and psychotic behavior. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may cause nausea, vomiting, diarrhea, dizziness, slurred speech, visual disturbances, irritability, loss of muscle control, drowsiness, delirium, serious mental disorders, coma, and death.

Long Term Exposure: Can cause lung irritation and bronchitis. May cause kidney damage. May affect the brain leading to disorientation and personality changes. Exposure can cause nausea, vomiting, vertigo (an illusion of movement), ataxia, slurred speech, drowsiness, dermatitis. A potential occupational carcinogen.

Points of Attack: Eyes, skin, respiratory system, kidneys, central nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests; kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider urine test for iodine. Consider chest X-ray after acute overexposure. Evaluate for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: Viton™ gloves, suits; Responder™ suits; Trychem 1000™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.5/0.8

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Methyl iodide itself does not burn. Poisonous gases, including iodine, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methyl Iodide*. Trenton, NJ

Methyl isoamyl ketone M:0980

Molecular Formula: $C_7H_{14}O$

Common Formula: $CH_3COCH_2CH_2CH(CH_3)_2$

Synonyms: 2-Hexanone, 5-methyl-; Isoamyl methyl ketone; Isopentyl methyl ketone; Ketone, methyl isoamyl; 5-Methylhexan-2-one; 2-Methyl-5-hexanone; 5-Methyl-2-hexanone; MIAK

CAS Registry Number: 110-12-3
RTECS® Number: MP3850000
UN/NA & ERG Number: UN2302/127
EC Number: 203-737-8 [*Annex I Index No.*: 606-026-00-4]
Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20; Safety phrases: S2; S23; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MIAK is a colorless liquid with a pleasant, fruity odor. Molecular weight = 114.21; Specific gravity (H_2O:1) = 0.81; Boiling point = 144°C; Freezing/Melting point = − 74°C; Vapor pressure = 5 mmHg at 20°C; Flash point = 36.1°C (cc); Autoignition temperature = 191°C. Explosive limits: LEL = 1.0% at 93.3°C; UEL = 8.2% at 93.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: Compound Description: Agricultural Chemical; Primary Irritant. MIAK is used as a solvent for cellulose esters, acrylics, and vinyl copolymers.

Incompatibilities: Reacts violently with strong oxidizers, strong bases, amines, and isocyanates. Attacks some plastic.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/475 mg/m^3 TWA.
NIOSH REL: 50 ppm/240 mg/m^3 TWA.
ACGIH TLV®[1]: 50 ppm/234 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 100 ppm
PAC-1: 150 ppm
PAC-2: 1500 ppm
PAC-3: 1500 ppm

DFG MAK: 10 ppm/47 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D.

Australia: TWA 50 ppm (240 mg/m^3), 1993; Belgium: TWA 50 ppm (234 mg/m^3), 1993; Denmark: TWA 50 ppm (230 mg/m^3), 1999; Finland: TWA 50 ppm (230 mg/m^3); STEL 75 ppm (350 mg/m^3), 1999; France: VME 50 ppm (240 mg/m^3), 1999; Norway: TWA 25 ppm (115 mg/m^3), 1999; Sweden: TWA 25 ppm (120 mg/m^3); STEL 50 ppm (250 mg/m^3), 1999; the Netherlands: MAC-TGG 233 mg/m^3, 2003; United Kingdom: TWA 50 ppm (237 mg/m^3); STEL 100 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 50 ppm. In addition, Several states have set guidelines or standards for MIAK in ambient air[60] ranging from 2.4 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 4.6 mg/m^3 (Connecticut) to 5.714 mg/m^3 (Nevada).

Determination in Air: OSHA Analytical Method PV-2042.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.72 (estimated).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl isoamyl ketone can affect you when breathed in and by passing through your skin. Exposure can cause you to become dizzy, lightheaded, and to pass out. Contact can irritate the eyes and skin. Repeated exposure can cause a skin rash. Methyl isoamyl ketone vapors can irritate the nose and throat. MIAK may affect the kidneys.

Long Term Exposure: Skin contact causes skin rash and drying and cracking. High exposures may cause liver damage and may affect the kidneys.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *Up to 500 ppm*: CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator). *Up to 1250 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 2500 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 5000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong oxidizers (such as chlorine, bromine, and fluorine), reducing agents, and aldehydes. Sources of ignition, such as smoking and open flames, are prohibited where methyl isoamyl ketone is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl isoamyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Shipping: 5-Methylhexan-2-one compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: Methyl Isoamyl Ketone*. Trenton, NJ

Methyl isobutyl carbinol M:0990

Molecular Formula: $C_6H_{14}O$

Common Formula: $CH_3CHOHCH_2CH(CH_3)_2$

Synonyms: Alcool methyl amylique (French); Isobutylmethylcarbinol; Isobutylmethylmethanol; MAOH; Methyl amyl alcohol; Methylisobutyl carbinol; 2-Methyl-4-pentanol; 4-Methylpentanol-2; 4-Methyl-2-pentanol; MIBC; MIC; 3-MIC; 2-Pentanol, 4-methyl-

CAS Registry Number: 108-11-2

RTECS® Number: SA7350000

UN/NA & ERG Number: UN2053/129

EC Number: 203-551-7 [*Annex I Index No.:* 603-008-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R10; R37; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MIBC is a colorless liquid with a mild odor. The odor threshold is 0.52 ppm. Molecular weight = 102.20; Specific gravity (H_2O:1) = 0.81; Boiling point = 132.8°C; Freezing/Melting point = − 90°C; Vapor pressure = 3 mmHg at 20°C; Flash point = 41°C. The explosive limits are LEL = 1.0%; UEL = 5.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: MIBC is used as a solvent; in the formulation of brake fluids; as an intermediate in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Contact with alkali metals produces hydrogen gas. Incompatible with strong oxidizers, strong acids, caustics, aliphatic amines, isocyanates.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/100 mg/m^3 TWA [skin].

NIOSH REL: 25 ppm/100 mg/m^3 TWA; 40 ppm/165 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 25 ppm/104 mg/m^3 TWA; 40 ppm/167 mg/m^3 STEL [skin].

NIOSH IDLH: 400 ppm.

No TEEL available.

DFG MAK: 20 ppm/85 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Australia: TWA 25 ppm (100 mg/m^3); STEL 40 ppm, [skin], 1993; Austria: MAK 25 ppm (50 mg/m^3), [skin], 1999; Belgium: TWA 25 ppm (104 mg/m^3); STEL 40 ppm, [skin] 1999; Denmark: TWA 25 ppm (100 mg/m^3), [skin], 1999; Finland: TWA 25 ppm (100 mg/m^3); STEL 40 ppm (170 mg/m^3), [skin], 1999; France: VME 25 ppm (100 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 100 mg/m^3, [skin], 2003; Russia: STEL 10 mg/m^3, [skin], 1993; Poland: MAC (TWA) 100 mg/m^3; MAC (STEL) 160 mg/m^3, 1999; Switzerland: TWA 25 ppm (100 mg/m^3); STEL 125 ppm, [skin], 1993; Switzerland: MAK-W 25 ppm (100 mg/m^3), KZG-W 125 ppm (500 mg/m^3), [skin], 1999; United Kingdom: TWA 25 ppm (106 mg/m^3); STEL 40 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 40 ppm [skin]. North Dakota has set a guideline of 1.0−1.65 mg/m^3 for MIBC in ambient air.[60]

Determination in Air: Use NIOSH Analytical Method #1402, alcohols II; #1405; OSHA Analytical Method 7.[18]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.4.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: MIBC can affect you when breathed in and by passing through your skin. Breathing the vapor can irritate the eyes, nose, and throat. Contact with the liquid can burn the eyes and can irritate the skin. Exposure to high concentrations can cause you to feel dizzy, lightheaded, and to pass out.

Long Term Exposure: Long-term contact can cause drying and cracking of the skin.

Points of Attack: Eyes, skin, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, pulmonary function tests; urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite) end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *250 ppm:* Sa (APF = 10) (any supplied-air respirator). *400 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv

(APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl amyl alcohol must be stored to avoid contact with peroxides, chlorates, perchlorates, permanganates, and nitrates since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl amyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; other, more flammable solvent may be added.

Reference

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Methyl n-Amyl Alcohol*. Trenton, NJ

Methyl isobutyl ketone M:1000

Molecular Formula: $C_6H_{12}O$

Common Formula: $CH_3COCH_2CH(CH_3)_2$

Synonyms: Hexone; Isobutyl methyl ketone; Isopropylacetone; KTI COP Rinse I; KTI PMMA Rinse; Methyl-isobutyl-cetone (French); 2-Methyl-4-pentanone; 4-Methyl-2-pentanone; MIBK; MIK; 2-Pentanone, 4-methyl-; Metil isobutil cetona (Spanish); RN-10 E beam negative resist rinse; Shell MIBK

CAS Registry Number: 108-10-1

RTECS® Number: SA9275000

UN/NA & ERG Number: UN1245/127

EC Number: 203-550-1 [*Annex I Index No.:* 606-004-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U161.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 33.

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20; R36/37; R66; Safety phrases: S2; S9; S16; S29 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MIBK is a colorless liquid with a pleasant, sweet, fruity odor. The odor threshold is 0.88 ppm. Molecular weight = 100.18; Specific gravity (H_2O:1) = 0.80; Boiling point = 116.7°C; Freezing/Melting point = −84.4°C; Vapor pressure = 16 mmHg at 20°C; Flash point = 18°C; Autoignition temperature: 450°C. Explosive limits: LEL = 1.2% at 93°C; UEL = 8.0% at 93°C. Hazard Identification (based on NFPA-704 M Rating

System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Human Data; Primary Irritant. MIBK is used as a solvent; a denaturant; and as an extractant; in the manufacture of methyl amyl alcohol; as a solvent in paints, varnishes, and lacquers; as an alcohol denaturant; as a solvent in uranium extraction from fission products.

Incompatibilities: Able to form unstable and explosive peroxides on contact with air. Reacts violently with strong oxidizers, potassium *tert*-butoxide, strong acids, aliphatic amines, reducing agents.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.10 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/410 mg/m^3 TWA.

NIOSH REL: 50 ppm/205 mg/m^3 TWA; 75 ppm/300 mg/m^3 STEL.

ACGIH TLV®[1]: 20 ppm/82 mg/m^3 TWA; 75 ppm/307 mg/m^3 STEL; BEI issued.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 75 ppm

PAC-2: 75 ppm

PAC-3: 500 ppm

DFG MAK: 20 ppm/83 mg/m^3 Peak Limitation Category I (2) [skin]; Pregnancy Risk Group C; BAT: 3.5 mg[hexone]/L in urine/end-of-shift.

Compound Description: Tumorigen; Reproductive Effector; Human Data; Primary Irritant.

Austria: MAK 100 ppm (400 mg/m^3), 1999; Denmark: TWA 25 ppm (100 mg/m^3), [skin], 1999; France: VME 50 ppm (205 mg/m^3), 1999; Japan: 50 ppm (105 mg/m^3), [skin], 1999; Norway: TWA 25 ppm (105 mg/m^3), 1999; Poland: MAC (TWA) 200 mg/m^3; MAC (STEL) 300 mg/m^3, 1999; Sweden: NGV 25 ppm (100 mg/m^3), KTV 50 ppm (200 mg/m^3), 1999; the Netherlands: MAC-TGG 104 mg/m^3, 2003. For ambient air in residential areas: The Czech Republic[35]: MAC of 0.2 mg/m^3 both on a momentary and a daily average basis; Russia[35]: MAC of 0.1 mg/m^3 on a once daily basis. Several states have set guidelines or standards for MIBK in ambient air[60] ranging from 0.28 mg/m^3 (Massachusetts) to 0.683 mg/m^3 (New York) to 2.05 mg/m^3 (Florida, North Dakota, South Carolina) to 2.50 mg/m^3 to 3.4 mg/m^3 (Virginia) to 4.1 mg/m^3 (Connecticut) to 4.76 mg/m^3 (Nevada) to 30.8 mg/m^3 (North Carolina).

Determination in Air: Charcoal adsorption, workup with CS_2; analysis by gas chromatography/flame ionization. See NIOSH (I) Method #1300, Ketones; #2555; OSHA Analytical Method 1004.[18]

Permissible Concentration in Water: The state of Massachusetts has set[61] a guideline of 40 μg/L (0.04 mg/L) for MIBK in drinking water. Russia has set a limit of 0.2 mg/L in surface water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl isobutyl ketone can affect you when breathed in. Exposure to high concentrations can cause you to feel dizzy and lightheaded, and to pass out. Breathing the vapor may cause loss of appetite, nausea, vomiting, and diarrhea. Contact or the vapor can irritate the eyes, nose, mouth, throat. Contact can irritate the skin. Ingestion caused chemical pneumonitis.

Long Term Exposure: Long-term exposure may damage the liver and kidneys. Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and styrene−butadiene rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl isobutyl ketone must be stored to avoid contact with strong oxidizers because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, and flames. Sources of ignition, such as smoking and open flames, are prohibited where methyl isobutyl ketone is used, handled, or stored in a manner that could crate a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of methyl isobutyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl isobutyl ketone.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.[22]

References

Nat. Inst. for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Methyl Isobutyl Ketone: Health and Environmental Effects Profile No. 129*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Methyl Isobutyl Ketone*. Trenton, NJ

Methyl isocyanate M:1010

Molecular Formula: C_2H_3NO

Common Formula: CH_3NCO

Synonyms: Isocyanate de methyle (French); Isocianato de metilo (Spanish); Isocyanatomethane; Isocyanic acid, methyl ester; Isocyanate methane; Methane, isocyanato-; Methylcarbamyl amine; Methyl carbonimide; Methyl ester of isocyanic acid; Methyl isocyanat (German)

CAS Registry Number: 624-83-9

RTECS® Number: NQ9450000

UN/NA & ERG Number: UN2480/155

EC Number: 210-866-3 [*Annex I Index No.:* 615-001-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): P064.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Developmental/Reproductive toxin (female) 11/12/10.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, T + ; R11; R24/25; R26; R37/38; R42; R42/43; R63; Safety phrases: S1/2; S16; S26; S27/28; S36/37/39; S43; S45; S63 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl isocyanate is a colorless liquid with a sharp odor which is a lachrymator (causes tears). Molecular weight = 57.06; Specific gravity (H_2O:1) = 0.96; Boiling point = 38.8−40°C; Freezing/Melting point = −45°C; Vapor pressure = 348 mmHg at 20°C; Flash point = −7°C; Autoignition temperature = 534°C. Explosive limits: LEL = 5.3%; UEL = 26°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 2. Reacts with water; solubility = 10% at 15°C.

Potential Exposure: Methyl isocyanate is used in carbamates and as chemical intermediate; in the manufacture of a wide variety of pesticides; in the production of polyurethane foams and plastics. A release of this chemical was involved in the world's largest chemical accident, causing the death of thousands of industrial workers in 1984 in Bhopal, India.

Incompatibilities: Rapid reaction in the presence of acid, alkalis, amine, iron, tin, copper, their salts, or their catalysts (such as triphenylarsenic oxide, triethylphosphine, and tributyltin oxide). Exothermic reaction with water, producing carbon dioxide, highly flammable and air-reactive methylamine, dimethylurea, and/or trimethyl biuret. The reaction with water is slow at ≤20°C but violent at elevated temperatures and/or in the presence of acids and bases. Elevated temperatures may cause polymerization; usually contains inhibitors to prevent polymerization. Reacts with water, acids, alcohols, glycols, amines, amides, ammonia, caprolactum, caustics, strong oxidizers. Attacks some plastics, rubber, or coatings. Attacks some forms of plastic, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.34 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.02 ppm/0.05 mg/m^3 TWA [skin].

NIOSH REL: 0.02 ppm/0.05 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.02 ppm/0.047 mg/m^3 TWA [skin].

NIOSH IDLH: 3 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.02 ppm

PAC-1: **0.025** ppm

PAC-2: **0.067** ppm

PAC-3: **0.2** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.01 ppm/0.024 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Austria: MAK 0.01 ppm (0.025 mg/m^3), 1999; Belgium: TWA 0.02 ppm (0.047 mg/m^3), [skin], 1993; Denmark: TWA 0.01 ppm (0.03 mg/m^3), [skin], 1999; France: VME 0.02 ppm (0.05 mg/m^3), [skin], 1999; Hungary: TWA 0.05 mg/m^3; STEL 0.06 mg/m^3, [skin], 1993; Norway: TWA 0.005 ppm (0.015 mg/m^3), 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, [skin], 2003; Russia: STEL 0.05 mg/m^3, [skin], 1993; Sweden: TWA 0.005 ppm, ceiling 0.01 ppm, 1999; Switzerland: MAK-W 0.01 ppm (0.025 mg/m^3), KZG-W 0.02 ppm (0.05 mg/m^3), 1999; United Kingdom: TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg [NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.02 ppm [skin]. Several states have set guidelines or standards for methyl isocyanate in ambient air[60] ranging from 0.17 μg/m^3 (New York) to 0.5 μg/m^3 (North Dakota) to 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (Connecticut and South Dakota).

Determination in Air: Use OSHA Analytical Method 54.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Corrosive to the respiratory tract. Causes irritation of eyes, nose, throat, and lungs, bronchitis, cough, shortness of breath, increased secretions, chest pain, difficulty in breathing, and increased blood acidity. Allergic reactions may occur and trigger asthmatic response in sensitized individuals. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Results of human volunteer experiments indicate the exposure for 1−5 min at 0.4 ppm causes no irritation of eyes, nose, or throat; at 2 ppm, irritation and tearing; at 4 ppm, stronger symptoms; and at 21 ppm exposure is unbearable; NIOSH reports that 3 ppm is immediately dangerous to life and health (IDLH). Improvement will occur in a few days if the dose is very low, and proper supportive therapy is given. At higher doses and longer durations of exposure, death may be immediate or delayed more than a month. *Skin:* Corrosive. Extremely irritating; can cause chemical burns. *Eyes:* Corrosive to the eyes. Levels of 2 ppm may cause irritation and tearing. Ulceration has occurred at high levels.

Very high levels may lead to permanent damage and blindness. *Ingestion:* Corrosive; causes vomiting, diarrhea, and abdominal pain.

Long Term Exposure: May cause allergic sensitization of skin and respiratory tract. Subsequent exposure even at extremely low levels may cause asthma attacks. May cause chronic lung disease and increased susceptibility to lung infection. May affect the lungs, causing tissue lesions. Exposure may cause miscarriages among pregnant women.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal at first if person is not having an attack at the time. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Warning: Effects may be delayed for up to 15 h. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: Prevent skin contact. **8 h**: polyvinyl alcohol gloves; Barricade™ coated suits; Responder™ suits, Trellchem™ HPS suits; Trychem 1000™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.2 ppm:* Sa (APF = 10) (any supplied-air respirator). *0.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *1 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *3 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl isocyanate must be stored to avoid contact with water, acid, alkali, amines; or iron, tin, copper (or their salts); and certain other catalysts since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl isocyanate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl isocyanate should be grounded and bonded. Drums must be quipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl isocyanate. Wherever methyl isocyanate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. For spills up to 5 gallons, cover with 6 in. of activated carbon for each 1 in. of liquid depth and let stand. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 3.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0+/11.0+
Night 7.0+/11.0+

Fire Extinguishing: This chemical is a flammable liquid. Use dry chemical, carbon dioxide, or alcohol foam. *Do not use water*. Material is extremely hazardous to health but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus (coat, pants, gloves, boots, and bands around legs, arms, and waist), should be provided. No skin surface should be exposed. Poisonous gases, including hydrogen cyanide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Stay away from ends of tanks. Do not get water inside container. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Spray cooling water on containers that are exposed to flames until well after fire is out. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration in the presence of a flammable solvent.[22] A flue gas scrubber is recommended as well.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 2, 68−70

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Isocyanate*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Methyl Isocyanate*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Methyl Isocyanate*. Trenton, NJ

Methyl isopropyl ketone M:1020

Molecular Formula: $C_5H_{10}O$

Common Formula: $CH_3COCH(CH_3)_2$

Synonyms: 2-Acetyl propane; Isopropyl methyl ketone; 3-Methyl-2-butanone; 3-Methyl butan-2-one; MIPK

CAS Registry Number: 563-80-4

RTECS® Number: EL9100000

UN/NA & ERG Number: UN2397/127

EC Number: 209-264-3 [*Annex I Index No.:* 606-007-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R11; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MIPK is a colorless liquid with an acetone-like odor. Molecular weight = 86.15; Specific gravity (H_2O:1) = 0.81; Boiling point = 93°C. Freezing point = − 92°C; Vapor pressure = 42 mmHg at 20°C; Flash point = 6°C; Autoignition temperature = 475°C. Explosive limits: LEL = 1.2%; UEL = 8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.5% at 20°C.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. This ketone is used as a solvent for nitrocellulose lacquers.

Incompatibilities: Violent reaction with oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 200 ppm/705 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm/705 mg/m^3 TWA; Notice of intended change: 20 ppm.

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 200 ppm

PAC-2: 200 ppm

PAC-3: 600 ppm

Australia: TWA 200 ppm (705 mg/m^3), 1993; Belgium: TWA 200 ppm (705 mg/m^3), 1993; Denmark: TWA 200 ppm (705 mg/m^3), 1999; Finland: TWA 200 ppm (700 mg/m^3); STEL 250 ppm (875 mg/m^3), 1999; France: VME 200 ppm (705 mg/m^3), 1999; Norway: TWA 100 ppm (350 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (720 mg/m^3), 1999; the Netherlands: MAC-TGG 705 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 200 ppm. Several states have set guidelines or standards for MIPK in ambient air[60] ranging from 7.05 mg/m^3 (North Dakota) to 11.75 mg/m^3 (Virginia) to 14.1 mg/m^3 (Connecticut) to 16.786 mg/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Routes of Entry: Inhalation of vapor, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye, nose, throat, and skin irritation. In high concentrations, narcosis may be produced with symptoms of headache, nausea, vomiting, lightheadedness, dizziness, a lack of coordination, narcosis, and unconsciousness.

Long Term Exposure: Removes the skin's natural oils; causes drying and cracking.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: Where there is potential for exposures *over 200 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with an organic vapor cartridge/canister. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from aldehydes. Sources of ignition, such as smoking and open flames, are prohibited where methyl isopropyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl isopropyl ketone. Wherever methyl isopropyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Methyl Isopropyl Ketone*. Trenton, NJ

Methyl isothiocyanate M:1030

Molecular Formula: C_2H_3NS

Common Formula: CH_3NCS

Synonyms: AI3-28257; Di-Trapex; EP-161E; Isothiocyanate de methyle (French); Isothiocyanatomethane; Isothiocyanic acid, methyl ester; Methane, isothiocyanato-; Methyl-isothiocyanat (German); Methyl mustard; Methyl mustard oil; Methylsenfoel (German); MIC; MIT; MITC; Morton WP-161E; Trapex; Trapex-40; Trapexide; Vorlex; Vorlex 201; Vortex; WN 12

CAS Registry Number: 556-61-6

RTECS® Number: PA6925000

UN/NA & ERG Number: UN2477/131

EC Number: 209-132-5 [*Annex I Index No.:* 615-002-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/25; R34; R43; R50/53; Safety phrases: S1/2; S36/37; S38; S45; S60, S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methyl isothiocyanate is a crystalline solid with a horseradish odor. Molecular weight = 73.12; Boiling point = 119°C; Freezing/Melting point = 35−36°C; Flash point = 32°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: It is used as a soil fumigant. A mixture of methyl isothiocyanate and chlorinated C-3 hydrocarbons is used as a soil fumigant for control of weeds, fungi, insects, and nematodes.

Incompatibilities: Unstable and reactive; sensitive to oxygen and to light. Incompatible with oxidizers, strong acids, alcohols, strong bases, amines, water, heat, and cold. Attacks iron, zinc, and other metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 33 mg/m^3

PAC-3: 500 mg/m^3

Russia[43] set a MAC of 0.1 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Highly irritating to the eyes, skin, and mucous membranes. Coughing, wheezing, and/or shortness of breath and other symptoms of extreme pulmonary irritation would be expected if vapors are inhaled. Very high exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, dizziness, depression, seizures, and even loss of consciousness. This material is very toxic; probable human oral lethal dose is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150 lb) person. Human oral minimum lethal dose: approximately 1 g/kg.

Long Term Exposure: May cause skin allergy and bronchitis. May affect the thyroid gland.

Points of Attack: Lungs, skin, thyroid.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Evaluation of thyroid function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyl isothiocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where methyl isothiocyanate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I. This material carries a plus sign (+), indicating that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and wash area following cleanup. Ventilate and wash spill areas when cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: Methyl isothiocyanate is a flammable solid. Poisonous gases are produced in fire, including cyanides, sulfur oxides, and nitrogen oxides. Use dry chemical, CO_2, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Isothiocyanate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methyl Isothiocyanate*. Trenton, NJ

Methyl mercaptan M:1040

Molecular Formula: CH_4S

Common Formula: CH_3SH

Synonyms: Mercaptan methylique (French); Mercaptomethane; Methanethiol; 1-Methanethiol; Methanthiol (German); Methyl sulfhydrate; Metilmercaptano (Spanish); Thiomethanol; Thiomethyl alcohol

CAS Registry Number: 74-93-1

RTECS® Number: PB4375000

UN/NA & ERG Number: UN1064/117

EC Number: 200-822-1 [*Annex I Index No.*: 016-021-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).; *Theft hazard* 500 (≥45.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U153.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. *Note:* Subject to an administrative stay under EPCRA Section 313. Not reportable until stay is lifted. See 8/22/94 (59 FR 43048).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F + , T, N; Risk phrases: R12; R23; R50/53; Safety phrases: S2; S16; S25; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methyl mercaptan is a colorless gas or white liquid with a disagreeable odor like garlic or rotten cabbage. The odor threshold = 0.0016 ppm. Shipped as a liquefied compressed gas. The odor threshold is 0.002 ppm. Molecular weight = 48.11; Specific gravity (H_2O:1) = 9.90 (liquid at 0°C); Relative density (H_2O:1): 0.9 (a liquid at 0°C); Boiling point = 6.1°C; Freezing/Melting point = − 121.1°C; Vapor pressure = 1.7 atm; Relative vapor density (air = 1) = 1.66; Flash point = − 17°C (liquid). Explosive limits: LEL = 3.9%; UEL = 21.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Mutagen. Methyl mercaptan is used in methionine synthesis, and widely as an intermediate in pesticide manufacture.

Incompatibilities: Violent reaction with strong oxidizers, bleaches, copper, nickel and their alloys, aluminum. Reacts with acids producing flammable and toxic hydrogen sulfide.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.97 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/20 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.5 ppm/1 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 0.5 ppm/0.98 mg/m^3 TWA.

NIOSH IDLH: 150 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.5 ppm

PAC-1: 6 ppm

PAC-2: **47** ppm

PAC-3: **68** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.5 ppm/1.0 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Australia: TWA 0.5 ppm (1 mg/m^3), 1993; Austria: MAK 0.5 ppm (1 mg/m^3), 1999; Belgium: TWA 0.5 ppm (0.98 mg/m^3), 1993; Denmark: TWA 0.5 ppm (1 mg/m^3), 1999; Finland: TWA 0.5 ppm (1 mg/m^3); STEL 1.5 ppm (3 mg/m^3), 1999; France: VME 0.5 ppm (1 mg/m^3), 1999; Hungary: STEL 1 mg/m^3, 1993; the Netherlands:

MAC-TGG 1 mg/m^3, 2003; Norway: TWA 0.5 ppm (1 mg/m^3), 1999; the Philippines: TWA 10 ppm (20 mg/m^3), 1993; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 2 mg/m^3, 1999; Russia: STEL 0.8 mg/m^3, 1993; Sweden: NGV 1 ppm, 1999; Switzerland: MAK-W 0.5 ppm (1 mg/m^3), KZG-W 1 ppm (2 mg/m^3), 1999; Thailand: TWA 10 ppm (20 mg/m^3), 1993; Turkey: TWA 10 ppm (20 mg/m^3), 1993; United Kingdom: TWA 0.5 ppm (1 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm. Russia[43] set a MAC of 9×10^{-6} mg/m^3 in ambient air in residential areas on a momentary basis. Several states have set guidelines or standards for methyl mercaptan in ambient air[60] ranging from 3.3 μg/m^3 (New York) to 10 μg/m^3 (Florida, North Dakota, South Carolina) to 16 μg/m^3 (Virginia) to 20 μg/m^3 (Connecticut) to 24 μg/m^3 (Nevada) to 50 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2542, Mercaptans; OSHA Analytical Method 26.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 13.8 μg/L based on health effects. Russia[43] set a MAC of 0.2 μg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can cause frostbite. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the central nervous system. Signs and symptoms of acute exposure to methyl mercaptan may include fever, cough, shortness of breath, a feeling of tightness and burning in the chest, respiratory distress, respiratory paralysis, and respiratory failure/collapse. Headache, loss of the sense of smell, dizziness, staggering gait, and heightened emotions may occur. Gastrointestinal symptoms include difficulty in swallowing, redness of the tongue and pharynx, nausea, vomiting, abdominal pain, and diarrhea. Urinary disturbances may also be found.

Long Term Exposure: May cause liver and kidney damage. Repeated exposure may cause bronchitis. Memory loss, damage to the central and peripheral nervous systems, tremor, convulsions, and coma may also occur. May affect the blood cell causing anemia.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, central nervous system, blood.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 h:** Barricade™ coated suits; Responder™ suits; Trychem 1000™ suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear the proper chemical goggles (indirect vent, impact and slash resistant with liquids; nonvented, impact resistant with fumes, gases, or vapors) and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl mercaptan must be stored to avoid contact with water, steam, or strong acids (such as hydrochloric, sulfuric, and nitric) because toxic flammable vapors will be released. It should not contact oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or sparks. Sources of ignition, such as smoking and open flames, are prohibited where methyl mercaptan is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyl mercaptan should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl mercaptan. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Methyl mercaptan requires a shipping label of “POISON GAS, FLAMMABLE GAS.” It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 2.6/4.1

Fire Extinguishing: Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Evacuate area endangered by gas. See isolation distances above. Combustion produces irritating sulfur dioxide. Very dangerous when exposed to heat, flame, or oxidizers. On decomposition it emits highly toxic fumes of sulfur oxides. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in

OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration followed by effective scrubbing of the effluent gas.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Mercaptans*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Methyl Mercaptan*. Trenton, NJ

Methylmercuricdicyanamide M:1050

Molecular Formula: $C_3H_6HgN_4$

Synonyms: Agrosol; Cyanoguanidine methyl mercury derivative; Cyano(methylmercury)guanidine; Guanidine, cyano-, methylmercury derivative; MEMA; Methylmercuric cyanoguanidine; Methylmercury dicyanandimide; Methylmercury dicyandiamide; Methylmerkuridikyandiamid (German); MMD; Morsodren; Morton EP-227; Morton soil drench; Pandrinox; Pano-Drench 4; Panodrin A-13; Panogen®; Panogen® 15; Panogen® 43; Panogen® PX; Panogen® turf fungicide; Panogen® turf spray; Panospray 30; R 8; R 8 fungicide

CAS Registry Number: 502-39-6

RTECS® Number: OW1750000

UN/NA & ERG Number: UN2777/151

EC Number: 207-935-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

California Proposition 65 Chemical: Cancer 5/1/96; Developmental/Reproductive toxin 7/1/87.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as mercury compounds.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methylmercuric dicyanamide is a crystalline solid. Molecular weight = 298.72; Freezing/Melting point = 156°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as a fungicide, a seed, soil, and turf treatment especially for cereals, sorghum, sugar beets, cotton, and flax. Not registered as a pesticide in the United States.

Permissible Exposure Limits in Air: As organo mercury compound.

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg/m^3 STEL [skin].

NIOSH IDLH: 2 mg[Hg]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0149 mg/m^3

PAC-1: 0.0447 mg/m^3

PAC-2: 2.98 mg/m^3

PAC-3: 2.98 mg/m^3

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3.

In addition, North Dakota has set a guideline of 1−3 μg/m^3 for alkyl mercury compounds in ambient air.[60]

Determination in Air: No method available.

Permissible Concentration in Water: *Methylmercury: To protect freshwater aquatic life:* 0.016 μg/L as a 24-h average, never to exceed 8.8 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 2.8 μg/L. *To protect human health:* 0.2 μg/L.[6]

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Alkyl mercury compounds are primary skin irritants and may cause dermatitis. When deposited on the skin, they give no warning, and if contact is maintained, can cause second-degree burns and blisters. Sensitization may occur. In the case of ingestion there is nausea and abdominal pain. Vomiting and diarrhea may occur. Burning or prickling of the lips, tongue, and extremities. The patient may be confused, hallucinated, and irritated; have disturbed sleep; loss of muscular coordination; and memory loss. Visual fields may narrow concentrically; emotional instability may occur as well as inability to concentrate, with stupor and coma. Methylmercuric dicyanamide is extremely toxic to humans. The probable lethal dose for humans is 5−50 mg/kg of body weight (between 7 drops and 1 teaspoon for a 150-lb person). Humans may be poisoned by feeding on the flesh of animals that have ingested this fungicide. Eating treated seeds may also cause poisoning. The poisoning may show delayed manifestations on the nervous system. Patients frequently become gradually worse after their illness is recognized and exposure is stopped.

Long Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. The central nervous system, including the brain, is the principal target tissue for this group of toxic compounds. Severe poisoning may produce irreversible brain damage resulting in loss of higher functions. The effects of chronic poisoning with alkyl mercury compounds are progressive. In the early stages, there are fine tremors of the hands, and in some cases, of the face and arms. With continued exposure, tremors may become coarse and convulsive; scanning speech with moderate slurring and difficulty in pronunciation may also occur. The worker may then develop an unsteady gait of a spastic nature which can progress to severe ataxia of the arms and legs. Sensory disturbances, including tunnel vision, blindness, and deafness, are also common. A late symptom, constriction of the visual fields, is rarely reversible and may be associated with loss of understanding and reason which makes the victim completely out of touch with his environment. Severe cerebral effects have been seen in infants born to mothers who had eaten large amounts of methylmercury-contaminated fish.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended: eye examination. Consider lung function tests for persons with frequent exposure. Examination of the nervous system. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Examination of the central nervous system and kidneys. Consideration should be given to the possible effects on the fetus of alkyl mercury exposure in the mother. Constriction of visual fields may be a useful diagnostic sign. Blood and urine levels of mercury have been studied, especially in the case of methylmercury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m^3:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m^3:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Mercury-based pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Fire and runoff from fire control water may produce irritating or poisonous gases of mercury and nitrogen oxides. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methylmercuric Dicyanamide*. Washington, DC: Chemical Emergency Preparedness Program

Methyl methacrylate monomer M:1060

Molecular Formula: $C_5H_8O_2$

Common Formula: $CH_2{=}C(CH_3)COOCH_3$

Synonyms: Acrylic acid, 2-methyl-, methyl ester; Diakon; MER; Metacrilato de metilo (Spanish); Methacrylate de methyle (French); Methacrylic acid Met; Methacrylic acid, methyl ester; Methacrylsaeuremethyl ester (German); Methyl ester of methacrylic acid; Methyl-methacrylat (German); Methyl methacrylate monomer; Methyl α-methylacrylate; Methyl 2-methyl-2-propenoate; Methyl 2-methylpropenoate; 2-Methyl propenoic acid, methyl ester; MMA; Monocite methacrylate monomer; NCI-C50680; Pegalan; 2-Propenoic acid, 2-methyl-, methyl ester

CAS Registry Number: 80-62-6

RTECS® Number: OZ5075000

UN/NA & ERG Number: UN1247/129

EC Number: 201-297-1 [*Annex I Index No.:* 607-035-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, Animal Lacks Carcinogenicity, *not classifiable as carcinogenic to humans*, Group 3, 1994; EPA: Evidence of noncarcinogenicity for humans; Not likely to be carcinogenic to humans; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U162.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 160.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (2); 8240 (5).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F,Xi; Risk phrases: R11; R37/38; R43; Safety phrases: S2; S24; S37; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl methacrylate is a colorless liquid with an acrid, fruity odor. The odor threshold is 0.05−0.083 ppm. Molecular weight = 100.13; Specific gravity (H_2O:1) = 0.94; Boiling point = 100°C; Freezing/Melting point = −48°C; Vapor pressure = 29 mmHg at 20°C; Flash point = 10°C; Autoignition temperature = 421°C. Explosive limits: LEL = 1.7%; UEL = 8.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water; solubility = 1.5%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Virtually all of the methyl methacrylate monomer produced is used in the production of polymers, such as surface coating resins, plastics (Plexiglas® and Lucite®), ion exchange resins, and plastic dentures.

Incompatibilities: Reacts in air to form a heat-sensitive explosive product at 60°C. Incompatible with nitrates, oxidizers, peroxides, strong acids, strong alkalis, oxidizers, reducing agents, amines, moisture. Contact with benzoyl peroxide may cause ignition, fire, and explosion. May polymerize if subjected to heat, polymerization catalysts (e.g. azoisobutyronitrile, dibenzoyl peroxide, di-*tert*-butyl peroxide, propionaldehyde), strong oxidizers, or ultraviolet light. Usually contains an inhibitor, such as hydroquinone.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.09 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 100 ppm/410 mg/m^3 TWA.
NIOSH REL: 100 ppm/410 mg/m^3 TWA.
ACGIH TLV®[1]: 50 ppm/205 mg/m^3 TWA; 100 ppm/410 mg/m^3 STEL, sensitizer, not classifiable as a human carcinogen.
NIOSH IDLH: 1000 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 17 ppm
PAC-1: **17** ppm
PAC-2: **120** ppm
PAC-3: **570** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 50 ppm/210 mg/m^3 TWA; Peak Limitation Category I(2); danger of skin sensitization; Pregnancy Risk Group C.
Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant.
Australia: TWA 100 ppm (410 mg/m^3), 1993; Austria: MAK 50 ppm (210 mg/m^3), 1999; Belgium: TWA 100 ppm (410 mg/m^3), 1993; Finland: TWA 100 ppm (410 mg/m^3); STEL 150 ppm (615 mg/m^3), 1999; France: VME 100 ppm (410 mg/m^3), VLE 200 ppm (820 mg/m^3), 1999; Hungary: TWA 50 mg/m^3; STEL 150 mg/m^3, 1993; the Netherlands: MAC-TGG 40 mg/m^3, 2003; the Philippines: TWA 100 ppm (410 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3; MAC (STEL) 400 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Sweden: NGV 50 ppm (200 mg/m^3), KTV 150 ppm (600 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (210 mg/m^3), KZG-W 100 ppm (420 mg/m^3), 1999; United Kingdom: TWA 50 ppm (208 mg/m^3); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm. Russia has set a MAC value of 0.1 mg/m^3 for ambient air in residential areas on a momentary basis and also on a daily average basis. Several states have set guidelines or standards for methyl methacrylate in ambient air[60] ranging from 7.0 μg/m^3 (Massachusetts) to 1367 μg/m^3 (New York) to 4100 μg/m^3 (Florida and North Dakota) to 6800 μg/m^3 (Virginia) to 8200 μg/m^3 (Connecticut) to 9742 μg/m^3 (Nevada) to 10,250 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2537, Methyl methacrylate; OSHA Analytical Method 94.

Permissible Concentration in Water: A limit in drinking water has been set by Russia[43] at 0.01 mg/L. Maine[61] has set a guideline of 200 μg/L for methyl methacrylate in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate eyes and skin. Inhalation irritates the respiratory tract. High exposure can cause dizziness, lightheadedness narcosis, and unconsciousness.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated or prolonged inhalation exposure may cause asthma. May affect the central nervous system and the peripheral nervous system. May affect the kidneys and liver. May damage the developing fetus.

Points of Attack: Central nervous system, kidneys, liver, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: polyvinyl alcohol gloves; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; Trellchem™ HPS suits. **4 h**: Teflon™ gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl methacrylate must be stored to avoid contact with oxidizers (such as nitrates, permanganates, perchlorates, chlorates, and peroxides), strong alkalis (such as sodium hydroxide and potassium hydroxide), and strong acids (such as nitric acid, hydrochloric acid, and sulfuric acid) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and ionizing radiation because methyl methacrylate will react and release heat quickly causing an explosion. Store and use with an appropriate inhibitor. Lack of an appropriate inhibitor may cause an explosive reaction.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration may be allowed.

References

US Environmental Protection Agency. (April 30, 1980). *Methyl Methacrylate: Health and Environmental Effects Profile No. 130*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 1, 86−90

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Methyl Methacrylate*. Trenton, NJ

Methyl parathion M:1070

Molecular Formula: $C_8H_{10}NO_5PS$

Synonyms: 8056HC; A-Gro; AI3-17292; Azofos; Azophos; Bay 11405; Bay E-601; Bladan M; Cekumethion; DALF; Devithion; *O*,*O*-Dimethyl *O*-(4-nitrophenyl)-monothiophosphat (German); Dimethyl-*p*-nitrophenyl monothiophosphate; Dimethyl *p*-nitrophenyl monothiophosphate; *O*,*O*-Dimethyl *O*-(*p*-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*,*p*-nitrophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-nitrophenyl phosphorothioate; Dimethyl *p*-nitrophenyl phosphorothionate; Dimethyl 4-nitrophenyl phosphorothionate; *O*,*O*-Dimethyl *O*-(*p*-nitrophenyl) thionophosphate; *O*, *O*-Dimethyl *O*-(*p*-nitrophenyl) thiophosphate; *O*,*O*-Dimethyl *O*,*p*-nitrophenyl thiophosphate; Dimethyl *p*-nitrophenyl thiophosphate; Dimethyl parathion; Drexel methyl parathion 4E; E 601; ENT 17,292; Folidoc; Folidol-80; Folidol M; Folidol M-40; Fosferno M 50; ME-Parathion; Meptox; Metacid 50; Metacide; Metafos (Pesticide); Metaphos; Methyl-E 605; Methyl fosferno; Methyl niran; Methylthiophos; Metilparationa (Spanish); Metron; M-Parathion; NCI-C02971; *p*-Nitrophenyldime thylthionophosphate; Nitrox; Nitrox 80; Oleovofotox; Parapest M-50; Parathion-methyl; Parathion metile; Partron M; Penncap M; Penncap MLS; Phenol, *p*-nitro-, *O*-ester with *O*,*O*-dimethyl phosphorothioate; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(*p*-nitrophenyl) ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(4-nitrophenyl) ester; Quinophos; Sinafid M-48; Sixty-three special E.C. insecticide; Thiophenit; Thylpar M-50; Toll; Vertac methyl parathion technisch 80%; Wofatox 50 EC

CAS Registry Number: 298-00-0

RTECS® Number: TG175000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152; UN1967 (Parathion and compressed gas mixture)/123

EC Number: 206-050-1 [*Annex I Index No.:* 015-035-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat, 1979; IARC: Human No Adequate Data, Animal No Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: *S. cerevisiae*—homozygosis; Negative: Carcinogenicity—mouse/rat; *In vitro* UDS—human fibroblast; Negative: TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P071.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 4.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8140 (0.5); 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as Parathion-methyl.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [methyl parathion (emulsifiable concentrates (EC) at/or >19.5% active ingredient and dusts at/or >1.5% active ingredient)].

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R5; R10; R24; R26/28; R48/22; R50/53; Safety phrases: S1/2; S22-; S28; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methyl parathion is a white to yellow-brown, crystalline solid with a garlic odor. Molecular weight = 263.22; Specific gravity (H_2O:1) = 1.36; Boiling point = 147.8; Freezing/Melting point = 37.2°C. The commercial product in xylene is a tan liquid (80% methyl parathion/20% xylene); Vapor pressure = 0.00001 mmHg at 20°C; Flash point = 46°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 2. Slightly soluble in water; solubility = 0.006% at 25°C.

Potential Exposure: A severely hazardous pesticide formulation. Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. This material is used as an insecticide on over 50 crops, primarily cotton, and on several ornamentals.

Incompatibilities: Incompatible with oxidizers, strong bases, heat. Mixtures with magnesium, or endrin may be violent or explosive. Slightly decomposed by acid solutions. Rapidly decomposed by alkalis. Explosive risk when heated above 50°C. The liquid xylene solution decomposes violently at 120°C.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.2 mg/m^3 TWA, measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI$_A$ issued as Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)*

TEEL-0: 0.02 mg/m^3

PAC-1: 0.06 mg/m^3

PAC-2: **1.2** mg/m^3

PAC-3: **3.5** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.2 mg/m^3, [skin], 1993; Belgium: TWA 0.2 mg/m^3, [skin], 1993; Denmark: TWA 0.2 mg/m^3, [skin], 1999; Finland: TWA 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; Hungary: TWA 0.1 mg/m^3; STEL 0.2 mg/m^3, [skin], 1993; Norway: TWA 0.2 mg/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, [skin], 2003; Russia: STEL 0.1 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.2 mg/m^3, [skin], 1999;

United Kingdom: LTEL 0.2 mg/m^3; STEL 0.6 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia set a MAC of 0.008 mg/m^3 for ambient air in residential areas on a once daily basis. Several states have set guidelines or standards for methyl parathion in ambient air[60] ranging from 2.0 μg/m^3 (North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2112, Methyl parathion.

Permissible Concentration in Water: Russia set a MAC of 0.02 mg/L in water bodies used for domestic purposes. Two states have set a guideline of 30 μg/L for methyl parathion in drinking water—California and Kansas.[61] A lifetime health advisory of 2 μg/L has been developed by EPA.

Determination in Water: Fish Tox = 5.59677000 ppb (HIGH). Octanol−water coefficient: Log $K_{ow} = 2.7$ (pure); 2.04 (V).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl parathion may affect the nervous system, causing convulsions, respiratory failure, and possible death. A cholinesterase inhibitor. Acute exposure to parathion-methyl may produce the following symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. High exposure may result in death. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Because this is a mutagen, handle it as a possible carcinogen—with extreme caution. Methyl parathion may damage the developing fetus. This material is extremely toxic; the probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. Human Tox = 2.00000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause personality changes, depression, anxiety, irritability. May cause liver damage. May damage the developing fetus.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects of exposure may be delayed. Medical monitoring is advised.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *2 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *10 mg/m^3*: CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter] or

GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *200 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD, PP (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from heat sources since violent reactions may occur. See incompatible material listed above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1. Methyl parathion, solid and liquid, carry the symbol "D." The letter "D" identifies proper shipping names that are appropriate for describing materials for *domestic* transportation but may be inappropriate for international transportation under the provisions of international regulations (e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved. Methyl parathion, solid, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II. Methyl parathion, liquid, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate and wash area of spill or leak after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Often available and used in a flammable liquid solution. Poisonous gases, including nitrogen oxides, sulfur oxide, and phosphorus oxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors from the liquid are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration (816°C, 0.5 s minimum for primary combustion; 1204°C, 1.0 s for secondary combustion) with adequate scrubbing and ash disposal facilities. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Methyl Parathion*, NIOSH Document No. 77-106

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 1, 90−97

US Environmental Protection Agency. (November 30, 1987) *Chemical Hazard Information Profile: Parathion-Methyl*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (August 1987). *Health Advisory: Methyl Parathion*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Methyl Parathion*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Methyl phenkapton M:1080

Molecular Formula: $C_9H_{11}Cl_2O_2PS_3$

Synonyms: (2,5-Dichlorophenylthio)methanethiol *S*-ester with *O*,*O*-dimethyl phosphorodithioate; *S*-([(2,5-Dichlorophenyl)thio]methyl) *O*,*O*-dimethyl phosphorodithioate; *O*,*O*-Dimethyl *S*-(2,5-dichlorophenylthio)methyl phosphorodithioate; ENT 25,554; Geigy 30494; Methyl phencapton

CAS Registry Number: 3735-23-7

RTECS® Number: TD6125000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

UN/NA & ERG Number: None assigned

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl phenkapton is a liquid product. Molecular weight = 349.25. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: This material is an acaricide, insecticide. Not registered as a pesticide in the United States.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 11 mg/m^3

PAC-3: 100 mg/m^3

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry containers and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Fire Extinguishing: This material may burn but does not ignite readily. Poisonous gases, including sulfur oxide, phosphorus oxide, and chlorine, are produced in fire. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Phenkapton*. Washington, DC: Chemical Emergency Preparedness Program

Methyl phosphonicdichloride M:1090

Molecular Formula: CH_3Cl_2OP

Common Formula: CH_3POCl_2

Synonyms: Dicloruro de metilfosfonico (Spanish); Methyl phosphonothioic dichloride, anhydrous; Phosphonic dichloride

CAS Registry Number: 676-97-1
RTECS® Number: TA1840000
UN/NA & ERG Number: UN9206/137
EC Number: 211-634-4
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl phosphonic dichloride is a low melting solid or colorless liquid. Molecular weight = 132.91; Boiling point = 162°C; Freezing/Melting point = 32°C; Flash point = $\geq 50°C$ (oc). Mixes violently with water.

Potential Exposure: Used as a chemical intermediate in pesticide manufacture.

Incompatibilities: Reacts violently with water, alcohols, forming hydrochloric acid/hydrogen chloride vapor. The reaction may be violent. Corrodes metals. Incompatible with strong oxidizers, alcohols, bases (including amines). May react violently, possibly explosively, when mixed with ethers and trace amounts of metal salts.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.06 mg/m^3
PAC-1: 0.2 mg/m^3
PAC-2: 3.14 mg/m^3
PAC-3: 15 mg/m^3

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Poisonous if inhaled or swallowed. Highly corrosive. Contact causes severe burns to skin and eyes. May cause permanent damage. Inhalation causes irritation. High levels of exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation or bronchitis to develop.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not breathe vapors. Do not get water inside container; stop leak if you can do so without risk. Do not touch spilled material. Use water spray to reduce vapors but do not put water on leak or spill area. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Dike spill for later disposal; do not apply water unless directed to do so. Clean up only under supervision of an expert. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a

hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.4/0.6

Fire Extinguishing: This material may burn but does not ignite readily. *Small fires:* dry chemical or carbon dioxide. *Large fires:* flood fire area with water from a distance. Do not get solid stream of water on spilled material or inside open containers. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. Poisonous gases, including hydrogen chloride and sulfur dioxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Phosphonic Dichloride*. Washington, DC: Chemical Emergency Preparedness Program

Methyl propionate M:1200

Molecular Formula: $C_4H_8O_2$

Synonyms: Methyl propanoate; Methyl propylate; Propanoic acid, methyl ester; Propionate de methyle (French); Propionato de metilo (Spanish)

CAS Registry Number: 554-12-1

RTECS® Number: UF5970000

UN/NA & ERG Number: UN1248/129

EC Number: 209-060-4 [*Annex I Index No.:* 607-027-00-2]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Xn; Risk phrases: R11; R20; Safety phrases: S2; S16; S24; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyl propionate is a colorless liquid with a sweet, fruity, rum-like odor. Molecular weight = 88.12; Boiling point = 80°C; Freezing/Melting point = −87°C; Flash point = −2°C; Autoignition temperature = 469°C. Explosive limits: LEL = 2.5%; UEL = 13.0%; Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Natural Product; Primary Irritant. Used as a solvent; and in making paints, lacquers, and varnishes. Also, used in flavorings and fragrances.

Incompatibilities: Forms explosive mixture with air. Violent reactions with strong oxidizers, strong acids, strong bases. Keep away from heat and moisture.

Permissible Exposure Limits in Air

No TEEL available.

Russia: STEL 10 mg/m^3, 1993.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause skin and eye irritation.

Long Term Exposure: Repeated high exposures may cause dizziness, lightheadedness, loss of coordination, and difficult breathing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl propionate you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyl propionate reqires a label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Methyl Propionate*. Trenton, NJ

Methyl propyl ether M:1210

Molecular Formula: $C_4H_{10}O$

Synonyms: Ether, methyl propyl; α-Methoxy propane; 1-Methoxypropane; Methyl *n*-propyl ether; Metopryl; Neothyl; Propane, 1-methoxy-

CAS Registry Number: 557-17-5

RTECS® Number: KO2280000

UN/NA & ERG Number: UN2612/127

EC Number: 209-158-7

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl propyl ether is a clear, highly flammable, peroxidizable liquid. Molecular weight = 74.14; Boiling point = 39°C; Flash point $\leq -20°C$. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0.

Potential Exposure: Used to make other chemicals.

Incompatibilities: Forms explosive mixture with air. May be able to form unstable and explosive peroxides. Violent reaction with strong oxidizers. Incompatible with strong acids.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Air: No methods listed.
Routes of Entry: Inhalation, eye and/or skin contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation causes coughing and wheezing. High exposure can cause loss of appetite, headache, dizziness, followed by sleepiness and loss of consciousness.
Long Term Exposure: Causes drying and cracking of the skin.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl propyl ether you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, heat, flames. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Shipping: Methyl propyl ether requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Methyl Propyl Ether*. Trenton, NJ

Methyl propyl ketone M:1220

Molecular Formula: $C_5H_{10}O$
Common Formula: $CH_3COCH_2CH_2CH_3$

Synonyms: Ethyl acetone; Methyl-*n*-propyl ketone; MPK; 2-Pentanone
CAS Registry Number: 107-87-9
RTECS® Number: SA7875000
UN/NA & ERG Number: UN1249/127
EC Number: 203-528-1
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: MPK is a colorless to water-white liquid with a strong odor resembling acetone and ether. The odor threshold is 7.7 ppm. Molecular weight = 86.15; Specific gravity (H_2O:1) = 0.81; Boiling point = 102°C; Freezing/Melting point = − 78°C; Vapor pressure = 27 mmHg at 20°C; Flash point = 7°C (cc); Autoignition temperature = 452°C. Explosive limits: LEL = 1.5%; UEL = 8.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 6%.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. MPK is used as a solvent; as a synthetic food flavoring agent; and in organic synthesis; as a solvent replacement for diethyl ketone and acetone.

Incompatibilities: Reacts violently with strong oxidants, strong bases, amines, and isocyanates. Attacks some plastics.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.52 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 200 ppm/700 mg/m^3 TWA.
NIOSH REL: 150 ppm/530 mg/m^3 TWA.
ACGIH TLV®[1]: 150 ppm/529 mg/m^3 STEL.
NIOSH IDLH: 1500 ppm.
Protective Action Criteria (PAC)
TEEL-0: 150 ppm
PAC-1: 150 ppm
PAC-2: 150 ppm
PAC-3: 1500 ppm
DFG MAK: No numerical value established. Data may be available.
Australia: TWA 200 ppm (700 mg/m^3), STEL 250 ppm, 1993; Austria: MAK 200 ppm (700 mg/m^3), 1999; Belgium: TWA 200 ppm (705 mg/m^3), STEL 250 ppm (881 mg/m^3), 1993; Denmark: TWA 200 ppm (700 mg/m^3), 1999; Finland: TWA 200 ppm (700 mg/m^3), STEL 250 ppm (875 mg/m^3), 1999; France: VME 200 ppm (700 mg/m^3), 1999; the Netherlands: MAC-TGG 700 mg/m^3, 2003; the Philippines: TWA 200 ppm (700 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3; MAC (STEL) 800 mg/m^3, 1999; Russia: STEL 200 mg/m^3, 1993; Switzerland: MAK-W 200 ppm (700 mg/m^3), KZG-W 400 ppm (1400 mg/m^3), 1999; Turkey: TWA 200 ppm (700 mg/m^3), 1993; United Kingdom: TWA 200 ppm (716 mg/m^3), STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm.

Determination in Air: Use NIOSH Analytical Method #1300, Ketones, #2555 Ketones I.[18]

Determination in Water: Octanol−water coefficient: Log K_{ow} = <1.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Methyl propyl ketone can affect you when breathed in and by passing through your skin. Exposure to the vapor can irritate the eyes, nose, throat, and lungs. Skin exposure to the liquid can cause a rash or burning feelings on contact. Contact irritates the eyes. Inhalation causes coughing, wheezing, and/or shortness of breath. Exposure to high concentrations can cause you to feel dizzy and lightheaded and to pass out.

Long Term Exposure: Long-term exposure can cause drying and cracking of the skin. Can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1500 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl propyl ketone must be stored to avoid contact with oxidizers since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flame. Sources of ignition, such as smoking and open flames, are prohibited where methyl propyl ketone is handled, used, or stored. Metal containers used in the transfer of 5 gallons or more of methyl propyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl propyl ketone. Wherever methyl propyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl propyl ketone is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Nat. Inst. for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Ketones*, NIOSH Document No. 78-173. Washington, DC

US Environmental Protection Agency. (December 6, 1977). *Chemical Hazard Information Profile: 2-Pentanone*. Washington, DC

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: Methyl Propyl Ketone*. Trenton, NJ

Methyl silicate M:1230

Molecular Formula: $C_4H_{12}O_4Si$

Common Formula: $(CH_3O)_4Si$

Synonyms: Methyl orthosilicate; Silicid acid, tetramethyl ester; Tetramethoxysilane; Tetramethyl ester of silicic acid; Tetramethyl silicate

CAS Registry Number: 681-84-5

RTECS® Number: VV9800000

UN/NA & ERG Number: UN2606/155

EC Number: 211-656-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl silicate is a liquid. Molecular weight = 152.25; Specific gravity (H_2O:1) = 1.02; Boiling point = 121°C; Freezing/Melting point = −2°C; Vapor pressure = 12 mmHg at 25°C; Flash point = 20°C (cc). Insoluble in water.

Potential Exposure: Methyl silicate is used in coating screens of television picture tubes. It may be used in mold binders and in corrosion-resistant coatings, as well as in catalyst preparation and as a silicone intermediate.

Incompatibilities: Incompatible with oxidizers, water, moisture. Violent reaction with metal hexafluorides of rhenium, molybdenum, and tungsten.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.23 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/6 mg/m^3 TWA.

ACGIH TLV®[1]: 1 ppm/6 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.91 ppm

PAC-1: 0.91 ppm

PAC-2: **0.91** ppm

PAC-3: **1.4** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Danger of skin sensitization.

Australia: TWA 1 ppm (6 mg/m^3), 1993; Belgium: TWA 1 ppm (6 mg/m^3), 1993; Denmark: TWA 1 ppm (6 mg/m^3), 1999; Finland: TWA 5 ppm (30 mg/m^3), STEL 10 ppm (60 mg/m^3), 1999; France: VME 1 ppm (6 mg/m^3), 1999; Japan: 1 ppm (6 mg/m^3), 1999; Norway: TWA 1 ppm (6 mg/m^3), 1999; the Netherlands: MAC-TGG 6 mg/m^3, 2003; United Kingdom: TWA 1 ppm (6.3 mg/m^3), STEL 5 ppm (32 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Methyl silicate can affect you when breathed in. Severely irritates and burns the eyes and skin. Exposure to the vapor can cause severe eye damage and cause permanent blindness. This can occur up to 12 h after exposure has ceased, even if no irritation is noticed at the time. Inhalation irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure to high levels can damage the lungs and kidneys.

Long Term Exposure: May cause kidney damage. Can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Eyes, respiratory system, kidneys, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the eyes and vision; kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 ppm* to liquid methyl silicate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Sources of ignition, such as smoking and open flames, are prohibited where methyl silicate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Methyl orthosilicate requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including silicon oxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol or polymer foam extinguishers. *Do not use water.* Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: Methyl Silicate*. Trenton, NJ

α-Methylstyrene M:1240

Molecular Formula: C_9H_{10}

Common Formula: $C_6H_5C(CH_3){=}CH_2$

Synonyms: AMS; Benzene, (1-methylethenyl)-; Isopropenyl benzene; 1-(Methylethyl) benzene; 1-Methyl-1-phenyl-ethene; 1-Methyl-1-phenyl-ethylene; Phenylpropylene; 2-Phenylpropylene; β-Phenylpropylene; Styrene, α-methyl-

CAS Registry Number: 98-83-9

RTECS® Number: WL5250000

UN/NA & ERG Number: UN2303/128

EC Number: 202-705-0 [*Annex I Index No.:* 601-027-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis studies; on test (prechronic studies), October 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R10; R36/37; R51/53; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Methylstyrene is a colorless liquid with a characteristic odor. Molecular weight = 118.19; Specific gravity (H_2O:1) = 0.91; Boiling point = 165.6°C; Freezing/Melting point = −23.3°C; Vapor pressure = 2 mmHg at 20°C; Flash point = 54°C; Autoignition temperature = 574°C. Explosive limits: LEL = 1.9%; UEL = 6.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Methylstyrene is used as an additive, a plasticizer, and as a copolymer; used in the production of modified polyester and alkyd resin formulations.

Incompatibilities: Incompatible with oxidizers, peroxides, halogens, catalysts for vinyl or ionic polymers; aluminum, iron chloride; copper. Methylstyrene may polymerize. Usually contains an inhibitor, such as *tert*-butyl catechol.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.83 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/480 mg/m^3 Ceiling Concentration.

NIOSH REL: 50 ppm/240 mg/m^3 TWA; 100 ppm/485 mg/m^3 STEL.

ACGIH TLV®[1]: 10 ppm/48 mg/m^3 TWA, confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 700 ppm.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 100 ppm

PAC-2: 100 ppm

PAC-3: 700 ppm

DFG MAK: 50 ppm/250 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant.

Australia: TWA 50 ppm (240 mg/m^3); STEL 100 ppm, 1993; Austria: MAK 100 ppm (480 mg/m^3), 1999; Belgium: TWA 50 ppm (242 mg/m^3); STEL 100 ppm (484 mg/m^3), 1993; Denmark: TWA 50 ppm (240 mg/m^3), 1999; Finland: TWA 100 ppm (480 mg/m^3); STEL 150 ppm (720 mg/m^3), 1999; France: VME 50 ppm (240 mg/m^3), 1999; Norway: TWA 50 ppm (240 mg/m^3), 1999; the Netherlands: MAC-TGG 240 mg/m^3, 2003; Switzerland: MAK-W 50 ppm (240 mg/m^3), 1999; Thailand: TWA 100 ppm (480 mg/m^3), 1993; United Kingdom: STEL 100 ppm (491 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm. Russia[43] set a MAC of 0.04 mg/m^3 (40 μg/m^3) for ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for methylstyrene in ambient air[60] ranging from 2.4−4.85 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 4.8 mg/m^3 (Connecticut) to 5.714 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 1501, aromatic hydrocarbons; OSHA Analytical Method 7.[18]

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.4$.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: The substance irritates the eyes, skin, and the respiratory tract. Prolonged skin contact causes a burning sensation, redness, and blisters. Exposure can cause headache, dizziness, lightheadedness, and difficult breathing.

Long Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and allergy with itching and skin rash. May affect the central nervous system, kidneys, and liver. May cause brain effects or damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, and kidneys.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite). Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Evaluate for brain effects. Evaluate nervous system. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)]; Sa (APF = 10) (any supplied-air respirator). *700 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Isopropenylbenzene requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible and reactive liquid. Poisonous gases are produced in fire. Water may be ineffective. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, often by admixture with a more flammable solvent.[24]

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Isopropenyl Benzene*. Trenton, NJ

Methyltetrahydrofuran M:1250

Molecular Formula: $C_5H_{10}O$

Synonyms: Furan, tetrahydromethyl-; 2-Methyl-tetrahydrofuran; Methyltetrahydrofuran, 2-

CAS Registry Number: 96-47-9; 25265-68-3

RTECS® Number: LU6208000

UN/NA & ERG Number: UN2536/127

EC Number: 246-769-8

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 2—Water polluting (*CAS: 96-47-9*).

Description: Methyltetrahydrofuran is a colorless liquid with an ether-like odor. Boiling point = 80°C; Freezing/Melting point = − 136°C; Flash point = − 11°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Used as a chemical intermediate and a solvent.

Incompatibilities: Strong oxidizers may cause fire and explosion.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

96-47-9

TEEL-0: 6 ppm

PAC-1: 15 ppm

PAC-2: 125 ppm

PAC-3: 600 ppm

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the skin and eyes. Irritates the respiratory tract.

Long Term Exposure: Closely related chemicals affect the nervous system although it is not known whether this chemical has this effect.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyltetrahydrofuran you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Methyltetrahydrofuran requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet:* Methyltetrahydrofuran. Trenton, NJ

Methyl thiocyanate M:1260

Molecular Formula: C_2H_3NS

Common Formula: CH_3CNS

Synonyms: Methyl rhodanate; Methylrhodanid (German); Methyl sulfocyanate; Methylthiokyanat; Thiocyanic acid, methyl ester

CAS Registry Number: 556-64-9

RTECS® Number: XL1575000

UN/NA & ERG Number: UN2810/153

EC Number: 209-134-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 10,000 lb (4540 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Methyl thiocyanate is a colorless liquid with an onion-like odor. Molecular weight = 73.12; Boiling point = 130−133°C; Freezing/Melting point = −51°C. Very slightly soluble in water.

Potential Exposure: It is used as an agricultural insecticide, a fumigant, and as a research chemical. No evidence of commercial production in the United States.

Incompatibilities: Incompatible with nitric acid. Violent reactions have occurred when mixed with chlorates, nitrates, nitric acid, peroxides, potassium chlorate, and sodium chlorate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 28.4 mg/m^3
PAC-3: 4 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Prolonged skin absorption may produce various eruptions, runny nose, dizziness, cramps, nausea, vomiting, and mild or severe disturbances of the nervous system. This material is highly toxic if ingested. The ingestion of a concentrated solution may lead to vomiting. The principal systemic reaction is probably one of central nervous system depression, interrupted by periods of restlessness; abnormally fast and deep respiratory movements and convulsions. Death is usually due to respiratory arrest from paralysis of the medullary centers.

Long Term Exposure: May cause injury to the liver and kidneys.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note: Because cyanide is probably largely responsible for poisonings, antidotal measures against cyanide should be instituted promptly. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *(for cyanides) Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Toxic liquid, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases, including nitrogen oxides, sulfur oxides, are produced in fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Thiocyanate*. Washington, DC: Chemical Emergency Preparedness Program

Methyltrichlorosilane M:1280

Molecular Formula: CH_3Cl_3Si

Synonyms: Methylsilicochloroform; Methylsilyl trichloride; KA 13; LS 40 (silane); Methylsilicon trichloride; Trichloromethylsilicon; Silane, trichloromethyl-; Trichloromethylsilane

CAS Registry Number: 75-79-6; *(alt.)* 175446-71-6

RTECS® Number: VV4550000

UN/NA & ERG Number: UN1250/155

EC Number: 200-902-6 [*Annex I Index No.:* 014-004-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

US EPA Hazardous Waste Number (RCRA No.): U164.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; 14; R36/37/38; Safety phrases: S2; S26; S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Methyltrichlorosilane is a colorless liquid with a sharp hydrochloric acid-like odor. Molecular weight = 149.48; Boiling point = 66°C; Freezing/Melting point = −90°C; Vapor pressure = 146.7 mmHg at 18°C; Flash point = − 6.2°C; − 8°C (cc); Autoignition temperature ≥404°C. Explosive limits: LEL = 7.6%; UEL ≥20%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: Compound Description: Primary Irritant. Methyltrichlorosilane is used as an intermediate to make silicones; for making water repellants, electrical insulation, heat-resistant paints, and other products.

Incompatibilities: Water, steam, acids, alkalis, chemically active metals (potassium, sodium, magnesium, and zinc). Reacts violently with strong oxidizers. Reacts violently with water, moisture, and alkalis producing hydrogen chloride. Attacks metals, such as aluminum, magnesium.

Permissible Exposure Limits in Air

AIHA WEEL: 1 ppm, Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.60** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: If the eyes have come in contact with methyltrichlorosilane, then irritation, pain, swelling, corneal erosion, and blindness may result. Dermatitis (red, inflamed skin), severe burns, pain, and shock generally follow dermal exposure. As with other chlorosilanes, acute exposures may be highly toxic and may cause death or permanent injury after very short exposures to small quantities. Skin contact may produce severe burns with pain and risk of secondary infections. Ingestion may produce oral, esophageal, and stomach burns; intensity will vary from mild to very severe; gastrointestinal damage is rare but may occur. Signs and symptoms of acute ingestion of methyltrichlorosilane may include excessive salivation, intense thirst, difficulty in swallowing, chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of methyltrichlorosilane. Acute inhalation exposure may result in hoarseness, laryngitis, a feeling of suffocation, dyspnea (shortness of breath), choking, respiratory tact irritation, chest pain. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Sneezing, bleeding of the nose and gums, and ulceration of the nasal and oral mucosa may also occur.

Long Term Exposure: Highly irritating material; may affect the lungs, and bronchitis may develop. Renal toxicity has been observed in animals.

Points of Attack: Lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyltrichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyltrichlorosilane must be stored to avoid contact with water, acids, chemically active metals (such as potassium, sodium, magnesium, and zinc), and alkalis since violent reactions occur and hydrogen chloride is produced. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyltrichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of methyltrichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyltrichlorosilane. Wherever methyltrichlorosilane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills can be neutralized by flushing with large quantities of water followed by treatment with sodium bicarbonate. Provide adequate protection against generated hydrogen chloride. Do not allow water to get into container since resulting pressure could cause container to rupture. Protect against potentially violent reaction with water. Avoid breathing vapors and contact with skin. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)
when spilled in water
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.3/2.0

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Dry chemical or carbon dioxide may be used for small fires. *Do not use water* or hydrous agents. However, water may be used for large fires if firefighters are protected from violent reactions of methyltrichlorosilane with water. Water may be used to keep containers cool. Self-contained breathing apparatus is required as combustion/decomposition yields acid gases/pulmonary irritants. Corrosion-resistant protective clothing, as well as appropriate foot, hand, arm, head, eye, and face protection are required where contact is possible. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyltrichlorosilane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Methyl Trichlorosilane*. Trenton, NJ

Methyl vinyl ketone M:1290

Molecular Formula: C_4H_6O
Common Formula: $CH_2{=}CHCOCH_3$
Synonyms: Acetyl ethylene; 3-Butene-2-one; Methylene acetone; Methyl-vinyl-cetone (French); Methylvinylketon (German); Metil vinil cetona (Spanish); MVK; γ-Oxo-α-butylene; Vinyl methyl ketone
CAS Registry Number: 78-94-4
RTECS® Number: EM9800000
UN/NA & ERG Number: UN1251 (stabilized)/131
EC Number: 201-160-6

Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Methyl vinyl ketone is a colorless liquid with a pungent odor. The odor threshold is 0.5 mg/m^3. Molecular weight = 70.01; Boiling point = 81°C; Flash point = −7°C; Autoignition temperature = 491°C. Explosive limits: LEL = 2.1%; UEL = 15.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Methyl vinyl ketone is used as an alkylating agent, a starting material for plastics; and an intermediate in the synthesis of steroids and vitamin A.

Incompatibilities: Forms explosive mixture with air. Heat or shock may cause explosive polymerization. Violent reaction with strong oxidizers.

Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.2 ppm/0.6 mg/m^3 [skin] danger of skin sensitization, Ceiling Concentration.
Protective Action Criteria (PAC)*
TEEL-0: 0.05 ppm
PAC-1: **0.17** ppm
PAC-2: **1.2** ppm
PAC-3: **2.4** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: [skin] danger of skin sensitization.
Russia: STEL 0.1 mg/m^3, [skin], 1993.

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Warning*: Methyl vinyl ketone is easily absorbed through the skin, causing general poisoning;

inhalation has central nervous system depressant effects. It is irritating to mucous membranes and respiratory tract and to the skin; it is a lachrymator and can cause eye injury. Liquid or high concentration of vapors causes blistering of the skin. Similar to other ketones, it can cause sore throat, sneezing, coughing, and salivation. Inhalation may cause nausea and vomiting; inhalation of high concentrations can cause headache, dizziness, fainting, tremor, uncoordination, lowered body temperature, depressed respiratory and heart rate, gasping, coma, and death. Direct aspiration of liquid into lungs can cause chemical pneumonia.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: For emergency situations, wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage room. Separate from oxidizing materials. MVK vapors are uninhibited and may form polymers in the flame arresters of storage tanks, resulting in stoppage of vent.

Shipping: Methyl vinyl ketone, stabilized, requires a shipping label of “POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID, CORROSIVE.” It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 48-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 2.3./3.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0 + /11.0 +
Night 7.0 + /11.0 +

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, alcohol foam, or carbon dioxide. Water spray may be ineffective as an extinguishing agent. *Small fires:* dry chemical, carbon dioxide, and foam. *Large fires:* fog or foam. Move container form fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. Spray cooling water on containers that are exposed to flames until well after fire is out. Wear positive pressure breathing apparatus and special protective clothing. *See above for isolation distances.* Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Methyl Vinyl Ketone*. Washington, DC: Chemical Emergency Preparedness Program

2-Methyl-5-vinylpyridine M:1300

Molecular Formula: C_8H_9N

Synonyms: 5-Ethenyl-2-methylpyridine; MVP; 5-Vinyl-2-picoline

CAS Registry Number: 140-76-1

RTECS® Number: UT2975000

UN/NA & ERG Number: UN3073 (stabilized)/131

EC Number: 205-432-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Methyl-5-vinylpyridine is a clear to faintly opalescent liquid. Molecular weight = 119.18; Boiling point = 181°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0; Flash point = 74°C.

Potential Exposure: 2-Methyl-5-vinylpyridine is used as a monomer for resins, oil additive, ore flotation agent, and dye acceptor.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1.9 mg/m^3

PAC-3: 40 mg/m^3

Russia[43] set a MAC of 2.0 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is poisonous by ingestion, inhalation, and absorption through the skin. Vapors may cause dizziness or suffocation.

Long Term Exposure: May cause liver and kidney damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Vinylpyridines require a label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID, CORROSIVE." They fall in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Pyridine, 2-Methyl-5-Vinyl*. Washington, DC: Chemical Emergency Preparedness Program

Metolachlor M:1310

Molecular Formula: $C_{15}H_{22}ClNO_2$

Synonyms: 2-Aethyl-6-methyl-*N*-(1-methyl-2-methoxyaethyl)-chloracetanilid (German); Bicep; CGA-24705; α-Chlor-6′-aethyl-*N*-(2-methoxy-1-methylaethyl)-acet-*o*-toluidin (German); 2-Chloro-6′-ethyl-*N*-(2-methoxy-1-methylethyl)acet-*o*-toluidide; α-Chloro-2′-ethyl-6′-methyl-*N*-(1-methyl-2-methoxyethyl)-acetanilide; 2-Chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl) acetamide; 2-Chloro-*N*-(6-ethyl-*o*-tolyl)-*N*-(2-methoxy-1-methylethyl)-acetamide; Codal®; Cotoran® Multi®; Dual®; 2-Ethyl-6-methyl-1-*N*-(2-methoxy-1-methylethyl)chloroacetanilide; Metelilachlor; Milocep; Ontrack 8E®; Primagram®; Primextra®

CAS Registry Number: 51218-45-2; *(alt.)* 63150-68-5; *(alt.)* 94449-58-8

RTECS® Number: AN3430000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: 257-060-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Possible Human Carcinogen.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Metolachlor is a colorless or tan to brown, oily liquid with a slightly sweet odor. Molecular weight = 283.83; Boiling point = 100°C at 0.001 mmHg. It is stable to about 300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant. It is a selective herbicide used for weed control in corn and for controlling grasses in a variety of crops including cotton and peanuts.

Incompatibilities: Oxidizers, strong acids, nitrates.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: The US EPA has set a lifetime health advisory of 10 μg/L. Several states have set guidelines for metolachlor in drinking water ranging from 1.0 μg/L (Illinois) to 17.5 μg/L (Kansas) to 25 μ/mL (Wisconsin).

Determination in Water: Extraction with methylene chloride followed by separation by gas chromatography and measurement using a nitrogen-phosphorus detector. Fish Tox = 1117.14617000 ppb (VERY LOW).

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. The acute oral LD_{50} for rats is 2780 mg/kg (slightly toxic). Signs of human intoxication from metolachlor and/or its formulations (presumably following acute deliberate or accidental exposures) include abdominal cramps, anemia, ataxia, dark urine, methemoglobinemia, cyanosis, hypothermia, collapse, convulsions, diarrhea, gastrointestinal irritation, jaundice, weakness, nausea, shock, sweating, vomiting, CNS depression, dizziness, dyspnea, liver damage, nephritis, cardiovascular failure, skin irritation, dermatitis, sensitization dermatitis, eye and mucous membrane irriation, corneal opacity, and adverse reproductive effects. Human Tox = 100.00000 ppb (VERY LOW).

Long Term Exposure: May cause tumors.

Points of Attack: Blood.

Medical Surveillance: Test for methemoglobinemia. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Pesticides, liquid, toxic, n.o.s. require the label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory*. Washington, DC: Office of Drinking Water

Metolcarb M:1320

Molecular Formula: $C_9H_{11}NO_2$

Common Formula: $C_6H_4(CH_3)OCONHCH_3$

Synonyms: Carbamic acid, methyl-, 3-methylphenyl ester; Carbamic acid, methyl-, 3-tolyl ester; *m*-Cresyl ester of *N*-methylcarbamic acid; *m*-Cresyl methyl carbamate; *m*-Cresyl methylcarbamate; Dicresyl; Dicresyl *N*-methylcarbamate; DRC 3341; Kumiai; Metacrate; Metholcarb; Methylcarbamic acid *m*-toyl ester; *m*-Methylphenyl methylcarbamate; 3-Methylphenyl *N*-methylcarbamate; Metolcarb; MTMC; S 1065; *m*-Tolyester kyseliny methyl karbaminove;

m-Tolyl *N*-methylcarbamate; 3-Tolyl *N*-methylcarbamate; Tsumacide; Tsumaunka

CAS Registry Number: 1129-41-5

RTECS® Number: FC8050000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151

EC Number: 214-446-0 [*Annex I Index No.:* 006-056-00-2]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P190.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] Reportable Quantity (RQ): 1000 lb (454 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R51/53 Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Metolcarb is a colorless crystalline solid. Molecular weight = 165.21; Freezing/Melting point = 74−75°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Metolcarb is an insecticide used for the control of rice leafhoppers, plant-hoppers, codling moth, citrus mealy bug, onion thrips, fruit flies, bollworms, and aphids. Not registered as a pesticide in the United States.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 4.8 mg/m^3

PAC-3: 200 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Metolcarb is a carbamate insecticide. Signs and symptoms of poisoning by carbamates are similar to those for organic phosphorus compounds. Symptoms of poisoning by organic phosphorus compounds include headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, myosis, tearing, salivation and other excessive respiratory tract secretion, vomiting, cyanosis, uncontrollable muscle twitches followed by muscular weakness, convulsions, coma, loss of reflexes, and loss of muscular control. Metolcarb exhibits high oral and skin toxicity, and moderate inhalation toxicity. Some carbamates appear to be carcinogenic, teratogenic, and/or mutagenic. Carbamates are cholinesterase inhibitors.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Carefully observe victim since effects may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a

full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Carbamate pesticides, solid, toxic, require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Solid carbamate pesticides may burn but do not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, and foam. For large fires, use water spray, fog, or foam. Dike fire control water for later disposal. Stay upwind and keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Metolcarb*. Washington, DC: Chemical Emergency Preparedness Program

Metribuzin M:1330

Molecular Formula: $C_8H_{14}N_4OS$

Synonyms: 4-Amino-6-*tert*-butyl-3-(methylthio)-1,2,4-triazin-5-one; 4-Amino-6-*tert*-butyl-3-methylthio-As-triazin-5-one; 4-Amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5-(4H)-one; As-triazin-5(4H)-one,4-amino-6-*tert*-butyl-3-(methylthio)-; Bay 61597; Bay DIC 1468; Bayer 6159H; Bayer 6443H; Bayer 94337; DIC 1468; Lexone; Lexoneex; Metribuzina (Spanish); Sencor; Sencoral; Sencorer; Sencorex; 1,2,4-Triazin-5-(4H)-one, 4-Amino-6-(1,1-dimethylethyl)-3-(methylthio)-

CAS Registry Number: 21087-64-9

RTECS® Number: XZ2990000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, poisonous)/151

EC Number: 244-209-7 [*Annex I Index No.:* 606-034-00-8]

Regulatory Authority and Advisory Bodies

EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Safe Drinking Water Act: Priority List (55 FR 1470).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: 22; R50/53; Safety phrases: S2; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Metribuzin is a colorless crystalline solid with a mild sulfurous odor; Freezing/Melting point = 125−127°C; Vapor pressure = 4×10^{-7} mmHg. Slightly soluble in water. Available in different concentrations (4%, 50%, 75%).

Potential Exposure: Those involved in manufacture, formulation, and application of this herbicide.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA, not classifiable as a human carcinogen.

No TEEL available.

Guidelines or standards for metribuzin in ambient air[60] have been set by several states ranging from 50 μg/m^3 (North Dakota) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: The US EPA has set a lifetime health advisory of 175 μg/L. Several states have set guidelines for metribuzin in drinking water[61] ranging from 1.0 μg/L (Illinois) to 25 μg/L (Wisconsin) to 175 μg/L (Kansas).

Determination in Water: Solvent extraction with methylene chloride followed by exchange to acetone; separation by gas chromatography and measurement with a thermionic bead detector. Fish Tox = 7683.76758000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Metribuzin can affect you when breathed in and by passing through your skin. Acute poisoning can cause difficult breathing and drowsiness. High exposures may cause upset stomach, fatigue, and depression of the central nervous system, causing poor coordination, tremors, and weakness. Human Tox = 200.00000 ppb (VERY LOW).

Long Term Exposure: Repeated or high exposure may cause liver enzyme changes, goiter, and may affect thyroid function.

Points of Attack: Central nervous system, thyroid, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a pesticide cartridge. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, dry area.

Shipping: Triazine pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Metribuzin itself does not burn. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Metribuzin*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Metribuzin*. Trenton, NJ

Metronidazole M:1340

Molecular Formula: $C_6H_9N_3O_3$

Synonyms: Acromona; Anagiardil; Atrivyl; Bayer 5360; Bexon; Clont; Cont; Danizol; Deflamon-wirkstoff; Efloran; Elyzol; Entizol; 1-(β-Ethylol)-2-methyl-5-nitro-3-azapyrrole; Eumin; Flagemona; Flagesol; Flagil; Flagyl; Giatricol; Gineflavir; 1-(β-Hydroxyethyl)-2-methyl-5-nitroimidazole; 1-(2-Hydroxy-1-ethyl)-2-methyl-5-nitroimidazole; 1-(2-Hydroxyethyl)-2-methyl-5-nitroimidazole; 1-Hydroxyethyl-2-methyl-5-nitroimidazole; Klion; Meronidal; 2-Methyl-1-(2-hydroxyethyl)-5-nitroimidazole; 2-Methyl-3-(2-hydroxyethyl)-4-nitroimidazole; Metronidaz; Metronidazol; Metronidazolo; Monagyl; Nalox; Neo-Tric; NIDA; Novonidazol; NSC-50364; Orvagil; 1-(β-Oxyethyl)-2-methyl-5-nitroimidazole; RP 8823; Sanatrichom; SC 10295; Trichazol; Trichocide; Trichomol; Trichomonacid "Pharmachim"; Trichopol; Tricom; Tricowas B; Trikojol; Trimeks; Trivazol; Vagilen; Vagimid; Vertisal

CAS Registry Number: 443-48-1

RTECS® Number: NI5600000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 207-136-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Metronidazole is an odorless, white, yellow, or cream-colored crystalline solid. Darkens on exposure to light. Molecular weight = 171.18; Freezing/Melting point = 158−160°C. Soluble in water.

Potential Exposure: Metronidazole is an orally administered drug for the treatment of infections due to *entamoeba histolytica*, *trichomonas vaginalis*, *giardia lamblia* and has also been used for treating Vincent's infection. It can be used as a trichomonacide in veterinary medicine. One firm has petitioned EPA to use metronidazole as a disinfectant for cooling tower water.

Permissible Exposure Limits in Air

No standards or TEEL available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <-0.1$.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include headache, anorexia, nausea, occasional vomiting, diarrhea, and rash.

Long Term Exposure: There is evidence that this substance is carcinogenic in animals. Possibly carcinogenic to humans.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Dampen spilled material with water to avoid dust. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Metronidazole*. Trenton, NJ

Mevinphos M:1350

Molecular Formula: $C_7H_{13}O_6P$

Synonyms: AI3-22374; Apavinphos; 2-Butenoic acid, 3-[(dimethoxyphosphinyl)oxy]-, methyl ester; 2-Carbomethoxy-1-methylvinyl dimethyl phosophate, α-isomer; α-2-Carbomethoxy-1-methylvinyl dimethyl phosphate; (α-2-Carbomethoxy-1-methylvinyl) dimethyl phosphate; 2-Carbomethoxy-1-methylvinyl dimethyl phosphate; 2-Carbomethoxy-1-propen-2-yl dimethyl phosphate; Caswell No. 160B; CMDP; Compound 2046; Crotonic acid, 3-hydroxy-, methyl ester, dimethyl phosphate; Crotonic acid, 3-hydroxy-, methyl ester, dimethyl phosphate, (*E*)-; 3-[(Dimethoxyphosphinyl)oxy]-2-butenoic acid methyl ester; *O*,*O*-Dimethyl *O*-(2-carbomethoxy-1-methylvinyl) phosphate; *O*,*O*-Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate; Dimethyl-1-carbomethoxy-1-propen-2-yl phosphate; Dimethyl (2-methoxycarbonyl-1-methylvinyl) phosphate; Dimethyl methoxycarbonylpropenyl phosphate; Dimethyl (1-methoxycarboxypropen-2-yl) phosphate; *O*,*O*-Dimethyl *O*-(1-methyl-2-carboxyvinyl) phosphate; Dimethyl phosphate of methyl 3-hydroxy-*cis*-crotonate; Duraphos; ENT 22,374; EPA pesticide chemical code 015801; Gesfid; Gestid; 3-Hydroxycrotonic acid methyl ester dimethyl phosphate; Menite; (*cis*-2-Methoxycarbonyl-1-methylvinyl) dimethyl phosphate; *cis*-2-Methoxycarbonyl-1-methylvinyl dimethylphosphate; 2-Methoxycarbonyl-1-methylvinyl dimethyl phosphate; 1-Methoxycarbonyl-1-propen-2-yl dimethyl phosphate; Methyl 3-[(dimethoxyphosphinyl)oxy]-2-butenoate; Methyl-3-[(dimethoxyphosphinyl)oxy]-2-butenoate, α-isomer; Methyl 3-(dimethoxyphosphinyloxy)crotonate; Methyl 3-hydroxy-α-crotonate dimethyl phosphate; Methyl 3-hydroxycrotonate dimethyl phosphate ester; Methyl-3-hydroxy-α-crotonate, dimethyl phosphate ester; Mevinfos (Spanish); NSC 46470; PD 5; *cis*-Phosdrin; Phosdrin; Phosfene; Phosphene; Phosphoric acid, dimethyl ester, with methyl 3-hydroxycrotonate; Phosphoric acid, (1-methoxycarboxypropen-2-yl) dimethyl ester

CAS Registry Number: 7786-34-7

RTECS® Number: GQ5250000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 232-095-1 [*Annex I Index No.:* 015-020-00-5]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (India, Norway) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Very Toxic Substance (World Bank).[15]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S23; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Mevinphos is a pale yellow to orange high-boiling liquid with a weak odor. The carrier solvent may change the physical properties listed here. Molecular weight = 224.17; Specific gravity (H_2O:1) = 1.25; Boiling point = decomposes; Freezing/Melting point = 7°C (*trans*-); 21°C (*cis*-); Vapor pressure: 0.0001 mmHg at 20°C; Flash point = 30°C (oc); 79.5°C (oc).[ICSC] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water. Commercial product is a mixture of the *cis*- and *trans*-isomers. Insecticide that may be absorbed on a dry carrier.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Human Data. Those engaged in the manufacture, formulation, and application of this contact and systemic insecticide and acaricide.

Incompatibilities: Decomposes in heat (below boiling point at 300°C) producing phosphoric acid and phosphorus oxides fumes. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Corrosive to cast iron, some stainless steels, and brass. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.17 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 mg/m^3 TWA [skin].

NIOSH REL: 0.01 ppm/0.1 mg/m^3 TWA; 0.03 ppm/0.3 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 measured as inhalable fraction and vapor TWA [skin]; not classifiable as a human carcinogen; BEI_A issued as Acetylcholinesterase-inhibiting pesticides.

NIOSH IDLH: 4 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.01 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 36.6 mg/m^3

DFG MAK: 0.01 ppm/0.093 mg/m^3 TWA; Peak Limitation Category II(2) [skin].

Arab Republic of Egypt: TWA 0.01 ppm (0.1 mg/m^3) [skin] 1993; Australia: TWA 0.01 ppm (0.1 mg/m^3); STEL 0.03 ppm [skin] 1993; Austria: MAK 0.01 ppm (0.1 mg/m^3) [skin] 1999; Belgium: TWA 0.01 ppm (0.09 mg/m^3); STEL 0.03 ppm [skin] 1993; Denmark: TWA 0.01 ppm (0.1 mg/m^3) [skin] 1999; Finland: TWA 0.001 ppm, 1999; France: VME 0.01 ppm (0.1 mg/m^3) [skin] 1999; the Netherlands: MAC-TGG 0.1 mg/m^3 [skin] 2003; Norway: TWA 25 ppm (125 mg/m^3), 1999; the Philippines: TWA 0.1 mg/m^3 [skin] 1993; Switzerland: MAK-W 0.01 ppm (0.1 mg/m^3) [skin] 1999; Thailand: TWA 0.1 mg/m^3, 1993; United Kingdom: TWA 0.01 ppm (0.09 mg/m^3); STEL 0.03 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.27 mg/m^3 (skin). Several states have set guidelines or standards for mevinphos in ambient air[60] ranging from 1−3 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: No criteria set. This chemical is highly toxic to aquatic life.

Determination in Water: Fish Tox = 0.96183000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Short Term Exposure: Cholinesterase inhibitor. Mevinphos may affect the nervous system, causing convulsions, respiratory failure. This material is super toxic; the probable oral lethal dose for humans is less than 5 mg/kg or a taste (less than 7 drops) for a 150-lb person. It has direct and immediate effects whether it is swallowed, inhaled, or absorbed through the skin. Symptoms include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, dizziness, runny nose, tightness in the chest, blurring and dimming of vision, slurring of speech, twitching of muscles, mental confusion, disorientation, troubled breathing, blueing of skin, convulsions, coma, and death. Human Tox = 1.75000 ppb (HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: NIOSH lists the following tests: Blood serum; Cholinesterase, Blood Serum, Red blood cells/count. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.1 ppm:* Sa (APF = 10) (any supplied-air respirator). *0.25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *0.5 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *4 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mevinphos is 50% hydrolyzed in aqueous solutions at an unspecified temperature in 1.4 h at pH 11, 35 days at pH 7, and 120 days at pH 6. Decomposition is rapidly accomplished by lime sulfur. Mevinphos may also be incinerated. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 1, 97−101

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mevinphos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Mevinphos*. Trenton, NJ

Mexacarbate M:1360

Molecular Formula: $C_{12}H_{18}N_2O_2$

Synonyms: Carbamate, 4-dimethylamino-3,5-xylyln-methyl-; Carbamic acid, methyl-, 4-(dimethylamino)-3,5-xylyl ester; Carbamic acid, methyl-, methylcarbamate (ester); 4-(Dimethylamine)-3,5-xylyl *N*-methylcarbamate;

4-(Dimethylamino)-3,5-dimethylphenol methylcarbamate (ester); 4-(Dimethylamino)-3,5-dimethylphenyl *N*-methylcarbamate; 4-(Dimethylamino)-3,5-xylenol, methylcarbamate (ester); 4-(*N*,*N*-Dimethylamino)-3,5-xylyl *N*-methylcarbamate; 4-Dimethylamino-3,5-xylyl *N*-methylcarbamate; 4-Dimethylamino-3,5-xylyl methylcarbamate; 5-Dimethylphenol methylcarbamate ester; DowCo® 139; ENT 25766; Methylcarbamic acid, 4-(dimethylamino)-3,5-xylyl ester; Methyl 4-dimethylamino-3,5-xylyl carbamate; Methyl-4-dimethylamino-3,5-xylyl ester of carbamic acid; Mexacarbato (Spanish); NCI-C00544; OMS-47; Phenol, 4-(dimethylamino)-3,5- dimethyl-methylcarbamate (ester); 3,5-Xylenol, 4-(dimethylamino)-, methylcarbamate; Zactran; Zectane; Zectran; Zextran

CAS Registry Number: 315-18-4

RTECS® Number: FC0700000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151

EC Number: 206-249-3 [*Annex I Index No.*: 006-054-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat, 1979; IARC: Human No Adequate Data, Animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P128.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R1; R28; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mexacarbate is an odorless, white to tan crystalline solid. Molecular weight = 222.32; Freezing/Melting point = 85°C; Vapor pressure = 0.1 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: It is an insecticide for nonagricultural uses, e.g., lawn and turf, flowers, gardens, vines, forest lands, woody shrubs and trees; and also a molluscicide. It is not produced or used commercially in the United States.

Incompatibilities: Alkalis, strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2.5 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 14 mg/m^3

PAC-3: 14 mg/m^3

Determination in Water: Fish Tox = 31.03658000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin, and/or contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Extremely toxic: probable oral lethal dose for humans is 5−50 mg/kg, between 7 drops and 1 teaspoonful for a 70-kg person (150 lb). Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. Symptoms of carbamate poisoning resemble those of parathion. This material is similar to carbaryl; symptoms of carbaryl exposure include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, sweating, lassitude, and weakness. Runny nose and sensation of tightness in chest may occur with inhalation exposures. Blurring or dimness of vision, tearing, eye muscle spasm, loss of muscle coordination, slurring of speech, and twitching of muscles may also occur.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Mexacarbate may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place or a refrigerator.

Shipping: Carbamate pesticide, solid, toxic, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mexacarbate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Mexacarbate*. Trenton, NJ

Mica M:1370

Molecular Formula: $Al_6H_4K_2O_{24}Si_6$

Common Formula: $K_2Al_4(Al_2Si_6O_{20})(OH)_4$

Synonyms: Amber mica; Biotite; Fluorophlogopite; Lepidolite; Margarite; Mica silicate; Muscovite; Phlogopite; Roscoelite, suzorite mica; Zimmwaldite

CAS Registry Number: 12001-26-2

RTECS® Number: VV8760000

UN/NA & ERG Number: Not regulated.

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Description: Mica (Muscovite) takes the form of a colorless, odorless solid that separates into flakes or thin sheets of hydrous silicates. Molecular weight = 797 (approx.); Specific gravity (H_2O:1) = 2.6−3.2. Insoluble in water.

Potential Exposure: Mica is used as reinforcing filler for plastics, substitute for asbestos; for insulation in electrical equipment; used in the manufacture of roofing shingles, wallpaper, and paint.

Incompatibilities: Silicates react with lithium.

Permissible Exposure Limits in Air

OSHA PEL: 20 mppcf, $<$1% crystalline silica TWA.

NIOSH REL: 3 mg/m^3 respirable dust; containing <1% quartz TWA.
ACGIH TLV®[1]: 3 mg/m^3 respirable fraction TWA.
NIOSH IDLH: 1500 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 3 mg/m^3
PAC-1: 9 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 500 mg/m^3
Australia: TWA 2.5 mg/m^3, 1993; Belgium: TWA 3 mg/m^3, 1993; Switzerland: MAK-W 3 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3 (total dust); MAC-TGG 2.5 mg/m^3 (respirable dust), 2003; United Kingdom: TWA 10 mg/m^3, total inhalable dust; TWA 0.8 mg/m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 3 mg/m^3, respirable fraction.

Determination in Air: Use NIOSH Analytical Method (IV) #0600, Particulates NOR (respiratory).

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Unknown at this time.

Long Term Exposure: Pneumoconiosis, cough, dyspnea, weakness, weight loss. Repeated heavy exposure can irritate the lungs. After years of high exposure, lung scarring (fibrosis) may result. This causes an abnormal chest X-ray and may cause cough and a shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: lung function tests; chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 15 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *Up to 30 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 75 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 150 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F APF = 50 (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Mica silica itself does not burn. Poisonous gases are produced in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill.

Reference

New Jersey Department of Health and Senior Services. (January 1996). *Hazardous Substances Fact Sheet: Silica, Mica*. Trenton, NJ

Michlers ketone M:1380

Molecular Formula: $C_{17}H_{20}N_2O$
Common Formula: $(CH_3)_2N\text{-}C_6H_4\text{-}CO\text{-}C_6H_4\text{-}N(CH_3)_2$
Synonyms: Benzophenone, 4,4′-bis(dimethylamino)-; *p*,*p*′-Bis(dimethylamino)benzophenone; 4,4′-Bis(dimethylamino) benzophenone; Bis(4-dimethylaminophenyl) ketone; Bis[*p*-(*N*,*N*-dimethylamino)phenyl] ketone; Cetona de michler (Spanish); Methanone, bis[4-(dimethylamino)phenyl]-; *p*,*p*′-Michler's ketone; NCI-C02006; *N*,*N*,*N*′,*N*′-Tetramethyl-4,4′-diaminobenzophenone; Tetramethyldiaminobenzophenone
CAS Registry Number: 90-94-8
RTECS® Number: DJ0250000
UN/NA & ERG Number: UN1602 (Dye intermediate, liquid, toxic, n.o.s.)/151
EC Number: 202-027-5 [*Annex I Index No.:* 606-073-00-0]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (feed); clear evidence: rat, mouse, 1979.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer 1/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R41; R68; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Michler's ketone is a blue powder or white to green-colored leaflet material. Molecular weight = 268.37; Boiling point ≥360°C (decomposition); Freezing/Melting point = 172−176°C; Flash point = 220°C; Autoignition temperature = 480°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.
Potential Exposure: Mutagen. Animal Carcinogen. Michler's ketone is a dye intermediate and derivative of dimethylaniline. It is also used in antifreeze formulations, cosmetics, cleaning compounds, heat transfer fluids; as a chemical intermediate in the synthesis of at least 13 dyes and pigments, especially auramine derivatives.
Incompatibilities: Ketones can react violently with oxidizers and strong reducing agents, aldehydes, nitric acid. Contact with hydrogen peroxide may form heat- and shock-sensitive explosives.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3.5 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 40 mg/m^3
DFG MAK: Carcinogen Category 2.
Routes of Entry: Inhalation and skin adsorption.
Harmful Effects and Symptoms
Irritates the eyes, skin, and mucous membranes. Absorbed through the skin.
Short Term Exposure: May have a narcotic or an anesthetic effect.
Points of Attack: Gastrointestinal or liver cancer.
Long Term Exposure: A potential occupational carcinogen.
First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and

storage. Store in a refrigerator or a cool, dry place away from peroxides, aldehydes, strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dye intermediates, liquid, toxic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Mineral oil M:1385

Synonyms: Adepsine oil; Heavy mineral oil mist; Mist of white mineral oil; Cutting oil; Heat-treating oil; Hydraulic oil; Cable oil; Lubricating oil; Paraffin oil mist; White mineral oil mist

CAS Registry Number: 8012-95-1; *(alt.)* 39355-35-6; *(alt.)* 79956-36-8; *(alt.)* 83046-05-3

RTECS® Number: PY8030000

EC Number: 232-384-2 (paraffin oils)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*highly refined*): Human No Adequate Data, Animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3; IARC (*untreated and poorly refined*): Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1; NTP (*untreated and poorly refined*): Known to be a human carcinogen.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mineral oil mist is a colorless, oily liquid aerosol dispersed in air with an odor like burned lubricating oil. The odor threshold is 1.0 ppm. Specific gravity (H_2O:1) = 0.865 at 60°C; Boiling point = 250−360°C; Vapor pressure = <0.5 mmHg at 20°C; Flash point = 193°C; Autoignition temperature = 260−371°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Human Data; Primary Irritant. Mineral oil is used in cosmetics, pharmaceutical bases, food, and fiber production; as carriers and bases; as a lubricating oil; and as a solvent for inks in the printing industry. Oil mist would be encountered in quenching of hot metal parts and in metal machining operations.

Incompatibilities: Strong oxidizers, nitric acid.

Permissible Exposure Limits in Air

As oil mist (mineral)

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA; 10 mg/m^3 STEL.

ACGIH TLV®[1]: 5 mg/m^3 inhalable fraction from highly refined and pure mineral oil, TWA.

NIOSH IDLH: 2500 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; Belgium: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; Finland: TWA 5 mg/m^3, 1999; Hungary: STEL 5 mg/m^3, carcinogen, 1993; Japan: 3 mg/m^3, Group 1 carcinogen, 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Sweden: NGV 3 mg/m^3; STEL 5 mg/m^3, 1993; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: LTEL 5 mg/m^3; STEL 10 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 mg/m^3. Several states have set guidelines or standards for mineral oil mist in ambient air[60] ranging from 16.7 μg/m^3 (New York) to 25 μg/m^3 (South Carolina) to 50 μg/m^3 (Florida) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5026, Oil mist, mineral; #5524, Metalworking Fluids

Permissible Concentration in Water: The EEC[35] set a MAC of 10 μg/L in drinking water. Russia set a MAC of 6.5 mg/L in surface water for fishery purposes.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May irritate nose and throat. If taken into lungs may cause coughing and swelling of lung tissue; may cause pneumonia. Similarity to kerosene indicates that headache, nausea, ringing in the ears, weakness, confusion, drowsiness, coma, and death may occur. *Skin:* May cause redness and swelling if not promptly removed. *Eyes:* May cause severe irritation if not promptly removed. *Ingestion:* Will cause burning sensation in mouth, throat, and stomach if swallowed. Vomiting, diarrhea, and belching may follow. If liquid gets into lungs, it may cause rapid breathing, blue skin coloration, rapid heartbeat, and fever with rapid onset of chemical pneumonia and possible secondary infection. Death may result from as little as half a liquid ounce in the absence of lung involvement.

Note: Food grades are highly purified and are of low toxicity.

Long Term Exposure: Prolonged contact may cause skin irritation; acne-like rash may develop. May cause skin allergy with itching and rash. There is some evidence that some substances referred to as "mineral oils" may be carcinogens. However, this information is unclear at this time and mineral oils (except for food grades) should be treated with caution.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Special tests of the sputum to look for oil droplets. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m^3:* 100XQ (APF = 10) [Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators] or Sa (APF = 10) (any supplied-air respirator). *125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *2500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive

concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Mineral Seal Oil*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 47−48

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Oil Mist, Mineral*. Trenton, NJ

Mirex M:1390

Molecular Formula: $C_{10}Cl_{12}$

Synonyms: Bichlorendo; CG-1283; Dechlorane 4070; 1,1a,2,2,3,3a,4,5,5,5a,5b,6-Dodecachlorooctahydro-1,3,4-metheno-1H-cyclobuta(c,d)pentalene; Dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta(c,d)pentalene; Dodecachloropentacyclodecane; ENT 25,719; Ferriamicide; 1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene dimer; Hexachlorocyclopentadienedimer; HRS 1276; NCI-C06428; Perchlorodihomocubane; Perchloropentacyclodecane

CAS Registry Number: 2385-85-5
RTECS® Number: PC8225000
UN/NA & ERG Number: UN2761/151
EC Number: 219-196-6 [*Annex I Index No.:* 602-077-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen.

Banned or Severely Restricted (several countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 1/188.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R21/22; R40; R50/53; R62; R63; R64; Safety phrases: S2; S13; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Mirex is a snow-white crystalline solid. Molecular weight = 545.50; Boiling point = (decomposes) 485°C; Vapor pressure = 8×10^{-7} mm at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of the insecticide (particularly effective against fire ants). Also used as a fire retardant in plastics. Not produced in the United States but may be found in imported products.

Incompatibilities: Strong oxidizers, dichromates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 100 mg/m^3

Several states have set guidelines or standards for mirex in ambient air[60] ranging from zero (Massachusetts) to 0.03 μg/m^3 (New York) to 0.88 μg/m^3 (Pennsylvania) to 4500 μg/m^3 (South Carolina).

Permissible Concentration in Water: 0.001 mg/L for protection of aquatic life (Sax—see reference below).

Determination in Water: Fish Tox = 1.98564000 ppb (HIGH).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Can irritate the respiratory tract. This compound is moderately toxic (the LD_{50} value for rats is 300 mg/kg). *Skin:* Can cause irritation, burning sensation, and rash. *Eyes:* Can cause irritation. *Ingestion:* No cases of human toxicity reported. Possible symptoms include nausea, vomiting, restlessness, tremor, weight loss, nervous system and liver abnormalities, skin rash, and reproductive failure. Exposure can cause nausea and vomiting, headache, dizziness, muscular weakness, fatigue, convulsions, and unconsciousness.

Long Term Exposure: May damage the developing fetus. May cause damage to the testes. May damage the liver and cause anemia. High exposure can cause arrhythmia (irregular heartbeat) and may cause death. Mirex has caused cataracts, liver and thyroid cancer, and birth defects in both rats and mice. Whether it does so in humans is not known.

Points of Attack: Blood, liver, nervous system.

Medical Surveillance: Complete blood count (CBC), liver function tests; EKG, examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Gastric lavage or catharsis may be useful. High urine organic chlorine is indicative of exposure but not of severity.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Pesticide respirators may be used to limit exposure. Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool area in closed containers away from oxidizers and dichromates. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Organochlorine pesticides, solid toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum; do not use wet method. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mirex is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 48 (1980) and 7, No. 5, 88−91 (1987)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Mirex*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Mirex*. Trenton, NJ

Mitomycin C M:1400

Molecular Formula: $C_{15}H_{18}N_4O_5$
Synonyms: Ametycin; 7-Amino-9-α-methoxymitosane; 7-Amino-9-α-methoxymitosane; Azirino (2′,3′: 3,4) pyrrolo (1,2-a) indole-4,7-dione, 6-amino-8-([(aminocarbonyl) oxy] methyl)-1,1a, 2,8,8a,8b-hexahydro-8-α-methoxy-5-methyl-, [1aS-(1a-a, 8b, 8a-a, 8ba)]; MIT-C; MITO-C; Mitocin-C; Mitomycin; Mitomycin-C; Mitomycinum; MMC; Mutamycin; Mytomycin; NCI-C04706; NSC 26980
CAS Registry Number: 50-07-7
RTECS® Number: CN0700000
DOT ID and ERG Number: UN3249 (medicine, solid, toxic, n.o.s)/151
EC Number: 200-008-6
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (ipr); clear evidence: rat; no evidence: mouse, 1975.
US EPA Hazardous Waste Number (RCRA No.): U010.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
California Proposition 65 Chemical: Cancer 4/1/88.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Mitomycin is a blue-violet crystalline solid. Molecular weight = 334.37; Freezing/Melting point = $\geq 360°C$. Soluble in water.
Potential Exposure: This compound is an antitumor antibiotic complex. This drug is usually injected intravenously.
Incompatibilities: Keep away from heat.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 12.5 mg/m^3
PAC-2: 23 mg/m^3
PAC-3: 23 mg/m^3
Routes of Entry: Inhalation. It is not known if this chemical penetrates the unbroken skin.
Harmful Effects and Symptoms
Short Term Exposure: Contact may irritate and damage the eyes. Toxic doses as low as 750 mg/kg have been reported in humans. The major toxic effect is myelosuppression, characterized by marked leukopenia and thrombocytopenia; this may be delayed and cumulative. Interstitial pneumonia and glomerular damage resulting in kidney failure are unusual but well-documented complications. Administration of mitomycin has been recognized as causing pneumonitis, alveolitis, and pulmonary fibrosis. Administration of mitomycin can cause kidney damage. Kidney toxicity was observed in 1−5% of patients. Depressed immune conditions were also noted. Headaches, blurred vision, confusion, drowsiness, fatigue, diarrhea, and pain have been occasionally noted as symptoms of mitomycin exposure. These do not appear to be dose related by intravenous administration. Fever and anorexia occur in 15% of patients. Hair loss, sloughing of skin, and loss of feeling occur in approximately 4% of patients. Labored breathing, cough, and pneumonia occur in some cases. Renal toxicity is sometimes observed.
Long Term Exposure: Causes mutations. Causes cancer in animals. There is limited evidence that Mitomycin C is a teratogen in animals. Can damage the bone marrow and cause kidney damage.
Points of Attack: Blood, kidneys.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: complete blood count and platelet count. Kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposure to mitomycin C, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool,

well-ventilated area away from heat (temperatures over 40°C). If you are required to work in a "sterile" environment, you require special training. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including oxides of nitrogen, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Mitomycin C*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Mitomycin C*. Trenton, NJ

Molybdenum M:1410

Molecular Formula: Mo

Synonyms: Elemental molybdenum; Molybdate; Molybdenum metal

CAS Registry Number: 7439-98-7

RTECS® Number: QA4680000 (elemental)

UN/NA & ERG Number: No citation for metal.

EC Number: 231-107-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Molybdenum is a silvery-white metal or dark gray or black powder with a metallic luster. Molecular weight = 95.94; Boiling point = 4825°C; Freezing/Melting point = 2652°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Molybdenite is the only important commercial source. This ore is often associated with copper ore. Molybdenum is insoluble in water and soluble in hot concentrated nitric and sulfuric acid.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector. Most of the molybdenum produced is used in alloys: steel, stainless steel; tool steel; case iron; steel mill rolls; manganese, nickel, chromium, and tungsten. The metal is used in electronic parts (contacts, spark plugs, X-ray tubes, filaments, screens, and grids for radios), induction heating elements, electrodes for glass melting, and metal spraying applications. Molybdenum compounds are utilized as lubricants; as pigments for printing inks; lacquers, paints, for coloring rubber animal fibers, leather, and as a mordant; as catalysts for hydrogenation cracking; alkylation, and reforming in the petroleum industry; in Fischer−Tropsch synthesis; in ammonia production; and in various oxidation−reduction and organic cracking reactions; as a coating for quartz glass; in vitreous enamels to increase adherence to steel; in fertilizers, particularly for legumes; in electroplating to form protective coatings; and in the production of tungsten. Hazardous exposures may occur during high-temperature treatment in the fabrication and production of molybdenum products, spraying applications, or through loss of catalyst. MoO_3 sublimes above 800°C.

Incompatibilities: *Soluble compounds:* alkali metals, sodium, potassium, molten magnesium. *Insoluble compounds:* Violent reaction with oxidizers, nitric acid, sulfuric acid. Forms explosive mixture with potassium nitrate. Metallic Mo is a combustible solid in the form of dust or powder and is potentially explosive.

Permissible Exposure Limits in Air

Mo, Metal and insoluble compounds

OSHA PEL: 15 mg[Mo]/m^3 total dust TWA. [*Note:* The PEL also applies to other insoluble molybdenum compounds (as Mo).]

NIOSH: See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV®[1]: 10 mg[Mo]/m^3 inhalable fraction; 3 mg [Mo]/m^3 respirable fraction.

NIOSH IDLH: 5000 mg[Mo]/m^3.
Protective Action Criteria (PAC)
Elemental
TEEL-0: 15 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 500 mg/m^3
Mo, soluble compounds
OSHA PEL: 5 mg[Mo]/m^3 TWA.
NIOSH: See Appendix D of the *NIOSH Pocket Guide*.
ACGIH TLV®[1]: 0.5 mg[Mo]/m^3 respirable fraction TWA confirmed animal carcinogen with unknown relevance to humans.
DFG MAK: No numerical value established. Data may be available; testing for carcinogenic effects.
NIOSH IDLH: 1000 mg[Mo]/m^3.
Russia[43] established a MAC of 2 mg/m^3 for *soluble compounds, aerosol condensates*; 4 mg/m^3 for *soluble compounds as dusts*; MAC of 6 mg/m^3 for *insoluble compounds.* Several states have set guidelines or standards for molybdenum in ambient air[60] ranging from 100−200 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada) to 160 μg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Russia[43] has established a molybdenum limit of 0.5 mg/L in bodies used for domestic purposes. EPA[32] has suggested a permissible ambient goal of 70 μg/L based on health effects.

Determination in Water: With atomic-absorption spectrophotometry, a detection limit of 20 μg/L is attainable by direct aspiration into the flame, necessitating concentration for ordinary determinations. When the graphite furnace is used to increase sample atomization, the detection limit is lowered to 0.5 μg/L or. Neutron activation may be used at even lower detection limits, according to US EPA.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the skin and eyes. Inhalation can irritate the respiratory tract causing coughing and wheezing.

Long Term Exposure: Can cause headache, fatigue, loss of appetite, muscle and joint pain. Uric acid levels may be elevated which can lead to gout. May damage the liver and kidneys. May cause low blood count (anemia). In animals: irritation of eyes, nose, throat; anorexia, diarrhea, weight loss; listlessness; liver, kidney damage. Soluble compounds (e.g., sodium molybdate) and freshly generated molybdenum fumes are considerably more toxic. Inhalation of high concentrations of molybdenum trioxide dust is highly irritating to animals and has caused weight loss, diarrhea, loss of muscular coordination, and a high mortality rate. Molybdenum trioxide dust is more toxic than the fumes. Large oral doses of ammonium molybdate in rabbits caused some fetal deformities.

Points of Attack: *Soluble compounds:* Eyes, respiratory system, kidneys, blood. *Insoluble compounds:* Eyes, respiratory system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests for molybdenum and compounds: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). Preemployment and periodic physical examinations should evaluate any irritant effects to the eyes or respiratory tract and the general health of the worker. Liver and kidney function tests. Complete blood count (CBC). Uric acid level. Molybdenum is considered to be an essential trace element in many species, including humans. However, excessive intake of molybdenum may produce signs of copper deficiency. The normal intake of copper in the diet may be sufficient to combat or prevent systemic toxic effects due to molybdenum poisoning.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection (chemical goggles and face shield unless full face-piece respiratory protection is worn). Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *For Insoluble Compounds:* OSHA *Up to 75 mg/m^3*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 150 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 375 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 750 mg/m^3:*

100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 5000 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*If not present as a fume.

For Soluble Compounds: *25 mg/m^3*: Qm* (APF = 25) (any quarter-mask respirator). *50 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100*; or Sa* (APF = 10) (any supplied-air respirator). *125 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter).* *250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie* (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Molybdenum must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from bromine, trifluoride, fluorine, chlorine trifluoride, and lead dioxide.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemicals appropriate for extinguishing metal fires, such as dry sand, dolomite, or graphite. *Do not use water*. Poisonous gases are produced in fire. Dust or powdered molybdenum may cause a dust explosion. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery is indicated whenever possible. Processes for recovery of Molybdenum from scrap, flue dusts, spent catalysts, and other industrial wastes have been developed.

References

US Environmental Protection Agency. (November 1975). *Molybdenum: A Toxicological Appraisal*, Report EPA-600/1-75-004. Research Triangle Park, NC: Health Effects Research Laboratory

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Molybdenum*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 345−357

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Molybdenum.* Trenton, NJ

Molybdenum trioxide M:1420

Molecular Formula: MoO_3

Synonyms: MO 1202T; Molybdena; Molybdenum oxide; Molybdenum(VI) oxide; Molybdenum oxide (MoO_3); Molybdenum(VI) oxide; Molybdenum(VI) trioxide; Molybdic acid anhydride; Molybdic anhydride; Trioxido de molibdeno (Spanish)

CAS Registry Number: 1313-27-5

RTECS® Number: QA4725000

DOT ID and ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 215-204-7 [*Annex I Index No.*: 042-001-00-9]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Safe Drinking Water Act: Priority List (55 FR 1470) as molybdenum.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R36/37; R40; Safety phrases: S2; S22; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Molybdenum trioxide is an odorless, white crystalline powder that turns yellow when heated; Freezing/Melting point = 795°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Molybdenum trioxide is used in agriculture; in the manufacture of metallic molybdenum, ceramic glazes, enamels, pigments, and in analytical chemistry.

Incompatibilities: Explodes on contact with molten magnesium. Violent reaction with strong oxidizers, such as chlorine trifluoride, bromine pentafluoride. Not compatible with strong acids, active metals (sodium, potassium, lithium).

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mo]/m^3 TWA *soluble compounds*.

NIOSH: See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV®[1]: 0.5 mg[Mo]/m^3 TWA *soluble compounds*, confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 1000 mg[Mo]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 0.75 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Carcinogen Category 3B.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: No specific values set for MoO_3; see this section in the entry on "Molybdenum and Compounds."

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of the skin and eyes. Dust or mist can irritate the respiratory tract causing cough and/or tightness in the chest. Can cause anorexia, weight loss, headache, muscle and joint aches, listlessness, hair loss, lack of muscular coordination, diarrhea, liver and kidney damage.

Long Term Exposure: Can irritate the lungs; bronchitis may develop. May cause anemia. May affect the liver and kidneys.

Points of Attack: Lungs, blood, liver and kidneys.

Medical Surveillance: NIOSH lists the following tests for molybdenum and compounds: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: tests for liver and kidney function, complete blood count; uric acid level; lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *For Soluble Compounds: 25 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator).* *50 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100*; or Sa (APF = 10) (any supplied-air respirator).* *125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode)*; or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter).* *250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter)*; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Molybdenum trioxide must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); alkalis, sodium, potassium, and molten magnesium since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solids, organic, n.o.s. compound require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Molybdenum trioxide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 3, 73−78

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Molybdenum Trioxide*. Trenton, NJ

Monocrotophos M:1430

Molecular Formula: $C_7H_{14}NO_5P$

Common Formula: $(CH_3O)_2P(O)OC(CH_3){=}CHCONHCH_3$

Synonyms: Apadrin; Azodrin; Biloborn; Bilobran; C 1414; Ciba 1414; Crisodin; Crisodrin; Crotonamide, 3-hydroxy-*N*-methyl-, dimethylphosphate, (*E*)-; Crotonamide, 3-Hydroxy-*N*-methyl-, dimethylphosphate, *cis*-; 3-(Dimethoxyphosphinyloxy)-*N*-methyl-*cis*-crotonamide; *O*,*O*-Dimethyl-*O*-(2-*N*-methylcarbamoyl-1-methyl)-vinyl-phosphat (German); *O*,*O*-Dimethyl *O*-(2-*N*-methylcarbamoyl-1-methylvinyl) phosphate; (*E*)-Dimethyl 1-methyl-3-(methylamino)-3-oxo-1-propenyl phosphate; Dimethyl 1-methyl-2-(methylcarbamoyl)vinyl phosphate, *cis*-; Dimethyl phosphate ester of 3-hydroxy-*N*-methyl-*cis*-crotonamide; Dimethyl phosphate of 3-hydroxy-*N*-methyl-*cis*-crotonamine; ENT 27,129; Glore Phos 36; 3-Hydroxy-*N*-methyl-*cis*-crotonamide dimethyl phosphate; 3-Hydroxy-*N*-methylcrotonamide dimethyl phosphate; *cis*-1-Methyl-2-methyl carbamoyl vinyl phosphate; Monocron; Monocrotofos (Spanish); Monodrin; Nuvacron; Phosphate de dimethyle et de 2-methylcarbamoyl 1-methyl vinyle (French); Phosphoric acid, dimethyl ester, with *cis*-3-hydroxy-*N*-methylcrotonamide; Pillardin; Plantdrin; SD 9129; Shell SD 9129; Susvin; Ulvair

CAS Registry Number: 6923-22-4

RTECS® Number: TC4375000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 230-042-7 [*Annex I Index No.:* 015-072-00-9]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *In vitro* UDS—human fibroblast; *S. cerevisiae*—homozygosis; Negative: *D. melanogaster* sex-linked lethal; TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [monocrotophos and dustable powder formulations containing a combination of monocrotophos (solid pesticide and soluble liquid formulations of the substance that exceed 600 g active ingredient/L)].

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24; R28; R50/53; R68; Safety phrases: S1/2; S36/37; SS45-S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Monocrotophos is a colorless to reddish-brown solid with a mild ester odor. Molecular weight = 223.19; Specific gravity (H_2O:1) = 1.3; Boiling point = 125°C; Freezing/Melting point = 53.9°C (pure); 25−30°C (the reddish brown technical product); Vapor pressure = 7×10^{-6} mm at 20°C; Flash point = >93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water. Commercially available as a water-miscible solution.

Potential Exposure: The liquid form is a severely hazardous pesticide formulation. Those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Alkaline pesticides. Attacks black iron, drum steel, stainless steel, brass.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.25 mg/m^3 TWA.

ACGIH TLV®[1]: 0.05 mg/m^3 TWA, inhalable fraction and vapor; [skin], not classifiable as a human carcinogen; BEI$_A$ releases as Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.63 mg/m^3

PAC-3: 25 mg/m^3

Several states have set guidelines or standards for monocrotophos in ambient air[60] ranging from 2.5 μg/m^3 (North Dakota) to 40 μg/m^3 (Virginia) to 5.0 μg/m^3 (Connecticut) to 6.0 μg/m^3 (Nevada). Australia: TWA 0.25 mg/m^3, 1993; Belgium: TWA 0.25 mg/m^3, 1993; Denmark: TWA 0.25 mg/m^3, 1999; France: VME 0.25 mg/m^3 1999; Switzerland: MAK-W 0.25 mg/m^3, 1999; the Netherlands: MAC-TGG 0.25 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2045, Monocrotophos.

Determination in Water: Fish Tox = 728.00039000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Monocrotophos is a highly toxic, direct acting, water-soluble cholinesterase inhibitor which appears to be capable of penetrating through the skin but is excreted rapidly and does not accumulate in the body. Acute exposure to monocrotophos may result in the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Dyspnea (shortness of breath) may lead to respiratory collapse. Giddiness is common. Monocrotophos acts on the nervous system. Extremely toxic; probable oral lethal dose to humans 5−50 mg/kg or between 7 drops and 1 teaspoon for a 70-kg (150 lb) person. Repeated inhalation or skin contact with this material may, without symptoms, progressively increase susceptibility to poisoning. Monocrotophos may cause mutations. Handle with extreme caution. In animals: possible teratogenic effects. Human Tox = 0.35000 ppb (EXTRA HIGH).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause personality changes with depression, anxiety, irritability.

Points of Attack: Eyes, respiratory system, central nervous system, cardiovascular system, blood cholinesterase, reproductive system.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, or wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. As with other organophosphorus pesticides, do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with vermiculite, dry sand, earth, or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. *Large spills*: dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid. Like other organophosphorus pesticides, extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and full protective clothing. Poisonous gases, including nitrogen oxides and phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in heat of fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be hydrolyzed with water.[22] Incineration in a unit with effluent gas scrubbing is recommended for larger amounts. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Monocrotophos*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Monocrotophos*. Trenton, NJ

Morpholine M:1440

Molecular Formula: C_4H_9NO

Synonyms: Diethyleneimide oxide; Diethylene imidoxide; Diethylene oximide; N,N-Dimethylacetamide; Diethylenimide oxide; *p*-Isoxazine, tetrahydro-; 1-Oxa-4-azacyclohexane; 2H-1,4-Oxazine, tetrahydro-; Tetrahydro-1,4-isoxazine; Tetrahydro-1,4-oxazine; Tetrahydro-2H-1,4-oxazine; Tetrahydro-*p*-oxazine

CAS Registry Number: 110-91-8

RTECS® Number: QD6475000

UN/NA & ERG Number: UN2054/132

EC Number: 203-815-1 [*Annex I Index No.*: 613-028-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, No Adequate Data; Animal, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Gene-Tox Program, Positive: Host-mediated assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R10; R20/21/22; R34; Safety phrases: S1/2; S23; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Morpholine is a colorless liquid with a weak ammonia or fish-like odor. The odor threshold is 0.01 ppm. Molecular weight = 87.14; Specific gravity (H_2O:1) = 1.007; Boiling point = 128.9°C; Freezing/Melting point = −5°C; Vapor pressure = 6 mmHg at 20°C; Flash point = 37°C. Autoignition temperature = 310°C. Explosive limits: LEL = 1.4%; UEL = 11.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Morpholine is used as a separating agent for volatile amines; an intermediate for textile lubricants; in the synthesis of rubber accelerators and pharmaceuticals. It is also used as a solvent; as a boiler water additive; and in the formulation of waxes, polishers, and cleaners.

Incompatibilities: Strong acids, strong oxidizers, metals, nitro compounds. Corrosive to metals; attacks copper and its compounds.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.56 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 20 ppm/70 mg/m^3 TWA [skin].

NIOSH REL: 20 ppm/70 mg/m^3 TWA; 30 ppm/105 mg/m^3 STEL [skin].

ACGIH TLV®[1] 20 ppm/71 mg/m^3 TWA [skin].

DFG MAK: 10 ppm/36 mg/m^3 TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group D.

NIOSH IDLH: 1400 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 30 ppm

PAC-2: 30 ppm

PAC-3: 1400 ppm

Australia: TWA 20 ppm (70 mg/m^3); STEL 30 ppm, [skin], 1993; Austria: MAK 20 ppm (70 mg/m^3), [skin], 1999; Belgium: TWA 20 ppm (71 mg/m^3); STEL 30 ppm, [skin] 1999; Denmark: TWA 20 ppm (70 mg/m^3), [skin], 1999; Finland: TWA 20 ppm (70 mg/m^3); STEL 30 ppm (105 mg/m^3), [skin], 1999; France: VME 20 ppm (70 mg/m^3), VLE 30 ppm (105 mg/m^3), 1999; Hungary: STEL 10 mg/m^3, [skin], 1993; Norway: TWA 20 ppm (70 mg/m^3), 1999; the Netherlands: MAC-TGG 36 mg/m^3, [skin], 2003; the Philippines: TWA 20 ppm (70 mg/m^3), [skin], 1993; Poland: MAC (TWA) 70 mg/m^3; MAC (STEL) 100 mg/m^3, 1999; Russia: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1993; Sweden: NGV 20 ppm (70 mg/m^3), KTV 30 ppm (110 mg/m^3), [skin], 1999; Switzerland: MAK-W 20 ppm (70 mg/m^3), KZG-W 40 ppm (140 mg/m^3), [skin], 1999; United Kingdom: TWA 20 ppm (72 mg/m^3); STEL 30 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia set a MAC of 0.01 mg/m^3 for ambient air in residential areas (10 μg/m^3) on a once-daily basis. Several states have set guidelines or standards for morpholine in ambient air[60] ranging from 0.7−1.05 mg/m^3 (North Dakota) to 1.15 mg/m^3 (Virginia) to 1.4 mg/m^3 (Connecticut) to 1.6667 mg/m^3 (Nevada).

Determination in Air: Use NIOSH (II-3) Method #S-150.

Permissible Concentration in Water: Russia[35][43] set a MAC of 0.04 mg/L for water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.9$.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance is corrosive to the eyes, skin, and the respiratory tract. Contact can cause redness, swelling, and burns. Exposure can cause corneal (eye) swelling resulting in blurring vision. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Morpholine may damage the liver and kidneys. Can cause a skin rash.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: butyl rubber gloves, suits, boots; 4H™ and Silver Shield™ gloves. Also, polyvinyl alcohol and Viton are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *550 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *1000 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1400 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Morpholine must be stored to avoid contact with strong acids (such as nitric acid) and strong oxidizers (such as chlorine, chlorine dioxide, bromine, nitrates, and permanganates) since violent reactions occur.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).[22]

References

US Environmental Protection Agency. (November 16, 1977). *Chemical Hazard Information Profile: Morpholine*. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 82−84

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Morpholine*. Trenton, NJ

Muscimol M:1450

Molecular Formula: $C_4H_6N_2O_2$

Synonyms: Agarin; 5-Aminomethyl-3-hydroxyisoxazole; 5-(Aminomethyl)-3-isoxazolol; 5-(Aminomethyl)-3-(2H)isoxazolone; 5-Hydroxy-5-aminomethylisoxazole; Muscimol

CAS Registry Number: 2763-96-4

RTECS® Number: NY3325000

UN/NA & ERG Number: Not regulated.

EC Number: 220-430-4

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P007.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances, TPQ = 500/10,000 lb (227/4550 kg).

Reportable Quantity (RQ): 1000 lb(455 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Muscimol is a crystalline solid. Molecular weight = 114.12; Freezing/Melting point = 175°C (decomposes).

Potential Exposure: Formerly used as a sedative and as an antiemetic; and for experimental laboratory purposes.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 17 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Muscimol is a potent central nervous system depressant. Initially, drowsiness, stupor, or sleep is followed by mild nausea and vomiting. Muscle spasms in extremities, various emotional changes and distorted perceptions of space and time, but only rarely hallucinations. This compound is a natural constituent of amanita mushrooms and is extremely toxic. It is a potent central nervous system depressant and is believed to be responsible for most of the nervous system effects that result from eating this mushroom. The lowest toxic dose in humans has been reported at 109 mg/kg.

Long Term Exposure: May be neurotoric.

Points of Attack: Central nervous system.

Medical Surveillance: Examination of the nervous system. Examination for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 81

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Muscimol.* Washington, DC: Chemical Emergency Preparedness Program

Mustard gas (Agents H, HD & HT, WMD) M:1460

Molecular Formula: $C_4H_8Cl_2S$; $C_4(H_8)C1_2(S)$

Common Formula: $(ClCH_2CH_2)_2S$

Synonyms: Bis(β-chloroethyl) sulfide; Bis(2-chloroethyl) sulfide; 1-Chloro-2-(β-chloroethylthio)ethane; β,β′-Dichlorodiethyl sulfide; 2,2′-Dichlorodiethyl sulfide; Dichloro diethyl sulfide; β,β′-Dichloroethyl sulfide; 2,2′-Dichloroethyl sulfide; Di-2-chloroethyl sulfide; Distilled mustard (HD); Ethane, 1,1′-thiobis-2-chloro-; Gas mostaza (Spanish); H and HD (military designations); Iprit; Kampstoff lost; Lost (German); Pyro (Agent HD); Senfgas; Sesquimustard; S-Lost (German); Sulfide, bis(2-chloroethyl); Sulfur mustard; Sulfur mustard gas; 1,1′-Thiobis(2-chloroethane); Yellow cross gas; Yellow cross liquid; S-Yperite; Yperite

HT: Mixture of BIS(2-chloroethyl)sulfide and BIS[2-(2-chloroethylthio)ethyl]ether; Mustard-T mixture

CAS Registry Number: 505-60-2; 39472-40-7, 68157-62-0; *(alt.)* 69020-37-7; 6392-89-8 (HT); 3563-36-8 (HD)

RTECS® Number: WQ090000

UN/NA & ERG Number: UN2810/153

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g. [*505-60-2; 3563-36-8 (HD)*].

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998; HT (Agent T) should be treated as a suspect carcinogen due to its similarity to Mustard Agent HD.

US EPA Gene-Tox Program, Positive: *D. melanogaster*—whole sex chrom. loss; Positive: *D. melanogaster*—reciprocal translocation; Positive: L5178Y cells *In vitro*—TK test; *N. crassa*—reversion; Positive: *D. melanogaster* sex-linked lethal; Positive/dose response: TRP reversion; Positive/limited: Carcinogenicity—mouse/rat.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
US DOT 49CFR172.101, Inhalation Hazard Chemical.
California Proposition 65 Chemical: Cancer 2/27/87.
WGK (German Aquatic Hazard Class): No value assigned (all above CAS numbers).

Description: Mustard gas, a chlorinated sulfur compound (s), is an oily, yellow to black liquid (clear when pure) with a sweet, burnt garlic or horseradish-like odor. The odor threshold for HD is 0.0006 mg/m^3. Molecular weight = 159.08; Specific gravity (H_2O = 1) = 1.27 at 20°C; Volatility = 610 mg/m^3 at 20°C; 920 mg/m^3 at 25°C; Boiling point = (decomposes) 215−217°C; Freezing/Melting point = 13−14°C; Vapor pressure = 0.072 mmHg at 20°C; 0.11 mmHg at 25°C; Vapor density (air = 1) = 5.5; Flash point (ignited by large explosive charges) = 104°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1₩. Slightly soluble in water (reaction). Soluble in acetone, CH3(C1), tetrachloroethane, ethylbenzoate, and ether. Thickened is essentially the same as HD except for viscosity, which uses HD K125 (acryloid copolymer, 5%) as a thickener. K125 is not known to be hazardous except in a finely-divided, powder form. The viscosity of HD is between 1000 and 1200 centistokes at 25°C.

HT is a mixture of 60% HD and 40% Agent HT [(bis-(2-chloroethylthio ethyl)ether], a closely related vesicant with a lower freezing point). Agent HT is essentially the same as Agent HD, but HT is more stable. HT is a clear, yellowish, highly viscous liquid. It has a longer duration of effectiveness and has a lower garlic-like odor similar to HD. Although volatility is low, vapors can reach hazardous levels in warm weather. Specific gravity (water = 1) = 1.2361 at 25°C; Boiling point: 120°C at 0.02 torr; 174°C at 2.0 torr; Freezing/Melting point = 9.6−9.9°C; 13−14°C[NIOSH]; Volatility (mg/L) = 4.1×10^{-4} at 25°C; Viscosity (centistoke) = 14.7 at 25°C; Vapor pressure = 0.025 mmHg at 0°C; 0.090 mmHg at 30°C. Vapor density (air = 1) = 9.08; Flash point = 100°C. Practically insoluble in water; solubility = 0.8 g/L at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Mustard gas is used as an alkylating agent. It has also been used as a chemical warfare agent, causing delayed casualties. It is a vesicant and blister agent in chemical warfare (especially during World War I, military designation H or HD). Mustard gas is used as a model compound in biological studies. Mustard gas has been tested as an antineoplastic agent, but its clinical use as a tumor inhibitor has been minimal.

Incompatibilities: Sulfur mustard is stable at ambient temperatures. Reacts with oxidizers (vigorous), strong acids, acid fumes, strong alkalis, oxygen, water, steam, and other forms of moisture. On contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and chlorine. Rapidly corrosive to brass at 65°C. Will corrode steel at a rate of 0.0001 in/month at 65°C. Contact with metals may evolve flammable hydrogen gas. HD reacts with water; will hydrolyze, forming HCI and thiodiglycol. When heated to decomposition (between 149°C and 177°C), highly toxic fumes of hydrochloric acid, oxides of sulfur and chlorine are emitted.

Persistence of Chemical Agent: HD: Summer: 3 days to 1 week; Winter: May last for weeks.

Permissible Exposure Limits in Air
IDLH: 0.7 mg/m^3.
STEL: 0.003 mg/m^3.
WPL (Worker population limit): 0.0004 mg/m^3.
GPL (General population limit): 0.00002 mg/m^3.
AEGL (Acute Exposure Guidelines): 0.06 ppm/0.4 mg/m^3 (10 min); 0.001 ppm/0.008 mg/m^3 (8 h).
Protective Action Criteria (PAC) HD, 505-60-2*
TEEL-0: 0.0035 ppm
PAC-1: **0.01** ppm
PAC-2: **0.02** ppm
PAC-3: **0.32** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: [skin] Carcinogen Category 1 as bis(β-chloroethyl)sulfide.
Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000.

Determination in Air: Available monitoring equipment for agent HD is the M8/M9 Detector paper, blue bank tube; M256/M256A1 kits; bubbler. Depot Area Air Monitoring System (DAMMS); automated Continuous Air Monitoring System (ACMS); CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED); and the Minature Chemical Agent Monitor (MINICAM).

Determination in Water: Ecotoxicology: Log K_{ow} (estimated) = 2.41: Log $K_{benzene-water}$ = 0.15. Bulk mustard can persist for decades in soil or water. When exposed to sea water, mustard forms a thick outer "crust" over a core of mustard which allows the mustard to be brought to the surface where it can injure unsuspecting fishermen, who may snare plastic lumps of mustard gas in their nets. Mustard and a number of its hydrolysis products are oxidized (air, oxygen, hypochlorite, hydrogen peroxide, nitric acid, potassium permanganate, and chromic acid) to give the less toxic sulfoxide and sulfone analogs. Mustard and its hydrolysis products do not significantly degrade in sunlight and are stable at less than 49°C.

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Sulfur mustard causes severe, delayed burns to the eyes, skin, and respiratory tract. Sulfur mustard damages cells within minutes of contact; however, the onset of pain and other health effects is delayed until hours after exposure. Large exposures to sulfur mustard may be fatal.[CDC]

Short Term Exposure: Contact with the liquid or exposure to high vapor concentrations can cause severe burns and permanent eye damage. There is no pain on contact but hours later redness, swelling, and pain occur. Blindness may result. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. In 1−12 h there may be coughing, swollen eyelids, reddened skin, and severe itching. There may be swelling and destruction of tissue in the respiratory tract and exposed skin. Ingestion may cause nausea and destruction of tissue in the respiratory tract and exposed skin. Ingestion may cause nausea and vomiting. The median lethal dosage is 1500 mg-min/m^3 for inhalation and 10,000 mg-min/m^3 for skin absorption (masked personnel). The median incapacitating dosage is 200 mg-min/m^3 for eye injury and 2000 mg-min/m^3 for skin absorption (masked personnel). Wet skin absorbs more material than dry skin. May cause death or permanent injury after very short exposure to small quantities. It is a blistering gas and is highly irritating to eyes, skin, and lungs. Pulmonary lesions are often fatal. HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. Median doses of HD in humans are: LD_{50} (skin) = 100 mg/kg; ICt_{50} (skin) = 2000 mg-min/m^3 at 21−27°C (humid environment); = 1000 mg-min/m^3 at 32°C (dry environment); ICt_{50} (eyes) = 200 mg-min/m^3; ICt_{50} (inhalation) = 1500 mg-min/m^3 (Ct unchanged with time) LD_{50} (oral-rat) = 0.7 mg/kg. Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m^3, respectively.

Acute physiological action, local: HD affects both the eyes and the skin. *Skin* damage occurs after percutaneous resorption. Being lipid soluble, HD can be reabsorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4−24 h following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane, and perspiration-covered skin are more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

Acute physiological action, systemic: Occur primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal dose of HD can produce injury to bone marrow, lymph nodes, and spleen, as indicated by a drop in WBC count and, therefore, results in increased susceptibility to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15- to 20-min latency period.

Long Term Exposure: HD can cause sensitization, chronic bronchitis, and lung impairment (cough, shortness of breath, chest pain); and can cause cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects. Mustard gas is a carcinogen.

Points of Attack: Lungs, eyes.

Medical Surveillance: Lung function tests. Examination of the eyes, including slit lamp. Consider chest X-ray following acute overexposure.

First Aid: There is no antidote for sulfur mustard toxicity. If this chemical gets into the eyes instantly flush with water. A delay of seconds can cause permanent damage. *Inhalation*: Remove from the source *immediately*. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. *Seek medical attention immediately*. *Eye contact:* Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source; flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. *Transfer the patient to a medical facility immediately. Ingestion:* Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately. *Skin contact:* Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with solution of sodium hypochlorite or liquid household bleach (see decontamination procedure below) within 1 min. Cut and remove contaminated clothing, flush contaminated skin area again with sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin becomes contaminated with a thickened agent, blot/wipe off the material immediately with an absorbent pad/paper towel prior to using decontaminating solution.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let anything to get into the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Be sure that you have decontaminated the victims as much as you can before they leave the area so that they do not spread the agent. Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes, and other items.

Personal Protective Methods: *Protective gloves, mandatory*: Butyl, toxicological agent, protective gloves (M3, M4, glove set). As a minimum, chemical goggles will be worn. For splash hazards use goggles and face shield. Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 butyl boots; M3 gloves; impregnated underwear; M9 series mask and coveralls (if desired); or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available. In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required. *Ventilation*: Local Exhaust: Mandatory. Must be filtered or scrubbed. *Special:* Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located so that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent HD. Other: recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed with 20 cm inside hoods.

Swatch Test Results for Level A Suits and Chemical Protective Gloves for HD (Mustard gas)

Item	**Breakthrough**
25-mil chemical protective gloves	360 min
Kappler Suit Model 42483	150 min
TYCHEM 10,000 Pkg Style No. 12645	330 min
Trellchem HPS suit	>480 min
Ready 1 Limited Use Suit: Model 91	125 min
First Team XE HazMat suit	385 min
Commander Ultrapro Suit, Style 79102	280 min
Kappler Suit Model 50660	435 min
TYCHEM Style No. 11645	>480 min
Trellchem TLU suit	>480 min
Chemturion Suit: Model 13	110 min
Chempruf II BETEX Suit	125 min
Commander Brigade: F91	>480 min

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Do not use chemical cartridge or canister respirators. Less than or equal to 0.003:* Protective mask not required provided that: as an 8-h TWA (a) Continuous real-time monitoring (with alarm capability is conducted in the work area at the 0.003 mg/m^3 level of detection. (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 mg/m^3. (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices. *If these conditions are not met then the following applies:* full face-piece chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.) *Greater than 0.003 as an 8-h TWA*: The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to 2 h or less. *Note*: When 30 mil DPE is not available, the M9 or M40 series mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible and may not exceed 1 h. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots, respectively, to reduce aspiration.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Stable at ambient temperatures. Decomposition temperature is 149−177°C. Mustard is a persistent agent depending on pH and moisture and has been known to remain active for up to 3 years in soil. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks either visually or using a detector kit, prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HD must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HD should be stored in containers made of glass for Research, Development, Test, and Evaluation (RDTE) for small quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

Shipping: Toxic liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone B] require a shipping label of "POISONOUS/TOXIC MATERIALS." Bis-(2-chloroethyl) sulfide UN 2810, Inhalation Hazard. It falls in Hazard Class 6.1 and Packing Group III.[NIOSH]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. To clean up a spill, cover with up to 15% calcium hypochloride. Place in container; neutralize after 12 h if necessary. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if it is without hazard. Use water spray to knock down vapors. Avoid breathing vapors and bodily contact with the material. Keep upwind. Wash away any material which may have contacted the body with copious amounts of soap and water. Downwind evacuation must be considered. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

If spills or leaks of THD (Thickened HD) occur, follow the same procedures as those for HD, but dissolve the THD in acetone prior to introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. The THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD. Handling the THD requires careful observation of the "stringers" (elastic, thread-like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

H, HD, when used as a weapon

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Recommended field procedures (H, HD)*:* The mustard should be contained using vermiculite, diatomaceous earth, clay, or fine sand, and neutralized as soon as possible using copious amounts of 5.25% sodium hypochlorite solution. Scoop all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled per IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of the material used to decontaminate exterior of drum in accordance with IAW, federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 5.25% Sodium Hypochlorite solution is not available, then the following decontaminates may be used instead and are listed in the order of preference: Calcium Hypochlorite Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]; and Super Tropical Bleach Slurry (STB).

Warning: Pure, undiluted calcium hypochlorite (HTH) will burn on contact with liquid blister agent.

Recommended laboratory procedures: A minimum of 65 g of decontamination fluid per gram of HD is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 h, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 mL of the decontaminate in a test tube. Add several crystals of potassium Iodine and swirl to dissolve. Add 3 mL of 50 wt.% sulfuric acid: water and swirl. IMMEDIATE iodine color indicates the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait for 2 h, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. A 10-wt.% calcium hypochlorite (HTH) mixture may be substituted for sodium hypochlorite. Use 65 g of decon/gram of HD and continue the test as described for sodium hypochlorite. Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of the material used to decontaminate exterior of drum in accordance with IAW federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits. *Note*: Surfaces contaminated with HD, and then rinse decontaminated, may evolve sufficient mustard vapor to produce a physiological response.

Recommended field procedures (HT): HT should be contained using vermiculite, diatomaceous earth, clay, or fine sand, and neutralized as soon as possible using copious amounts of alcoholic caustic, carbonate, or Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]. Caution must be exercised when using these decontaminates since acetylene will be given off. Household bleach can also be used if accompanied by stirring to allow contact. Scoop up all contaminated material and place in approved DOT containers. Cover the contents with additional decontaminant. All leaking containers will be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate the outside of the container and label according to DOT and EPA requirements. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to federal, state, and local laws. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. *Warning:* Never use dry High Test Hypochlorite (HTH) or Super Tropical Bleach (STB) since they will react violently with HT and may burst into flames.

Recommended laboratory procedures: A minimum of 65 g of decontamination solution per gram of HT is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 h, the resulting solution will be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 mL of the decontaminate in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 mL of 50 wt.% sulfuric acid: water and swirl. Immediate iodine color shows the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait for 2 h, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. Scoop up all material and place in approved DOT containers. Cover the contents with additional decontaminate as above. The exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits.

A 10-wt.% calcium hypochlorite mixture may be substituted for sodium hypochlorite. Use 65 g of decon/gram of HT and continue the test as described for sodium hypochlorite. *Note:* Surfaces contaminated with HT, then rinse decontaminated, may evolve sufficient HT vapor to produce a physiological response. HT on laboratory glassware may be oxidized by vigorous reaction with concentrated nitric acid.

Waste disposal method: All neutralized material should be collected, contained, and thermally decomposed in EPA-approved incinerators that will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated materials or protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3 ×) level. Contaminated clothes and personal belongings should be placed in a sealed double bag and placed inside properly labeled drums and held for shipment back to the DA issue point.

Note: Several states define decontaminated surety material as a RCRA hazardous waste.

Fire Extinguishing: This chemical may burn but does not easily ignite. HD will hydrolyze, forming HCI and thiodiglycol. Poisonous gases, including oxides of sulfur and chlorides, are produced in fire. Extinguish with water, foam, dry chemical, or carbon dioxide. Protective clothing and self-contained breathing apparatus are required in the presence of mustard gas. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: All decontaminated material should be collected, contained and chemically decontaminated or thermally decomposed in an EPA-approved incinerator, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using calcium hypochlorite (HTH) or bleach and analyzed to assure it is free of detectable contamination (3X) level.

Contaminated clothes and personal belongings should be placed in a sealed double bag and subsequently placed inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the procedures outlined above with the following exceptions: (a) HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid. (b) Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited.

Note: Several states define decontaminated surety material as a RCRA Hazardous Waste.

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N

Naled N:0100

Molecular Formula: $C_4H_7Br_2Cl_2O_4P$
Synonyms: AI3-24988; Arthodibrom; Bromchlophos; Bromex; BRP; Dibrom; *O*-(1,2-Dibrom-2,2-dichloraethyl)-*O*,*O*-dimethyl-phosphat (German); 1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate; *O*,*O*-Dimethyl *O*-(1,2-dibromo-2,2-dichloroethyl) phosphate; Dimethyl 1,2-dibromo-2,2-dichloroethyl phosphate; *O*,*O*-Dimethyl *O*-2,2-dichloro-1,2-dibromoethyl phosphate; ENT 24,988; Ethanol, 1,2-dibromo-2,2-dichloro-, dimethyl phosphate; Hibrom; OMS 75; Ortho 4355; Orthodibrom; Orthodibromo; Phosphate de *O,O*-dimethyle et de *O*-(1,2-dibromo-2-dichlorethyle) (French); Phosphoric acid, 1,2-dibromo-2,2-dichloroethyl dimethyl ester
CAS Registry Number: 300-76-5; *(alt.)* 53095-31-1
RTECS® Number: TB9450000
UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152
EC Number: 206-098-3 [*Annex I Index No.*: 015-055-00-6]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA, 1998 Status of Pesticides: Supported.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.
European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R21/22; R36/38; R50; Safety phrases: S2; S36/37; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Naled is a white crystalline solid (when pure) or light straw-colored liquid (above 26.7°C) with a slightly pungent insecticide odor. Molecular weight = 380.80; Specific gravity (H_2O:1) = 1.96 at 25°C; Boiling point = (decomposes) 110°C; Freezing/Melting point = 26.7°C; Vapor pressure = 2×10^{-4} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Insoluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Primary Irritant. Those involved in the manufacture, formulation, and application of this insecticide, fungicide, bactericide, acaricide. Also used in cooling towers, veterinary medicine, pulp and paper mill systems, hospitals, swimming pools, and bathrooms.
Incompatibilities: Incompatible with oxidizers. Hydrolyzed in presence of water. Degraded by sunlight. Decomposes when heated and on contact with acids, acid fumes, bases, producing fumes of hydrogen chloride, hydrogen bromide, phosphorus oxides. Reacts with acids, strong oxidizers in sunlight. Reacts with water. Corrosive to metals. Attacks some plastics, rubber, and coatings.
Permissible Exposure Limits in Air
OSHA PEL: 3 mg/m^3 TWA.
NIOSH REL: 3 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.1 mg/m^3 inhalable fraction and vapor [skin, sensitizer]; not classifiable as a human carcinogen; BEI$_A$ issued as Acetylcholinesterase-inhibiting pesticides.
NIOSH IDLH: 200 mg/m^3.
No TEEL available.
DFG MAK: 1 mg/m^3, measured as the inhalable fraction TWA; Peak Limitation Category II(2); [skin] danger of skin sensitization; Pregnancy Risk Group C.
Australia: TWA 3 mg/m^3, [skin], 1993; Austria: MAK 3 mg/m^3, 1999; Belgium: TWA 3 mg/m^3, [skin], 1993; Finland: TWA 3 mg/m^3; STEL 6 mg/m^3, 1999; France: VME 3 mg/m^3, [skin], 1999; Norway: TWA 3 mg/m^3, 1999; the Netherlands: MAC-TGG 3 mg/m^3, 2003; Thailand: TWA 3 mg/m^3, 1993; United Kingdom: TWA 3 mg/m^3; STEL 6 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for dibrom in ambient air[60] ranging from 30 μg/m^3 (North Dakota) to 50 μg/m^3 (Virginia) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada).
Determination in Air: No method available.
Permissible Concentration in Water: Mexico[35] has set maximum permissible concentration values of 3.0 μg/L for coastal waters and 0.03 mg/L (30 μg/L) for estuaries.
Determination in Water: Fish Tox = 10.17349000 ppb (INTERMEDIATE).
Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact. Absorbed by the skin.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the nervous system causing convulsions, respiratory failure. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. High exposure can result in death. Highly toxic; a probable human lethal dose may be between 1 teaspoon and 1 oz. Human Tox = 14.00000 ppb (INTERMEDIATE).
Long Term Exposure: May cause skin allergy. Cholinesterase inhibitor; cumulative effect is possible. This

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chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, skin, eyes, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: cholinesterase: blood plasma, red blood cells/count; cholinesterase: blood serum, red blood cells/count; cholinesterase: red blood cells/count. Before employment and at regular times after that, the above tests are recommended. Cholinesterase levels tests for the enzyme poisoned by this chemical. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended.

Note to physician: 1−4 mg atropine; maintenance: 2-mg doses at intervals of 15−60 min.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *75 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *150 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *200 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. It must be stored to avoid contact with strong oxidizers, such as chlorine and chlorine dioxide, since violent reactions occur. Keep away from acids, acid fumes, sunlight, heat, and water.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Naled in Packing Group III.

Spill Handling: *Dry:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is noncombustible. Use agents suitable for surrounding fire. Poisonous gases, including hydrogen chloride, hydrogen bromide, phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This pesticide is more stable to hydrolysis than dichlorvos (50% hydrolysis at pH 9 at 37.5°C in 301 min). It is unstable in alkaline conditions, in presence of iron, and is degraded by sunlight. About 10% hydrolysis per day is obtained in ambient water. Incineration is recommended for large amounts.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (August 1976). *Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates*, Report EPA 560/2/76-007. Washington, DC

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 44−47

New Jersey Department of Health and Senior Services. (December 1998). *Hazardous Substances Fact Sheet: Dimethyl-1,2-Dibromo-2,2-Dichloroethyl Phosphate*. Trenton, NJ

Naphthas N:0110

Synonyms: *coal tar naphtha:* Coal tar naphtha; Crude solvent coal tar naphtha; High solvent naphtha; Naphtha

Petroleum naphtha: Aliphatic petroleum naphtha; Petroleum naphtha; Petroleum spirit; rubber solvent

VM&P naphtha: Ligroin; Painters naphtha; Petroleum ether; Petroleum spirit; Refined solvent naphtha; Varnish makers' & painters' naphtha

CAS Registry Number: 8002-05-9 (petroleum distillate; petroleum asphalt); 8030-30-6; *(alt.)* 50813-73-5; *(alt.)* 54847-97-1 (naphtha, low boiling point); 121448-83-7 (coal tar naphtha); 8032-32-4 (ligroin or VM&P naphtha); *(alt.)* 8031-06-9; 64475-85-0 (naphtha, petroleum spirits); 64742-89-8 [Naphtha (petroleum) light aliphatic; rubber solvent]

RTECS® Number: SE7449000 [petroleum distillates (naphtha)]; DE3030000 (coal tar naphtha); OI6180000 (VM&P naphtha)

UN/NA & ERG Number: UN1136 (coal tar distillate)/128; UN1268 (petroleum distillates, n.o.s. or petroleum products, n.o.s.)/128; UN1300 (turpentine substitute)/128; UN1993/128

EC Number: 232-298-5 [*Annex I Index No.:* 649-049-00-5] (crude solvent coal tar naphtha); 232-443-2 [*Annex I Index No.:* 649-262-00-3] (naphtha, low boiling point); 232-453-7 [*Annex I Index No.:* 649-263-00-9] (ligroin or VM&P naphtha)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*8002-05-9*): Human, No Adequate Data; Animal, Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% VM&P naphtha.

European/International Regulations *(8002-05-9)*: Hazard Symbol: T; Risk phrases: R45; Safety phrases: S53; S45; (*8030-30-6; Naptha, low boiling point* and *8032-32-4 ligroin or VM&P naphtha*): Hazard Symbol: T; Risk phrases: R45; R46; R65; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*CAS: 8002-05-9*); 1—Slightly water polluting (*CAS: 8030-30-6; 8032-32-4*).

Description: Naphthas derived from both petroleum and coal tar are included in this group. *Petroleum naphthas* are colorless liquids with a gasoline- or kerosene-like odor. A mixture of paraffins (C5−C13) may contain a small amount of aromatic hydrocarbons and are termed "close-cut" fractions. "Medium-range" and "wide-range" fractions are made up of 40−80% aliphatic hydrocarbons, 25−50% naphthenic hydrocarbons, 0−10% benzene, and 0−20% other aromatic hydrocarbons. Molecular weight = (approx.) 99 [petroleum distillates (naphtha)]; Specific gravity (H_2O:1) = 0.63−0.66 [petroleum distillates (naphtha)]; Boiling point = 35−60°C; Freezing/Melting point = −73°C; Vapor pressure = (approx.) 40 mmHg [petroleum distillates (naphtha)]; Flash point = −40 to −66°C [petroleum distillates (naphtha)]; Autoignition temperature = 288°C. Explosive Limits: LEL = 1.1%; UEL = 5.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.

Coal tar naphtha is a mixture of aromatic hydrocarbons, principally toluene, xylene, and cumene. Coal tar naphtha is a reddish-brown, mobile liquid with an aromatic odor. Shipped as a molten solid. Benzene is present in appreciable amounts in those coal tar naphthas with low boiling points. Molecular weight = (approx.) 110; Specific gravity (H_2O:1) = 0.89−0.97; Boiling point = 160−220°C; Vapor pressure = <5 mmHg at 20°C; Flash point = 38−43°C. Explosive Limits: LEL = 1.0%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): (coal tar) Health 2, Flammability 2, Reactivity 0. Insoluble in water.

VM&P naphtha is a clear to yellowish liquid with a pleasant, aromatic odor: Molecular weight = (approx) 87−114; Specific gravity (H_2O:1) = 0.73−0.76; Boiling point = 100−177°C; Vapor pressure = 2−20 mmHg at 20°C; Flash points = −2 to 29°C; Autoignition temperature = 232°C. Explosive limits: vary somewhat but typical values are LEL = 0.9%; UEL = 6.7%. Hazard Identification (based on NFPA-704 M Rating System): (VM&P) Health 1, Flammability 3, Reactivity 0. See also Stoddard Solvent.

Potential Exposure: Compound Description [*Petroleum distillates (naphtha)*]: Human Data; Primary Irritant; (*coal tar naphtha*) Agricultural Chemical; Tumorigen, Human Data; Primary Irritant; *(VM&P naphtha)* Reproductive Effector; Primary Irritant. Naphthas are used as organic solvents for dissolving or softening rubber, oils, greases, bituminous paints, varnishes, and plastics. The less flammable fractions are used in dry cleaning. The heavy naphthas are used as a vehicle for various pesticides. Coal tar naphthas are used as quick-drying paint solvent, in the manufacture of floor coverings, resin solution, varnish; VM&P naphtha is used as a solvent for lacquers and varnishes and as a rapid-dry paint thinner.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Naphtha, petroleum distillates

Conversion factor: 1 ppm = 4.05 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 500 ppm/2000 mg/m^3 TWA.

NIOSH REL: 350 mg/m^3 TWA; 1800 mg/m^3 [15 min] Ceiling Concentration.

NIOSH IDLH: 1100 ppm [LEL].

Protective Action Criteria (PAC)

Petroleum asphalt 8002-05-9

TEEL-0: 350 mg/m^3

PAC-1: 350 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Naphtha, coal tar

Conversion factor: 1 ppm = 4.50 mg/m^3 (approx.) at 25°C & 1 atm.

OSHA PEL: 100 ppm/400 mg/m^3 TWA.

NIOSH REL: 100 ppm/400 mg/m^3 TWA.

NIOSH IDLH: 1000 ppm [LEL].

Australia: TWA 480 mg/m^3, 1993; Denmark: TWA 25 ppm (145 mg/m^3), 1999; Hungary: TWA 300 mg/m^3; STEL 800 mg/m^3, 1993; the Philippines: TWA 100 ppm (400 mg/m^3), 1993; Poland: MAC (TWA) 300 mg/m^3; MAC (STEL) 900 mg/m^3, 1999; Russia: STEL 100 mg/m^3, 1993; Switzerland: MAK-W 300 mg/m^3 (1100 mg/m^3), 1999; Turkey: TWA 100 ppm (400 mg/m^3), 1993

VM&P naphtha, legroin, paint solvent 8032-32-4:

OSHA PEL: None.

NIOSH REL: 350 mg/m^3 TWA; 1800 mg/m^3 [15 min] Ceiling Concentration.

ACGIH withdrawn; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 75 ppm

PAC-1: 75 ppm

PAC-2: 400 ppm

PAC-3: 1100 ppm

Poland: TWA 500 mg/m^3; STEL 1500 mg/m^3, 1999. In addition, Several states have set guidelines or standards for naphtha in ambient air[60] ranging from zero (Nevada) to 60−27,000 μg/m^3 (Connecticut) to 225 μg/m^3 (Virginia).

64742-89-8 [naphtha (petroleum) light aliphatic; rubber solvent]

Protective Action Criteria (PAC)

TEEL-0: 87.9 ppm

PAC-1: 87.9 ppm

PAC-2: 453 ppm

PAC-3: 1100 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1550, Naphthas, OSHA Analytical Method 48.

Routes of Entry: Inhalation of vapor, ingestion, skin and/or eye contact. Percutaneous absorption of liquid is important in development of systemic effects if benzene is present.

Harmful Effects and Symptoms

Short Term Exposure: The naphthas are irritating to the skin conjunctiva and the mucous membranes of the upper respiratory tract. Skin "chapping" and photosensitivity may develop after repeated contact with the liquid. If confined against skin by clothing, the naphthas may cause skin burn. Exposure can cause dizziness, lightheadedness, and unconsciousness. Petroleum naphtha has a lower order of toxicity than that derived from coal tar, where the major hazard is brought about by the aromatic hydrocarbon content.

Sufficient quantities of both naphthas cause central nervous system depression. Symptoms include eye irritation followed by headache and nausea. In severe cases, dizziness, convulsions, and unconsciousness occasionally result. Symptoms of anorexia and nervousness have been reported to persist for several months following an acute overexposure, but this appears to be rare. One fraction, hexane, has been reported to have been associated with peripheral neuropathy. If benzene is present, coal tar naphthas may produce blood changes, such as leukopenia, aplastic anemia, or leukemia. The kidneys and spleen have also been affected in animal experiments. At vapor concentrations up to 450 ppm, petroleum naphtha inhalations may produce slight throat irritation. At 880 pm, definite throat irritation is observed. Vapors may also irritate the nose. High concentrations may produce difficulty in breathing, blue coloration of skin, excitement, and dizziness. Inhalation of vapors in the absence of oxygen is immediately life-threatening. A vapor concentration up to 450 ppm causes mild, temporary irritation; at 880 ppm more severe irritation may be experienced. Human Tox = 14.00000 ppb (INTERMEDIATE).

Long Term Exposure: Irritates the eyes and upper respiratory system. Coal tar naphtha may contain benzene, a cancer-causing agent in humans. Exposure may cause nervous system and kidney damage. Some coal tar naphthas contain other substances that can cause blood cell damage. Longer exposure may cause drying and cracking of the skin, and make the skin sunburn more easily. Swallowing the liquid may cause chemical pneumonia.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: Preplacement and periodic medical examinations should include the central nervous system. If benzene exposure is present, workers should have a periodic complete blood count (CBC) including hematocrits, hemoglobin, white blood cell count and differential count, mean corpuscular volume and platelet count, reticulocyte count, serum bilirubin determination, and urinary phenol in the preplacement examination and at 3-month intervals. There are no specific diagnostic tests for naphtha exposure but urinary phenols may indicate exposure to benzene and aromatic hydrocarbons. It should be noted that benzene content of vapor may be higher than predicted by content in the liquid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get immediate medical attention.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, Neoprene™ rubber, Silvershield™, chlorinated polyethylene, styrene-butadiene rubber, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Coal tar naphthas: Up to 1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Causes eye irritation or damage; may require eye protection.

Petroleum naphtha: NIOSH: *Up to 850 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 1100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA

(APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

VM & P naphtha: 3500 mg/m^3: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *8750 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)]. *17,500 mg/m^3:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Naphthas must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where naphthas are handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of naphthas should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of naphtha. Wherever naphtha is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in DOT Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are flammable liquids. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Use water for cooling only. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Refined Petroleum*, NIOSH Document No. 77-192. Washington, DC

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New York State Department of Health. (May 1986). *Chemical Fact Sheet*: *VM&P Naphtha*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency. (September 28, 1984). *Chemical Hazard Information Profile: Naphtha (Petroleum) Solvents*. Washington, DC: Office of Toxic Substances

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Naphtha (Coal Tar)*. Trenton, NJ

Naphthalene N:0120

Molecular Formula: $C_{10}H_8$

Synonyms: Agitene 141/super; Albocarbon; Camphor tar; Dezodorator; Mighty 150; Moth balls; Moth flakes; Naftaleno (Spanish); Naphthaline; Napthalene, moletn; Napthalin; Napthaline; Napthene; NCI-C52904; Tar camphor

CAS Registry Number: 91-20-3

RTECS® Number: QJ0525000

UN/NA & ERG Number: UN1334 (crude and refined)/133; UN2304 (molten)/133

EC Number: 202-049-5 [*Annex I Index No.:* 601-052-00-2] (naphthalene, crude or refined)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; equivocal evidence: mouse; NTP: Carcinogenesis Studies (inhalation); some evidence: mouse; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 2002; EPA: Possible Human Carcinogen; Cannot be Determined.

US EPA Gene-Tox Program, Negative: Cell transform.—mouse embryo; Negative: Cell transform.—RLV F344 rat embryo; Negative: Histidine reversion—Ames test.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U165.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 5.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 4/19/02.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R50/53; Safety phrases: S2; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Naphthalene is a colorless to brown crystalline solid with a characteristic "moth ball" odor. Shipped as a molten solid. Odor threshold = 0.038 ppm. Molecular weight = 128.18; Specific gravity (H_2O:1) = 1.15; Boiling point = 217.8°C; Freezing/Melting point = 74−80°C; Vapor pressure = 0.08 mmHg at 20°C; Flash point = 78.9°C; Autoignition temperature = 540°C. Explosive limits: LEL = 0.9%; UEL = 5.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.003%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Naphthalene is used as a chemical intermediate or feedstock for synthesis of phthalic, anthranilic, hydroxyl (naphthols), amino (naphthylamines), and sulfonic compounds, which are used in the manufacture of various dyes and in the preparation of phthalic anhydride, 1-naphthyl-*N*-methyl carbonate, and β-naphthol. Naphthalene is also used in the manufacture of hydronaphthalenes, synthetic resins, lampblack, smokeless powder, and celluloid. Naphthalene has been used as a moth repellent.

Approximately 100 million people worldwide have G6PD deficiency which would make them more susceptible to hemolytic anemia on exposure to naphthalene. At present, more than 80 variants of this enzyme deficiency have been identified. The incidence of this deficiency is 0.1% in

American and European Caucasians but can range as high as 20% in American blacks and greater than 50% in certain Jewish groups. Newborn infants have a similar sensitivity to the hemolytic effects of naphthalene, even without G6PD deficiency.

Incompatibilities: Violent reactions with chromium(III) oxide, dinitrogen pentoxide, chromic anhydride, and strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 10 ppm/50 mg/m^3 TWA.

NIOSH REL: 10 ppm/50 mg/m^3 TWA; 15 ppm/75 mg/m^3 STEL.

ACGIH TLV®[1]: 10 ppm/52 mg/m^3 TWA; 15 ppm/79 mg/m^3 STEL [skin].

DFG MAK: [skin] Carcinogen Category 3B.

NIOSH IDLH: 250 ppm.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 15 ppm

PAC-2: 15 ppm

PAC-3: 250 ppm

Arab Republic of Egypt: TWA 10 ppm (50 mg/m^3), 1993; Austria: MAK 10 ppm (50 mg/m^3), 1999; Belgium: TWA 10 ppm (52 mg/m^3); STEL 15 ppm (79 mg/m^3), 1993; Denmark: TWA 10 ppm (50 mg/m^3), 1999; Finland: TWA 10 ppm (50 mg/m^3); STEL 20 ppm (100 mg/m^3), 1999; France: VME 10 ppm (50 mg/m^3), 1999; Hungary: TWA 40 mg/m^3; STEL 80 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 50 mg/m^3, 2003; Norway: TWA 10 ppm (50 mg/m^3), 1999; the Philippines: TWA 10 ppm (50 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3; MAC (STEL) 75 mg/m^3, 1999; Russia: STEL 20 mg/m^3, 1993; Switzerland: MAK-W 10 ppm (50 mg/m^3), 1999; United Kingdom: TWA 10 ppm (53 mg/m^3); STEL 15 ppm (80 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm [skin]. Russia[43] set a MAC of 0.003 mg/m^3 (3 μg/m^3) in ambient air in residential areas. Several states have set guidelines or standards for naphthalene in ambient air[60] ranging from 14 μg/m^3 (Massachusetts) to 166.7 μg/m^3 (New York) to 500 μg/m^3 (Florida) to 500−750 μg/m^3 (North Dakota) to 800 μg/m^3 (Virginia) to 1000 μg/m^3 (Connecticut) to 1190 μg/m^3 (Nevada) to 1250 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Methods #1501; OSHA Analytical Method 35.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 2300 μg/L on an acute toxicity basis and 620 μg/L on a chronic basis. *To protect saltwater aquatic life:* 2350 μg/L on an acute toxicity basis. For the protection of human health from the toxic properties of naphthalene ingested through water and through contaminated aquatic organisms, no ambient water criterion has been set due to insufficient data.[6] Russia[43] set a MAC of 0.004 mg/L in water bodies used for fishery purposes. Kansas has set a guideline of 143 μg/L for naphthalene in drinking water.[61]

Determination in Water: Methylene chloride extraction followed by high-pressure liquid chromatography with fluorescence or UV detection; or gas chromatography (EPA Method 610) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 3.3$.

Routes of Entry: Inhalation of vapor or dust, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. High levels cause headache, fatigue, confusion, excitement, malaise, nausea, and vomiting. *Inhalation:* Levels above 10 ppm may cause headache, nausea, excessive sweating, and vomiting. *Skin:* May cause irritation. If hypersensitive to naphthalene, severe irritation may occur. *Eyes:* Levels above 15 ppm may cause irritation. Direct contact may cause severe irritation, injury to the cornea, and a blurring of vision. *Ingestion:* Ingestion of ½ g (1/60 oz) may cause nausea, vomiting, abdominal pain, irritation of the bladder, and brown or black coloration of the urine. The symptoms usually disappear after a few days. Animal studies indicate that the probable lethal dose for an adult is 5−15 g (1/16−½ oz).

Long Term Exposure: Repeated exposure or ingestion may cause clouding of the eye (cataract). Inhalation of levels above 10 ppm may cause headaches, nausea, vomiting, and a feeling of general discomfort. Chronic skin problems are rare, except in cases of hypersensitivity. May cause skin allergy, kidney, and liver damage. May damage the red blood cells causing anemia.

Points of Attack: Eyes, skin, blood, liver, kidneys, central nervous system.

Medical Surveillance: NIOSH lists the following tests: blood plasma, hemoglobin; complete blood count; liver function tests; red blood cells/count, RBC hemolysis; urine (chemical/metabolite); urine (chemical/metabolite), hemoglobin; urinalysis (routine); white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following is recommended before beginning work and at regular times after that: examination of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Complete blood count (CBC). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or any supplied-air respirator.* *Up to 12.5 mg/m^3:* Sa:Cf (any supplied-air respirator operated in a continuous-flow mode)*; or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) 100, or P100 filter) or any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter*; or any self-contained breathing apparatus with a full face-piece; or any supplied-air respirator with a full face-piece. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable storage area. Naphthalene must be stored to avoid contact with chromium(III) oxide, dinitrogen pentoxide, and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where naphthalene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of naphthalene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Liquid naphthalene must avoid contact with water.

Shipping: Naphthalene, crude or Naphthalene, refined, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep naphthalene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but is not easily ignited. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Use caution when using water spray or foam directly on molten naphthalene as extensive foaming may occur. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1980). *Naphthalene: Ambient Water Quality Criteria*. Washington, DC

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US Environmental Protection Agency. (April 30, 1980). *Naphthalene, Health and Environmental Effects Profile No. 131*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report,* 5, No. 4, 71−74

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Naphthalene*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Naphthalene*. Trenton, NJ

Naphthenic acid N:0130

Molecular Formula: $R_2C\text{-}CR_2\text{-}CR_2\text{-}CR_2\text{-}CR\text{-}(CH_2)_n\text{-}COOH$ (where $n = 2-6$); $CnH_{2n}1COOH$

Synonyms: Acido naftalico (Spanish); Agenap; Agenap HMW-H; Cyclopentane carboxylic acid; Naphid; Sunaptic acid B; Sunaptic acid C

CAS Registry Number: 1338-24-5

RTECS® Number: QK8750000

UN/NA & ERG Number: UN3077/171

EC Number: 215-662-8

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Naphthenic acid is a gold to black, odorless liquid. Molecular weight = (approx.) 200−250 (mixture); Specific gravity (H_2O:1) = 0.982 at 20°C; Boiling point = 132−243°C; Freezing/Melting point = 31°C; Flash point = 149°C (oc). Explosive limits: LEL = 0.9−1%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0; Slightly soluble in water.

Potential Exposure: Used to make metallic naphthenates for paint dryers and cellulose preservatives. It is also used as a solvent, detergent, rubber reclaiming agent. Used in catalysts, cutting oils, drilling compounds, rust inhibitors, surfactants, emulsions, grease, and wood preservatives.

Incompatibilities: Incompatible with sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin, strong oxidizers. Corrosive to metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Lead salt

TEEL-0: 1.25 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: No method established.

Harmful Effects and Symptoms

Short Term Exposure: Vapors irritate the eyes, skin, and respiratory tract. Contact with the skin causes reddening.

Long Term Exposure: Repeated or prolonged contact causes dry and cracked skin and may cause contact dermatitis. May cause liver and central nervous system damage.

Medical Surveillance: There are no special tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals and other incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (June1999). *Hazardous Substances Fact Sheet: Naphthenic Acid*. Trenton, NJ

2-Naphthol N:0140

Molecular Formula: $C_{10}H_8O$

Synonyms: β-Hydroxynaphthalene; 2-Naphthalenol; 2-Naphthol; β-Naphthol

CAS Registry Number: 135-19-3

RTECS® Number: QL2975000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-182-7 [*Annex I Index No.:* 604-007-00-5]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/22; R50; Safety phrases: S2; S24/25; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 2-Naphthol is a white, crystalline solid with a slight phenolic odor. Darkens in air and on exposure to light. Molecular weight = 144.18; Boiling point = 285−286°C; Freezing/Melting point = 121−123°C; Flash point = 153°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0; (1-naphthol) Health 3, Flammability 1, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen, Primary Irritant. Those involved in rubber antioxidant production, synthesis of dyes, leather processing, fungicides, pharmaceuticals, and perfumes. Used as an antioxidant for fats, oils, as an antiseptic, in insecticides.

Incompatibilities: Oxidizers, iron salts, 2,3-dimethyl-1-phenyl-3-pyrazolin-5-one (antipyrine), camphor, phenol, menthol, urethane.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.0025 mg/m^3

PAC-1: 0.0075 mg/m^3

PAC-2: 0.05 mg/m^3

PAC-3: 500 mg/m^3

Russia: STEL 0.1 mg/m^3, 1993.

Russia[43] set a MAC of 0.006 mg/m^3 in ambient air in residential areas on a momentary basis and 0.003 mg/m^3 on a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.4 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin and eyes. Ingestion can cause nephritis, lens opacity, vomiting, diarrhea, abdominal pain, circulatory collapse, convulsion, hemolytic anemia, and death.

Long Term Exposure: May cause kidney damage, anemia. May cause mutations.

Points of Attack: Eyes, skin, blood, liver, kidneys, central nervous system.

Medical Surveillance: Complete blood count (CBC), kidney damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Self-contained breathing apparatus.

Storage: Color Code—Blue (*1-naphthol*): Health Hazard/ Poison: Store in a secure poison location. Color Code—Green (2-naphthol): General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dark place.

Shipping: Toxic solids, organic, n.o.s. compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mix with flammable solvent and atomize into an incinerator.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report,* 2, No. 3, 81−83 (1982) & 3, No. 6, 49−52 (1983) & 8, No. 3, 79−86 (1988)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

1,4-Naphthoquinone N:0150

Molecular Formula: $C_{10}H_6O_2$

Synonyms: 1,4-Dihydro-1,4-diketonaphthalene; Naftoquinona (Spanish); 1,4-Naphthalenedione; α-Naphthoquinone

CAS Registry Number: 130-15-4

RTECS®Number: QL7175000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-977-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U166.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,4-Naphthoquinone is a yellow to greenish-yellow crystalline solid with a pungent odor. Odor threshold = 0.02 ppm. Molecular weight = 158.16; Sublimation point = 100°C; Freezing/Melting point = 123−126°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector. 1,4-Naphthoquinone is used as a polymerization regulator for rubber and polyester resins, in the synthesis of dyes and pharmaceuticals, and as a fungicide and algicide.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 7.5 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 75 mg/m^3

Russia: STEL 0.1 mg/m^3, [skin] 1993.

Russia[43] set a MAC of 0.005 mg/m^3 in ambient air in residential areas both on a momentary and a daily average basis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Long Term Exposure: The most consistent findings reported in the literature for health effects of 1,4-naphthoquinone involve hematological changes, irritant and allergenic activity, and inhibition of biochemical oxidation processes. One study found 1,4-naphthoquinone to be oncogenic. Some evidence of inhibition of *in vitro* endocrine function and of nerve activity was reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: Toxic solids, organic, n.o.s. compound require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1, Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant

($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *1,4-Naphthoquinone, Health and Environmental Effects Profile No. 132*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report,* 4, No. 2, 81−83

1-Naphthylamine N:0160

Molecular Formula: $C_{10}H_9N$
Common Formula: $C_{10}H_7NH_2$
Synonyms: 1-Aminonaphthalene; C.I. azoic diazo component 114; Fast garnet B base; α-Naftilamina (Spanish); 1-Naftilamina (Spanish); 1-Naphthalenamine; Naphthalidine; 1-Naphthylamin (German); α-Naphthylamine; Naphthylamine; Naphthylamine-a; Napthalidine
CAS Registry Number: 134-32-7
RTECS® Number: QM1400000
UN/NA & ERG Number: UN2077/53
EC Number: 205-138-7 [*Annex I Index No.:* 612-020-00-2]
Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human, Inadequate Evidence; Animal, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; OSHA: Potential human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Host-mediated assay; Positive: *E. coli* polA with S9; Histidine reversion—Ames test; Negative: SHE—clonal assay; Cell transform.—RLV F344 rat embryo; Negative: *E. coli* polA without S9; *In vitro* UDS—human fibroblast; Negative: *S. cerevisiae*—homozygosis; Negative/limited: Carcinogenicity—mouse/rat; Inconclusive: Mammalian micronucleus; *N. crassa*—forward mutation; Inconclusive: Sperm morphology—mouse.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1004).

US EPA Hazardous Waste Number (RCRA No.): U167.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R51/53; Safety phrases: S2; S24; S6 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: α-Naphthylamine exists as white needle-like crystals which turn red on exposure to air. Has a weak ammonia-like odor. Molecular weight = 143.20; Specific gravity (H_2O:1) = 1.12; Boiling point = 300.6°C; Freezing/Melting point = 44.4°C; Vapor pressure = 1 mmHg at 104°C; Flash point = 157.2°C; Autoignition temperature = 460°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.002%; 1 mg/mL at 20°C.[NTP]

Potential Exposure: Compound Description: Tumorigen, Mutagen. α-Naphthylamine is used as an intermediate in dye production, for manufacturing herbicides and antioxidants, in the manufacture of condensation colors, rubber, and in the synthesis of many chemicals, such as α-naphthol, sodium naphthionate, *o*-naphthionic acid, Neville and Winther's acid, sulfonated naphthylamines, α-naphthylthiourea (a rodenticide), and *N*-phenyl-α-naphthylamine.

Incompatibilities: Oxidizes in air. Incompatible with nitrous acid, oxidizers, nitrates, organic anhydrides, isocyanates, aldehydes.

Permissible Exposure Limits in Air

OSHA: Cancer Suspect Agent, see 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: Confirmed Human Carcinogen.

Protective Action Criteria (PAC)
TEEL-0: 0.6 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 350 mg/m^3

Austria: carcinogen, 1999; Poland: MAC (TWA) 0 mg/m^3, MAC (STEL) 0 mg/m^3, 1999; Sweden: carcinogen, 1993. α-Naphthylamine is included in the Federal standard for carcinogens; all contact with it should be avoided.[63] Several states have set guidelines or standards for 1-naphthylamine in ambient air[60] ranging from zero in South Carolina to 0.03 $\mu g/m^3$ (New York).

Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical Method 93.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Percutaneous absorption.

Harmful Effects and Symptoms

Short Term Exposure: 1-Naphthylamine can affect you when breathed in and by passing through your skin. 1-Naphthylamine should be handled as a carcinogen, with extreme caution. High exposure can cause the skin and lips to turn blue. This reduces the ability of the blood cells to carry oxygen to body organs (methemoglobinemia). Higher levels can cause breathing difficulties, collapse, and possible death.

Long Term Exposure: Some related chemicals can damage the liver and/or cause skin allergies. It is not known whether 1-naphthylamine has these effects. A report of excess bladder cancer among individuals who worked with this chemical has been published. This may be due to contamination with 2-naphthylamine, a known human carcinogen.

Points of Attack: Bladder, skin. *Cancer site:* bladder.

Medical Surveillance: OSHA mandates the following tests or information: *Increased Risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking. *NIOSH lists the following tests: *increased risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking, cystoscopy, urinalysis (routine). Before beginning employment and at regular times after that, the following are recommended: urine cytology (a test for abnormal cells in the urine). A urine test for 1-naphthylamine can also be done to determine whether this cancer agent is entering the body. For accuracy, it should be done shortly after exposure. If symptoms develop or overexposure is suspected, the following may be useful: test for methemoglobin (most accurate a few hours after exposure; the blood sample must be promptly tested).

**Code of Federal Regulations. 29 CFR Part 1910.1000. Subpart Z. Air Contaminants.* US Government Printing Office. (July 1, 2004).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: *alpha*-Naphthylamine requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1-Naphthylamine may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers, however, water or foam may cause frothing. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalyst, or thermal device. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report,* 4, No. 3, 79−82

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: 1-Naphthylamine*. Trenton, NJ

2-Naphthylamine N:0170

Molecular Formula: $C_{10}H_9N$
Common Formula: $C_{10}H_7NH_2$
Synonyms: 2-Aminonaphthalene; C.I. 37270; Fast scarlet base B; NA; β-Naftilamina (Spanish); 2-Naftilamina (Spanish); 2-Naphthalenamine; β-Naphthamin (German); 2-Naphthylamin (German); 2-Naphthylamine; 6-Naphthylamine; Naphthylamine-b; 2-Naphthylamine mustard
CAS Registry Number: 91-59-8
RTECS® Number: QM2100000
UN/NA & ERG Number: UN1650/153
EC Number: 202-080-4 [*Annex I Index No.:* 612-022-00-3]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998; Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NIOSH: Potential occupational carcinogen; OSHA: Potential human carcinogen.
US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—mouse embryo; Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; Host-mediated assay; Positive: Mammalian micronucleus; *N. crassa*—forward mutation; Positive: *E. coli* polA with S9; Histidine reversion—Ames test; Positive: *S. cerevisiae* gene conversion; Negative: Cell transform.—BALB/c-3T3; *E. coli* polA without S9; Negative: Sperm morphology—mouse; *S. cerevisiae*—homozygosis; Inconclusive: *D. melanogaster* sex-linked lethal; Positive: CHO gene mutation.
Banned or Severely Restricted (several countries) (UN).[35]
Very Toxic Substance (World Bank).[15]
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1009).
US EPA Hazardous Waste Number (RCRA No.): U168.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.52; Nonwastewater (mg/kg), N/A.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/ L): 8270 (10).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer 2/27/87.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: 2-Naphthylamine is a white to red crystal with a faint, aromatic odor. Darkens in air to a reddish-purple color. Molecular weight = 143.20; Specific gravity (H_2O:1) = 1.06 at 97.8°C; Boiling point = 294°C; Freezing/Melting point = 109−110°C; Vapor pressure = 1 mmHg at 104°C; Flash point = 157°C. Soluble in hot water.
Potential Exposure: Compound Description: Tumorigen, Mutagen. 2-Naphthylamine is presently used only for research purposes. It is present as an impurity in α-naphthylamine. It is used as an intermediate in the preparation of other compounds. 2-Naphthylamine was widely used in the manufacture of dyestuffs, as an antioxidant for rubber, and in rubber-coated cables.
Incompatibilities: Strong oxidizers. A weak base. Incompatible with nitrous acid.
Permissible Exposure Limits in Air
OSHA: Cancer Suspect Agent, see 29CFR1910.1003.
NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: Exposure by all routes should be carefully controlled to levels as low as possible; Confirmed Human Carcinogen.
No TEEL available.
DFG MAK: [skin]; Carcinogen Category 1.
Australia: carcinogen, 1993; Austria [skin] carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; France: VME 0.001 ppm (0.005 mg/m^3), continuous; carcinogen, 1993; Poland: MAC (TWA) 0 mg/m^3, MAC (STEL) 0 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: [skin] carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. 2-Naphthylamine is included in the federal standard for carcinogens; all contact with it should be avoided. ACGIH states that β-naphthylamine is a human carcinogen without an assigned TLV. Several states have set guidelines of standards for 2-naphthylamine in ambient air[60] ranging from zero (North Dakota, New York and South Carolina) to 3.0 μg/m^3 (Virginia) to 19.07 μg/m^3 (Pennsylvania).
Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical Method 93.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient level goal based on health effects of 291 μg/L.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Percutaneous absorption.
Harmful Effects and Symptoms
Short Term Exposure: 2-Naphthylamine is irritating to the eyes and skin; has produced contact dermatitis. High levels

can interfere with the blood's ability to carry oxygen (methemoglobinemia). Higher levels can cause breathing difficulties, collapse, and even death.

Long Term Exposure: 2-Naphthylamine is a known human bladder carcinogen with a latent period of about 16 years. The symptoms are frequent urination, dysuria, and hematuria. Acute poisoning leads to methemoglobinemia or acute hemorrhagic cystitis. 2-Naphthylamine is carcinogenic, producing urinary bladder carcinomas in hamsters, dogs, and nonhuman primates, and hepatomas in mice, after oral administration. Epidemiological studies have shown that occupational exposure to 2-naphthylamine, either alone or when present as an impurity in other compounds, is causally associated with bladder cancer.

Points of Attack: Bladder, skin. *Cancer site:* bladder.

Medical Surveillance: OSHA mandates the following tests or information: *Increased Risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking. *NIOSH lists the following tests: *increased risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking, cystoscopy, urinalysis (routine). Preplacement and periodic examinations should include an evaluation of exposure to other carcinogens, use of alcohol, smoking, and medications, and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store away from heat and light in a refrigerator or a cool, dry place away from incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust. Transfer to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing

apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalyst, or thermal device.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report,* 2, No. 2, 56−58 (1982) & 3, No. 6, 52−56 (1983)

Neochromium trivalene N:0180

Molecular Formula: $CrHO_5S$

Common Formula: $Cr(OH)SO_4$

Synonyms: Basic chromic sulfate; Basic chromic sulphate; Basic chromium sulfate; Basic chromium sulphate; Chromium hydroxide sulfate; Chromium sulfate; Chromium sulfate, basic; Chromium sulphate; Koreon; Monobasic chromium sulfate; Monobasic chromium sulphate; Sulfuric acid, chromium salt, basic

CAS Registry Number: 64093-79-4

RTECS® Number: QO6800000

UN/NA & ERG Number: UN2240/154

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (insoluble salts): Not Classifiable as to human carcinogenicity; Cannot be Determined.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure.

Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Chromium(III) compounds, n.o.s.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List as chromium compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Neochromium is a violet or green powder. Molecular weight = 165.07; Boiling point = 98°C; Freezing/Melting point = 67°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Neochromium is used in papermaking, photography, dyeing, printing, and tanning.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Cr]/m^3 TWA.

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV®[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 25 mg Cr(III)/m^3.

No TEEL available.

DFG MAK: [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric Acid Ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: For the protection of freshwater aquatic life: *Trivalent chromium:* not to exceed e[1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: *Trivalent chromium:* 10,300 μg/L on an acute toxicity basis. *To protect human health: Trivalent chromium:* 170 μg/L; Hexavalent chromium 50 μg/L according to EPA.[6] For chromium, EPA[49] has set a long-term health advisory of 0.84 mg/L for adults and a lifetime health advisory of 0.12 mg/L (120 μg/L). EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] as 50 μg/L for Maine and 120 μg/L for Minnesota.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Neochromium can affect you when breathed in. Skin and eye contact can cause severe burns. Overexposure can irritate the nose, throat, and bronchial tubes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} (oral-rat) = 1500 mg/kg.

Long Term Exposure: Skin allergy sometimes occurs with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms. Breathing neochromium may cause a sore or hole in the nasal septum. Can irritate the lungs; bronchitis may develop. In addition, RTECS[9] states neochromium is tumorigenic, that is, it facilitates the action of known carcinogens.

Points of Attack: Eyes, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite), biologic tissue/biopsy, chest X-ray, pulmonary function tests, red blood cells/count, urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- and postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 25 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (any self-contained breathing apparatus with a full face-piece) or SaF (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This chemical requires a “CORROSIVE” label. It falls in Hazard Class 8 and Packing Group I.[19]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Neochromium may burn but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including sulfur oxides are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2004). *Hazardous Substances Fact Sheet: Neochromium*. Trenton, NJ

Neon N:0190

Molecular Formula: Ne
Synonyms: Neon, elemental
CAS Registry Number: 7440-01-9
RTECS® Number: QP4450000
UN/NA & ERG Number: UN1065 (compressed); UN1913 (liquid)
EC Number: 231-110-9
Description: Neon is a colorless, odorless, tasteless gas or liquid. Molecular weight = 20.18; Boiling point = −246°C; Freezing/Melting point = −249°C. Slightly soluble in water.
Potential Exposure: Neon is used in photoelectric bulbs and certain light tubes, in the electronic industry, in lasers, in plasma studies, and in other research.
Permissible Exposure Limits in Air
ACGIH TLV®[1]: Simple asphyxiant.
Protective Action Criteria (PAC)
TEEL-0: 65,000 ppm
PAC-1: 65,000 ppm
PAC-2: 230,000 ppm
PAC-3: 400,000 ppm
Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: asphyxiant, 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant. Large amounts of neon will decrease the amount of available oxygen. Oxygen content should be tested to ensure that it is at least 19% by volume.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Neon can affect you when breathed in. Exposure can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out and could cause suffocation from lack of oxygen. Contact with liquefied neon could cause frostbite. Before entering a confined space, be certain that sufficient oxygen exists.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Eye protection is required in laser operations to avoid eye burning. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash (gloves, footwear, headgear) which should be clean, available each day, and put on before work. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues.
Respirator Selection: Exposure to neon is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Storage areas should be dry and well ventilated. Protect cylinders of neon from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.
Shipping: Neon, *compressed,* and Neon, *refrigerated liquid (cryogenic liquid)*, require a shipping label of "NONFLAMMABLE GAS." Both fall in DOT Hazard Class 2.2.
Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas, but containers may explode in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Venting to atmosphere.

Reference

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Neon*. Trenton, NJ

Neopentane N:0200

Molecular Formula: C_5H_{12}

Common Formula: $CH_3C(CH_3)_2CH_3$

Synonyms: 2,2-Dimethylpropane; Dimethylpropane; Neopentane; *tert*-Pentane; Propane, 2,2-dimethyl-; Tetramethylmethane; 1,1,1-Trimethylethane

CAS Registry Number: 463-82-1

RTECS® Number: TY1190000

UN/NA & ERG Number: UN2044/115

EC Number: 207-343-7 [*Annex I Index No.:* 601-005-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List (neopentane not listed) *n*-pentane Concentration 1%.

European/International Regulations: Hazard Symbol: F +, N; Risk phrases: R12; R51/53; Safety phrases: S2; S9; S16; S33; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Neopentane is a volatile liquid. Molecular weight = 72.17; Boiling point = 9°C; Flash point = (Gas) − 7°C. Explosive limits: LEL = 1.4%; UEL = 7.5%; Autoignition temperature = 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 4, Reactivity 0. Insoluble in water.

Potential Exposure: Neopentane is used as a gasoline blending component and for making butyl rubber. A research chemical. Reacts with strong oxidizers, causing fire and explosion hazard. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

OSHA gives limits for *n-pentane* as do several states, but they do not single out "neopentane." *This is shown for reference only.*

OSHA PEL: 1000 ppm/2950 mg/m^3 TWA.

NIOSH REL: 120 ppm/350 mg/m^3 TWA.

ACGIH TLV®[1]: 600 ppm/1770 TWA.

NIOSH IDLH: 1500 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 610 ppm

PAC-1: 610 ppm

PAC-2: 610 ppm

PAC-3: 1500 ppm

DFG MAK: 1000 ppm/3000 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Austria: MAK 600 ppm (1899 mg/m^3), 1999; Denmark: TWA 500 ppm (1500 mg/m^3), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 600 ppm.

United Kingdom[33] TWA 600 ppm (1800 mg/m^3); STEL of 750 ppm (2250 mg/m^3) (all isomers of pentane).

Determination in Air: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1500, Hydrocarbons.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can cause skin irritation and severe burns with redness, itching. May affect the central nervous systems. Skin contact with the undiluted material for 5 h causes blisters; for 1 h it causes irritation, itching, erythema, pigmentation, swelling, burning, and pain. Skin contact can cause frostbite. Inhalation can cause headache, dizziness, and suffocation. The toxicity is via the inhalation route. It is narcotic in high concentrations. Ingesting the liquid may cause chemical pneumonia (aspiration).

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. See above.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as pentane): *1200 ppm:* Sa (APF = 10) (any supplied-air respirator). *1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Pentanes require a label of “FLAMMABLE LIQUID.” They fall in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (February 1999). *Hazardous Substances Fact Sheet: Dimethylpropane*. Trenton, NJ

Nerve agents

Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. Other organophosphate chemicals include commercial insecticides, such as Malathion®. These chemicals all cause similar effects on the human body by disrupting how nerves communicate and control muscles, glands, and organs. Though they cause similar effects, nerve agents are more toxic than commercial insecticides—so smaller amounts can cause effects of concern. Most of the nerve agents exist as liquids but some (such as GB) volatilize into the air on their own. VX is the least likely to become airborne, but in conditions involving explosions, it could vaporize and spread in the air. The major chemical warfare agents in this category and their code names are listed below along with their record number for quick access.

Cyclosarin, agent GF see C:1795.
Sarin, agent GB see S:0130.
Soman, agent GD see S:0565.
Tabun, agent GA see T:0110.
VX, agent VX see V:0250.

Niacinamide N:0210

Molecular Formula: $C_6H_6N_2O$

Synonyms: Acidamide; Nicotimanide; Nicotine acid amide; 3-Pyridine carboxamide; 3-Pyridine carboxylic acid amide; VI-Nicotyl; VI-Nictyl; Vitamin B_3; Vitamin Pp

CAS Registry Number: 98-92-0

RTECS® Number: QS3675000

EC Number: 202-713-4

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Niacinamide is a white crystalline powder or forms colorless needle-like crystals. Molecular weight = 122.14; Boiling point = 155°C; Freezing/Melting point = 129−130°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Highly soluble in water.

Potential Exposure: Compound Description: Mutagen. Used as a dietary supplement and food additive.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 6 mg/m^3
PAC-1: 20 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: These symptoms reported from cases of medical treatment or self-prescribed massive vitamin dosage. The sudden onset of nausea, vomiting, and fatigue have been reported following increased dose from 4 to 9 g daily. From animal studies, the lethal human dose has been estimated to be about ½ lb.

Long Term Exposure: The recommended dietary supplement is 10−20 mg per day. This level causes no adverse effects. Levels of 4−9 g/day may cause nausea and vomiting as well as serious changes in liver tissue and enzymes. May cause mutations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Niacinamide*. Albany, NY: Bureau of Toxic Substance Assessment

Nickel & compounds N:0220

Molecular Formula: Ni

Synonyms: *metal:* Alloy 725; Alloy 732; Alloy 735; Alloy 762; Alloy 770; C.I. 77775; FM 1208; HCA 1; Metallic Nickel; Ni; Ni 0901S (Harshaw); Ni 233; Ni 270; Ni 4303T; Nickel, Elemental; Nickel 0901 S; Nickel 200; Nickel 201; Nickel 203; Nickel 204; Nickel 205; Nickel 211; Nickel 212; Nickel 213; Nickel 222; Nickel 223; Nickel 225; Nickel 229; Nickel 233; Nickel 270; Nickel 4303 T; Nickel Sponge; Niklad 794-A; NP 2; Raney Alloy; Raney Nickel; RCH 55/5; Synonyms of other nickel compounds vary depending upon the specific compound.

CAS Registry Number: 7440-02-0

RTECS® Number: QR5950000 [*Annex I Index No.:* 028-002-00-7]

UN/NA & ERG Number: UN3077/171; metal powder, in bulk, may be pyrophoric: UN3089 (Metal powder, flammable, n.o.s.)/170; UN2881(Nickel catalyst, dry)/135 Nickel catalyst, dry

EC Number: 231-111-4 [*Annex I Index No.:* 028-002-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*Ni compounds*) Human Sufficient Evidence; Animal Sufficient Evidence*, carcinogenic to humans*, Group 1; (*elemental*): Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, (compounds) *carcinogenic to humans*, Group 1, 1997; NTP (*elemental and Ni compounds, soluble and insoluble*): 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH (*elemental and Ni compounds, soluble and insoluble*): Potential occupational carcinogen; US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 3.98; Nonwastewater (mg/L), 5.0 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (50); 7520 (400).

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Dropped from listing of Extremely Hazardous Substance (EPCRA) in 1988.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as elemental nickel.

Nickel compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains nickel as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1.

California Proposition 65 Chemical: Cancer 1/1/89; nickel compounds 5/7/04; Nickel refinery dust from the pyrometallurgical process 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration (most listed compounds are 0.1%). Nickel, water-insoluble compounds, n.o.s and Nickel, water-soluble inorganic compounds, n.o.s. are 1%. See list.

European/International Regulations: Hazard Symbol (*powder*): T,N; Risk phrases: R40; R43; R48/23; R52/53; Safety phrases: S2; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*nickel metal; nickel powder, particle size <0.1 mm*); 1—Slightly water polluting (*nickel, particle size >0.1 mm*).

Description: Nickel metal is a hard, ductile, magnetic metal with a silver-white color. Molecular weight = 58.71; Boiling point = 2837°C; Freezing/Melting point = 1555°C. Hazard Identification (based on NFPA-704 M Rating System) (*powder*): Health 2, Flammability 4, Reactivity 1; (*metal*) Health 1, Flammability 0, Reactivity 0. Insoluble in water. It occurs free in meteorites and in ores combined with sulfur, antimony, or arsenic. Processing and refining of nickel is accomplished by either the Oxford (sodium sulfide and electrolysis) or the Mond (nickel carbonyl) processes. In the latter, impure nickel powder is reacted with carbon monoxide to form gaseous nickel carbonyl which is then treated to deposit high-purity metallic nickel.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Nickel is used as an alloy additive in steel manufacture and in the production of coins and other utensils. Nickel forms alloys with copper, manganese, zinc, chromium, iron, molybdenum, etc. Stainless steel is the most widely used nickel alloy. An important nickel−copper alloy is Monel metal, which contains 66% nickel and 32% copper and has excellent corrosion resistance properties. Permanent magnets are alloys chiefly of nickel, cobalt, aluminum, and iron. Elemental nickel is used in electroplating, anodizing aluminum casting operations for machine parts and in coinage, in the manufacture of acid-resisting and magnetic alloys, magnetic tapes, surgical and dental instruments, nickel-cadmium batteries, nickel soaps in crankcase oil, in ground-coat enamels, colored ceramics, and glass. It is used as a catalyst in the hydrogenation synthesis of acrylic esters for plastics. Exposure to nickel may also occur during mining, smelting, and refining operations. The route by which most people in the general population receive the largest portion of daily nickel intake is through food. Based on the available data from composite diet analysis, between 300 and 600 μg nickel/day is ingested. Fecal nickel analysis, a more accurate measure of dietary nickel intake, suggests about 300 μg/day. The highest level of nickel observed in water was 75 μg/L. Average drinking water levels are about 5 μg/L. A typical consumption of 2 L daily would yield an additional 10 μg of nickel, of which up to 1 μg would be absorbed.

Incompatibilities: Nickel dust is a spontaneously flammable solid and a dangerous fire hazard.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*elemental*): 1.5 mg[Ni]/m^3 inhalable fraction TWA; not suspected as a human carcinogen; (*inorganic, insoluble compounds*) 0.2 mg[Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen; (*inorganic, soluble compounds*) 0.1 mg[Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 4.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 10 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1 DFG TRK: 0.50 μg [Ni]/L in urine, after several shifts; Category 1, human carcinogen, as inhalable dusts/aerosols from nickel metal, nickel carbonate arising in production and processing.

Arab Republic of Egypt: TWA 0.1 mg/m^3, 1993; Australia: TWA 1 mg/m^3, 1993; Austria: carcinogen, 1999; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3 [skin] carcinogen, 1999; France: VME 1 mg/m^3, continuous carcinogen, 1999; Hungary: STEL 0.005 mg[Ni]/m^3, Carcinogen (insoluble compounds), 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; the Philippines: TWA 1 mg/m^3, 1993; Poland: MAC (TWA) 0.25 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.5 mg/m^3 (*dust*), 1999; Switzerland: MAK-W 0.5 mg/m^3, carcinogen, 1999; Thailand: TWA 1 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Russia[35, 43] set a MAC of 0.0002 mg/m^3 in ambient air in residential areas for soluble nickel salts. Various states have set guidelines or standards for nickel in ambient air[60] ranging from 0.002 μg/m^3 (Rhode Island) to 0.002−0.018 μg/m^3 (Massachusetts) to 0.0303 μg/m^3 (Kansas) to 0.13−0.70 μg/m^3 (Montana) to 0.24 μg/m^3 (Pennsylvania) to 0.5 μg/m^3 (North Carolina and South Carolina) to 1.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Nevada) to 3.3 μg/m^3 (New York) to 5.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* e[0.76 ln (hardness) +1.06] as a 24-h average, never to exceed e[0.76 ln (hardness) +4.02] at any time. *To protect saltwater aquatic life:* 7.1 μg/L as a 24-h average, never to exceed 140 μg/L. *To protect human health:* 13.4 μg/L.[6] A lifetime health advisory of 150 μg/L has been developed by EPA.[49] Mexico[35] has set a limit of 0.1 mg/L in estuaries and 0.008 mg/L in coastal waters. The Czech Republic[35] has set a limit of 0.1 mg/L in surface waters and 0.05 mg/L in drinking water reserves. States which have set guidelines for nickel in drinking water[61] include Minnesota at 150 μg/L and Kansas at 1000 μg/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (heptoxime) determination, or by inductively coupled plasma (ICP) optical emission spectrometry. This gives total nickel; dissolved nickel may be determined by the same method preceded by 0.45-μm filtration.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel dusts and fumes can affect you when breathed in. Can cause irritation of the eyes and skin. Skin contact may cause skin allergy, with itching, redness and later, rash. Lung allergy occasionally occurs with asthma-type effects. Fumes from heated nickel can cause pneumonia-like illness with cough and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours or days. This can cause death.

Long Term Exposure: May cause skin sensitization and allergy. May cause skin allergy. May cause allergic asthma, pneumonitis. Breathing nickel dust and fume can cause a sore or hole in the nasal septum. May damage the kidneys and affect liver function. Nickel is a carcinogen and may damage the developing fetus. Occupational exposure to nickel refinery dust contains nickel subsulfide and is associated with lung cancer. Handle with extreme caution.

Points of Attack: Nasal cavities, lungs, skin, liver, kidneys. *Cancer site:* lung, throat, and nasal cavity.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray for acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended by NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter.

Storage: Pyrophoric (dry nickel powder, Raney nickel, and nickel catalyst) are fire hazards. Prior to working with these chemicals, you should be trained on its proper handling and storage. Finely divided nickel must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, fluorine, ammonia, phosphorus, sulfur, selenium, hydrazine, and performic acid. Sources of ignition, such as smoking and open flames, are prohibited where pulverized nickel is handled, used, or stored. Wherever pulverized nickel is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dry powder, in bulk, requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.2 and Packing Group II.

The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20,21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use dry chemicals, sand, water spray, or foam. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep nickel catalyst spills out of confined spaces, such as a sewers, because of the possibility of an explosion or fire. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel dust is flammable. Use dry chemical, soda ash, or lime extinguishers. Poisonous gases are produced in fire, including nickel carbonyl. Dry nickel catalyst may spontaneously ignite and the fire may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nickel compounds—encapsulation followed by disposal in a chemical waste landfill. However, nickel from various industrial wastes may also be recovered and recycled as described in the literature.

References

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US Environmental Protection Agency. (1980). *Nickel: Ambient Water Quality Criteria*. Washington, DC

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US Public Health Service. (October 31, 1987). *Toxicological Profile for Nickel.* Atlanta, GA: Agency for Toxic Substances and Disease Registry

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Nickel*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nickel Metal and Soluble Nickel Compounds*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: Nickel*. Trenton, NJ

Nickel ammonium sulfate N:0230

Molecular Formula: $H_{20}N_2NiO_{14}S_2$

Common Formula: $NiSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

Synonyms: Ammonium disulfatonickelate (II); Ammonium nickel sulfate; Nickel ammonium sulphate; Sulfato de niquel y amonio (Spanish); Sulfuric acid, ammonium nickel (2+) salt (2:2:1); Sulfuric acid, ammonium nickel(II) salt (2:2:1)

CAS Registry Number: 15699-18-0

RTECS® Number: WS6050000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 239-793-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (compounds) *carcinogenic to humans, carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA).[6, 49]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15

Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer (as nickel compounds) 5/7/07.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Nickel ammonium sulfate is a green, odorless powder. Molecular weight = 394.4. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: This material is used in electroplating.

Incompatibilities: Violent reaction with strong acids. Incompatible with nickel nitrate, sulfur, selenium, wood, organics, and other combustibles.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.489 mg/m^3
PAC-1: 1.47 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 48.9 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: The EPA[6] has set a limit of 13.4 μg/L to protect human health. A lifetime health advisory of 150 μg/L has more recently been promulgated by EPA.[49] See also this section in the entry on "Nickel and Soluble Compounds."

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel ammonium sulfate can affect you when breathed in. Eye and skin contact may cause irritation and burns. Lung damage may result from a single high exposure or lower repeated exposure. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This is sometimes delayed for 1−2 days after exposure.

Long Term Exposure: Skin contact may cause skin allergy with itching, redness, and later, rash. Lung allergy occasionally occurs, with asthma-type effects. High or repeated lower exposures may cause scarring of the lungs, and may damage the heart, liver, or kidneys.

Points of Attack: Lungs, kidneys, heart, liver, skin.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (person's urine nickel over 100 μg needs medical attention). Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility for medical observation up to 2 days and tests for urine nickel. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Nickel ammonium sulfate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sulfur.

Shipping: Toxic solid, inorganic, n.o.s. materials require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

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New Jersey Department of Health and Senior Services. (January 1996). *Hazardous Substances Fact Sheet: Nickel Ammonium Sulfate*. Trenton, NJ

Nickel carbonyl N:0240

Molecular Formula: C_4NiO_4

Common Formula: $Ni(CO)_4$

Synonyms: Nickel carbonyle (French); Nickel tetracarbonyl; Nickel tetracarbonyle (French); Niquel carbonilo (Spanish); Tetracarbonyl nickel

CAS Registry Number: 13463-39-3

RTECS® Number: QR6300000

UN/NA & ERG Number: UN1259/131

EC Number: 236-669-2 [*Annex I Index No.:* 028-001-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC[9]: *possibly carcinogenic to humans*, Group B2; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds; Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454.0 kg).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds.

US EPA Hazardous Waste Number (RCRA No.): P073.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1 lb (0.454 kg).
US DOT Marine Pollutant (49CFR, Subchapter 172.101, Appendix B.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
California Proposition 65 Chemical: Cancer 10/1/87; Developmental/Reproductive toxin 9/1/96.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: F, T+, N; Risk phrases: R61; R11; R26; R40; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Nickel carbonyl is a colorless, highly volatile, flammable liquid with a musty odor. The odor threshold is 1.3 ppm. It decomposes above room temperature producing carbon monoxide and finely divided nickel. Molecular weight = 170.75; Specific gravity (H_2O:1) = 1.32 at 17°C; Boiling point = 43.3°C; Freezing/Melting point = −19°C; Vapor pressure = 315 mmHg at 20°C; Flash point <−24°C (cc); Autoignition temperature: 60°C. Explosive limits: LEL = 2%; UEL = 34%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Human Data. Nickel carbonyl is used as an intermediate product in the refining of nickel. The primary use for nickel carbonyl is in the production of nickel by the Mond process. Impure nickel powder is reacted with carbon monoxide to form gaseous nickel carbonyl which is then treated to deposit high-purity metallic nickel and release carbon monoxide. Other uses include gas plating, the production of nickel products, in chemical synthesis as a catalyst, particularly for oxo reactions (addition reaction of hydrogen and carbon monoxide with unsaturated hydrocarbons to form oxygen-function compounds), e.g., synthesis of acrylic esters, and as a reactant.

Incompatibilities: May spontaneously ignite on contact with air. In the presence of air, oxidizes and forms a deposit which becomes peroxidized; this tends to decompose and ignite. May explode when heated above 60°C. Decomposes on contact with acids, producing carbon monoxide. Violent reaction with oxidizers; may cause fire and explosions. Vapor may promote the ignition of mixtures of combustible vapors (such as gasoline) and air. Attacks some plastics, rubber, and coatings. Store under inert gas blanket.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.98 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 0.0001 ppm/0.007 mg[Ni]/m^3 TWA.
NIOSH REL: 0.0001 ppm/0.007 mg[Ni]/m^3 TWA, potential carcinogen, limit occupational exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.05 ppm/0.12 mg[Ni]/m^3 TWA.
NIOSH IDLH: 2 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.001 ppm
PAC-1: 0.005 ppm
PAC-2: **0.036** ppm
PAC-3: **0.16** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: [skin] Carcinogen Category 2.
Compound Description: Tumorigen; Reproductive Effector; Human Data.
Arab Republic of Egypt: TWA 0.007 ppm (0.001 mg/m^3), 1993; Australia: TWA 0.05 ppm (0.1 mg/m^3), 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Denmark: TWA 0.001 ppm (0.007 mg[Ni]/m^3), [skin], 1999; Finland: TWA 0.001 ppm (0.007 mg/m^3); STEL 0.003 ppm, carcinogen, 1999; France: VME 0.05 ppm (0.23 mg[Ni]/m^3), 1999; the Netherlands: MAC-TGG 0.35 mg/m^3, 2003; Japan: 0.001 ppm (0.007 mg/m^3), 1999; Norway: TWA 0.001 ppm (0.007 mg/m^3), 1999; the Philippines: TWA 0.001 ppm (0.007 mg/m^3), 1993; Russia: TWA 0.001 ppm; STEL 0.0005 mg/m^3, carcinogen, 1993; Sweden: NGV 0.001 ppm (0.007 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 0.05 ppm (0.35 mg/m^3), [skin], carcinogen, 1999; Thailand: TWA 0.001 ppm (0.007 mg/m^3), 1993; Turkey: TWA 0.001 ppm (0.007 mg/m^3), 1993; United Kingdom: STEL 0.1 ppm (0.24 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 (Ni)ppm. The Czech Republic[35]: TWA 0.01 mg/m^3; ceiling value 0.02 mg/m^3. Several states have set guidelines or standards for nickel carbonyl in ambient air[60] ranging from 1.17 μg/m^3 (New York) to 1.75 μg/m^3 (Connecticut and South Carolina) to 5.0 μg/m^3 (Virginia) to 8.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #6007, Nickel carbonyl. Charcoal tube (low Ni); HNO_3; Graphite furnace atomic absorption spectrometry; NIOSH Analytical Method (IV) #6007.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects.

Routes of Entry: It may be possible for appreciable amounts of the liquid to be absorbed through the skin; also ingestion and eye and skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates and burns the eyes and skin. Irritates the respiratory tract. May affect the central nervous system and the kidneys, causing tissue lesions. Medical observation is advised for 3 days or more; delayed lung effects may occur. Probable oral lethal dose for a human is between 50 and 500 mg/kg, between one teaspoon and 1 oz per 150-lb person. Nickel carbonyl has also been estimated to be lethal in humans at atmospheric exposures of 30 ppm for 20 min. Autopsies show congestion, collapse, and tissue destruction as well as hemorrhage in the brain. Dermatitis, recurrent asthmatic attacks, and increased number of white blood cells (eosinophils) in respiratory tract are acute health hazards. Acute exposure to nickel carbonyl may result in dizziness, giddiness, weakness, convulsions, hallucinations, delirium, nausea, vomiting, and diarrhea. Following inhalation, respiration will initially be rapid, accompanied by a nonproductive cough and followed by pain and tightness in the chest. Pulmonary edema, cerebral edema, and hepatic (liver) degeneration may also occur. Vapor is irritating to the eyes, nose, and throat. Nickel contact dermatitis is the most common reaction to nickel carbonyl. Nickel itch may begin with a burning sensation and itching, often followed by erythema (redness) and nodular eruptions.

Long Term Exposure: Repeated or prolonged inhalation exposure may cause skin and lung sensitization and asthma. A potential occupational carcinogen. In animals: reproductive, teratogenic effects. Permanent lung damage may occur following a single high exposure or lower repeated exposure. High or repeated exposures may cause damage to the heart muscle, liver and/or kidney damage.

Points of Attack: Lungs, paranasal sinus, central nervous system, reproductive system, liver, kidney, heart.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis; blood plasma; chest X-ray, electrocardiogram, expired air, 2H; pulmonary function tests; forced vital capacity, forced expiratory volume (1 s); sputum cytology; urine (chemical/metabolite), urinalysis (routine); white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests. Urine or plasma test for nickel (unexposed persons have urine levels under 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days. Lung function tests. Chest X-ray (persons with urine levels over 100 μg/L need medical observation). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is advised for 3 days or more; delayed lung effects including pulmonary edema may occur.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nickel carbonyl must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric). Sources of ignition, such as smoking and open flames, are prohibited where nickel carbonyl is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of nickel carbonyl should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of nickel carbonyl. Wherever nickel carbonyl is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nickel carbonyl requires a shipping label of "POISONOUS/TOXIC MATERIALS; FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I. A US DOT Severe Marine Pollutant.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.9/1.5
Night 3.1/4.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0 + /11.0+
Night 7.0+ /11.0+

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Solid streams of water may be ineffective. Material is too dangerous to health to expose fire fighters. A few whiffs of the vapor could cause death. If liquid or vapor penetrates fire fighter's protective gear it will cause fatality. Normal full protective gear available to the average fire department will not provide adequate inhalation or skin protection. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a flammable solvent. Also, nickel carbonyl used in metalizing operations may be recovered and recycled. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report,* 5, No. 4, 76−82 (1985) and 8, No. 6, 8−16 (1988)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nickel Carbonyl.* Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nickel Carbonyl.* Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Nickel Carbonyl.* Trenton, NJ

Nickel chloride N:0250

Molecular Formula: Cl_2Ni

Common Formula: $NiCl_2$

Synonyms: Cloruro de niquel (Spanish); Nickel(2+) chloride; Nickel(2+) chloride (1:2); Nickel(II) chloride; Nickel (II) chloride (1:2); Nickel chloride (ous); Nickelous chloride

CAS Registry Number: 7718-54-9; 37211-05-5
7791-20-0 (hexahydrate)

RTECS® Number: QR6475000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-743-0 [*Annex I Index No.:* 028-011-00-6] (*37211-05-5*)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (compounds) *carcinogenic to humans, carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases (*7718-54-9*): R49; R61; R23/25; R38; R42/43; R48/23; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (CAS: 7718-54-9).

Description: Nickel chloride appears as green or brown scales, or sparkling golden-yellow powder. Molecular weight = 129.60; Sublimation temperature = 973°C; Freezing/Melting point = 1000°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0; (*hexahydrate*) Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Nickel chloride is used in electroplating and ink manufacturing.

Incompatibilities: Strong acids, potassium, sulfur. Forms an impact-sensitive mixture with potassium.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg[Ni]/m^3 TWA.

NIOSH REL: 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.1 mg[Ni]/m^3 TWA, inhalable fraction, confirmed human carcinogen.

NIOSH IDLH: 10 mg [Ni]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.221 mg/m^3
PAC-1: 0.221 mg/m^3
PAC-2: 0.221 mg/m^3
PAC-3: 22.1 mg/m^3

Hexahydrate

TEEL-0: 0.405 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 40.5 mg/m^3
PAC-3:40.5 mg/m^3

DFG MAK: Inhalable fraction, sensitization of the respiratory tract and skin, Carcinogen Category 1.

NIOSH IDLH: 10 mg[Ni]/m^3.

Russia set a MAC level of 0.005 mg/m^3 for nickel salts and aerosols.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: The EPA[6] has set a limit of 13.4 μg/L on nickel to protect human health. A lifetime health advisory of 150 μg/L has more recently been promulgated by EPA.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel chloride can affect you when breathed in. Exposure can irritate and inflame the air passages and sinuses, causing cough, phlegm, shortness of breath, and ulceration. Contact can irritate and burn the eyes or skin.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma-like allergy. Once allergy develops, even low future exposures can trigger symptoms. Repeated exposure can cause lung scarring and may affect the kidneys. Nickel chloride may cause mutations. Handle with extreme caution.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider lung function tests if lung symptoms are present. Kidney function tests. Chest X-ray. Daily testing for urine nickel for several days. Persons with urine nickel over 100 μg/L require immediate medical attention.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Nickel chloride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from potassium and sulfur. Mixtures of nickel chloride and potassium will produce a strong explosion on impact.

Shipping: Toxic solid, inorganic, n.o.s. materials require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nickel chloride itself may burn but does not easily ignite. Poisonous gases, including chlorine and nickel carbonyl, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle or disposal in a chemical waste landfill is recommended.[22]

Reference

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Nickel Chloride*. Trenton, NJ

Nickel cyanide N:0260

Molecular Formula: C_2N_2Ni

Common Formula: $Ni(CN)_2$

Synonyms: Cianuro de niquel (Spanish); Nickel(2+) cyanide; Nickel(II) cyanide; Nickel cyanide, solid

CAS Registry Number: 557-19-7

RTECS® Number: QR6495000

UN/NA & ERG Number: UN1653/151

EC Number: 209-160-8 [*Annex I Index No.:* 028-034-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (compounds) *carcinogenic to humans, carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds.

US EPA Hazardous Waste Number (RCRA No.): P074.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R49; R32; R42/43; R48/23;R50/53; Safety phrases:S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nickel cyanide is a yellowish-brown plate or powder that may change to a green color by absorbing moisture. It has a weak almond odor like cyanide. Molecular weight = 110.75; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Nickel cyanide is used in metallurgy and electroplating, and in making other chemicals.

Incompatibilities: Acids, active metals. Violent reaction with magnesium. Heat or acid contact can cause release of toxic cyanide.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*inorganic, soluble compounds*) 0.1 mg[Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.377 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 18.9 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Russia set a MAC level of 0.005 mg/m^3 for nickel salts and aerosols.

As cyanides

NIOSH recommends a level of 5 mg/m^3 not to be exceeded during any 10-min work period. ACGIH recommends a TWA of 5 mg/m^3.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO$_3$ Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Again one should consider the restrictions imposed both by nickel and by cyanide. However, the lifetime health advisories developed by EPA[49] are 154 μg/L for cyanide and 150 μg/L for nickel, which are nearly the same.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel cyanide can affect you when breathed in. Eye contact may cause irritation. Skin contact may cause skin allergy, with itching and redness, and later, rash. Fumes can cause pneumonia-like illness, with coughing and/or shortness of breath. Lung damage may result from a single high exposure or lower repeated exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Lung allergy occasionally occurs with asthma-type effect. High or repeated lower exposures may damage the heart, liver, or kidneys.

Long Term Exposure: Lung allergy occasionally occurs with asthma-type effect. Skin contact can cause allergy. High or repeated lower exposures may damage the lungs, with scarring of the lung tissue, and may cause damage to the heart, liver, or kidneys.

Points of Attack: Lungs, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests, urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If

this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility for medical observation up to 2 days and test for urine nickel. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection:

Nickel: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Cyanides: Up to 25 mg/m^3: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Nickel cyanide must be stored to avoid contact with magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids since heat and acids can release toxic cyanide.

Shipping: Nickel cyanide requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nickel cyanide itself does not burn. Poisonous gases, including cyanide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators

recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Nickel Cyanide*. Trenton, NJ

Nickel hydroxide N:0270

Molecular Formula: H_2NiO_2

Synonyms: Hidroxido niquel (Spanish); Nickel black; Nickel dihydroxide; Nickel(2+) hydroxide; Nickel(II) hydroxide; Nickelic hydroxide; Nickelous hydroxide

CAS Registry Number: 12054-48-7; *(alt)*12125-56-3

RTECS® Number: QR7040000

UN/NA & ERG Number: UN3077/171

EC Number: 235-008-5 [*Annex I Index No.*: 028-008-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (compounds) *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol (12054-48-7): T, N; Risk phrases: R49; R61; R20/22; R42/43; R48/23; R68; R50/53; Safety phrases:S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Nickel hydroxide is a light, apple-green powder. Molecular weight = 92.73; Freezing/Melting point = 230°C (decomposes); Autoignition temperature = 400°C.[CHRIS] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: It may be found in the workplace as a dust, liquid, or acid solution. This compound may be used in nickel plating operations.

Incompatibilities: Incompatible with strong acids. Aqueous solution may be acidic.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*inorganic, insoluble compounds*) 0.2 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)

12054-48-7

TEEL-0: 0.0237 mg/m^3

PAC-1: 0.06 mg/m^3

PAC-2: 0.4 mg/m^3

PAC-3: 15.8 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: The EPA[6] has set a limit on nickel to protect human health of 13.4 μg/L. A lifetime health advisory of 150 μg/L has more recently been promulgated by EPA.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel hydroxide can affect you when breathed in. Irritates and burns the eyes and skin on contact. Irritates the respiratory tract causing phlegm and/or shortness of breath. Lung damage may result from a single high or lower repeated exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Lung allergy occasionally occurs with asthma-type effects. High or repeated lower exposure may cause lung scarring and may damage the heart, liver, or kidneys. Skin contact may cause skin allergy, with itching, redness, and later rash. Nickel hydroxide is a carcinogen; handle with extreme caution.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel levels for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers away from strong acids. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel hydroxide is combustible but not easy to ignite. Use dry chemicals, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nickel, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recover and recycle where possible or dispose of in a chemical waste landfill.[22]

Reference

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Nickel Hydroxide*. Trenton, NJ

Nickel nitrate N:0280

Molecular Formula: N_2NiO_6

Common Formula: $Ni(NO_3)_2$

Synonyms: Nickel(2+) nitrate (1:2); Nickel(II) nitrate (1:2); Nickel nitrate hexahydride; Nickel nitrate (ous); Nickelous nitrate; Nitric acid, nickel(2+) salt; Nitric acid, nickel(II) salt

CAS Registry Number: 13138-45-9; 13478-00-7 (hexahydrate); 14216-75-2 (nickel dinitrate)

RTECS® Number: OR7200000

UN/NA & ERG Number: UN2725/140

EC Number: 236-068-5 [*Annex I Index No.:* 028-012-00-1]; 238-076-4 [*Annex I Index No.:* 028-012-00-1] (nickel dinitrate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (compounds) *carcinogenic to humans, carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations: Hazard Symbol: O, T, N; Risk phrases: R49; R61; R8; R20/22; R38; R41; R42/43; R48/23; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

14216-75-2

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: O, T, N; Risk phrases: R49; R61; R8; R20/22; R38; R41; R42/43; R48/23; R68; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Nickel nitrate is a green powder. Molecular weight = 182.73; Boiling point = 137°C; Freezing/Melting point = 55−57°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3 (Oxidizer). Highly soluble in water.

Potential Exposure: Nickel nitrate is used in electroplating, nickel catalyst production, and in the manufacture of brown ceramic colors.

Incompatibilities: A powerful oxidizer. Incompatible with strong acids, sulfur, combustibles, organics, and other easily oxidizable materials.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.311 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 31.1 mg/m^3

Hexahydrate

TEEL-0: 0.314 mg/m^3

PAC-1: 0.93 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 31 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Russia set a MAC level of 0.005 mg/m^3 for nickel salts and aerosols.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: The EPA[6] has set a limit to protect human health of 13.4 μg/L. A lifetime health advisory of 150 μg/L has more recently been promulgated by EPA.[49] See also this section in the entry on "Nickel and Soluble Compounds."

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel nitrate can affect you when breathed in. Irritates and burns the eyes and skin. Irritates the respiratory tract causing coughing and phlegm.

Long Term Exposure: Skin contact may cause skin allergy with itching, redness, and rash. Nickel nitrate may cause mutations. There is limited evidence that nickel nitrate may decrease fertility in males. Handle with extreme caution. Exposure may also cause lung allergy (asthma) to nickel. Once allergy asthma develops, even low future exposures can cause symptoms.

Points of Attack: Skin, lungs.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider lung function tests if lung symptoms are present.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, sulfur, combustibles, organics, or other readily oxidizable materials. Avoid storage on wood floors. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel nitrate is an oxidizer. It increases the flammability of any combustible substance. Extinguish fire using an agent suitable for type of surrounding fire. Nickel nitrate itself does not burn. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 64−67

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Nickel Nitrate*. Trenton, NJ

Nickel sulfate N:0290

Molecular Formula: $NiSO_4$

Synonyms: NCI-C60344; Nickelous sulfate; Nickel(2+) sulfate(1:1); Nickel(II) sulfate; Nickel sulphate; Sulfato de niquel (Spanish); Sulfuric acid, nickel(2+) salt; Sulfuric acid, nickel(II) salt

CAS Registry Number: 7786-81-4; 10101-97-0 (hexahydrate)

RTECS® Number: QR9350000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 232-104-9 [*Annex I Index No.:* 028-009-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: Carcinogenicity: IARC: (compounds) *carcinogenic to humans, carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Inconclusive: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nickel sulfate is a blue to blue-green crystalline solid with a sweet taste. Molecular weight = 154.77; Freezing/Melting point = 848°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0; (hexahysrate) Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Organometallic; Reproductive Effector; Human Data; Primary Irritant. Nickel sulfate is used in plating baths, and as an intermediate in the production of nickel ammonium sulphate, as a mordant in dyeing, and in printing textiles, coatings, and ceramics.

Incompatibilities: The aqueous solution is a weak acid. Sulfates may react violently with aluminum, magnesium.

Permissible Exposure Limits in Air

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA.

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

NIOSH IDLH: 10 mg[Ni]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.264 mg/m^3

PAC-1: 0.791 mg/m^3

PAC-2: 1.32 mg/m^3

PAC-3: 26.4 mg/m^3

Hexahydrate

TEEL-0: 0.448 mg/m^3

PAC-1: 1.34 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 44.8 mg/m^3

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Arab Republic of Egypt: TWA 0.1 mg[Ni]/m^3, 1993; Australia: TWA 1 mg[Ni]/m^3, 1993; Belgium: TWA 1 mg [Ni]/m^3 (insoluble compounds), 1993; Denmark: TWA 0.1 mg[Ni]/m^3, 1999; Finland: TWA 0.1 mg[Ni]/m^3, [skin], carcinogen, 1999; France: VME 1 mg[Ni]/m^3, 1999; Hungary: STEL 0.005 mg[Ni]/m^3, Carcinogen (insoluble compounds), 1993; the Philippines: TWA 1 mg[Ni]/m^3, 1993; Poland: MAC (TWA) 0.25 mg[Ni]/m^3, 1999; Russia: STEL 0.05 mg[Ni]/m^3, 1993; Sweden: NGV 0.1 mg[Ni]/m^3, carcinogen, 1999; Switzerland: MAK-W 0.5 mg[Ni]/m^3 (insoluble compounds), 1999; Switzerland: MAK-W 0.5 mg[Ni]/m^3, carcinogen, 1999; Thailand: TWA 1 mg[Ni]/m^3, 1993; United Kingdom: TWA 0.1 mg[Ni]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg [Ni]/m^3.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: The EPA[6] has set a limit to protect human health of 13.4 μg/L. A lifetime health advisory of 150 μg/L has more recently been promulgated by EPA.[49] See also this section in the entry on "Nickel and Soluble Compounds."

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nickel sulfate can affect you when breathed in. It may also cause infertility in males. High or repeated exposures can scar the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy, with itching, redness, and later rash. Repeated or prolonged inhalation exposure may cause asthma-like lung allergy. Lungs may be scarred by repeated or prolonged exposure to the aerosol. Nickel sulfate may cause mutations. Handle with extreme caution. Carcinogenic to humans. Animal tests show that this substance possibly causes toxic effects upon human reproduction. May cause kidney damage.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (persons with urine nickel over 100 μg/L need medical attention). Lung function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and

storage. Nickel sulfate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); wood, and other combustibles, since violent reactions occur. A regulated, marked area should be established where nickel sulfate is handled, used, or stored.

Shipping: Toxic solid, inorganic, n.o.s. materials require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel sulfate is not flammable. Use agent suitable for surrounding fire. Poisonous gases, including oxides of sulfur, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 68–71

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Nickel Sulfate*. Trenton, NJ

Nicotine N:0300

Molecular Formula: $C_{10}H_{14}N_2$

Synonyms: Black leaf; Campbell's nico-soap; Destruxol orchard spray; Di-tetrahydronicotyrine; Emo-Nib; ENT 3,424; Flux MAAG; Fumeto-Bac; Mach-Nic; 1-Methyl-2-(3-pyridyl) pyrrolidine; 3-(*N*-Methylpyrrolidino)pyridine; (s)-3-(1-Methyl-2-pyrrolidinyl)pyridine; 3-(1-Methyl-2-pyrrolidinyl)pyridine; (−)-3-(1-Methyl-2-pyrrolidyl)pyridine; 1-3-(1-Methyl-2-pyrrolidyl) pyridine; 3-(1-Methyl-2-pyrrolidyl) pyridine; Niagra P.A. dust; Nicocide; Nicodust; Nicofume; Nicotina (Spanish); 1-Nicotine; Nicotine alkaloid; Nikotin (German); Orthon-4 dust; Orthon-5 dust; Pyridine, 3-(1-methyl-2-pyrrolidinyl)-; Pyridine, (s)-3-(1-methyl-2-pyrrolidinyl)- and salts; Pyridine, 3-(tetrahydro-1-methylpyrrol-2-yl); β-Pyridyl-α-*N*-methylpyrrolidine; Tendust; Xl all insecticide

CAS Registry Number: 54-11-5; *(alt.)* 6912-85-2; *(alt.)* 16760-37-5

RTECS® Number: QS5250000

UN/NA & ERG Number: UN1654/151

EC Number: 200-193-3 [*Annex I Index No.:* 614-001-00-4]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *N. crassa—aneuploidy*; Histidine reversion—Ames test.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (in agriculture) (Germany, Hungary) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): No. P075.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin 4/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R25; R27; R51/53; Safety phrases: S1/2; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nicotine is a pale yellow to dark brown, oily liquid with a slight, fishy odor when warm. It is also available as a powder. Molecular weight = 162.23; Specific gravity (H_2O:1) = 1.01; Boiling point = 250°C; Freezing/Melting point = −78.9°C; Vapor pressure = 0.08 mmHg at 20°C; Flash point = 95°C (cc); Autoignition temperature = 240°C. Explosive limits: LEL = 0.7%; UEL = 4.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data; Natural Product. Nicotine is used in some drugs and in tanning. At one time, nicotine was used in the United States as an insecticide and fumigant; however, it is no longer produced or used in the United States for this purpose.

Incompatibilities: Contact with strong oxidizers may be violent. Incompatible with strong acids. Attacks some forms of plastics, rubber, and coatings. Nicotine decomposes on heating, producing nitrogen oxides, carbon monoxide, and other highly toxic fumes.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin].

NIOSH IDLH: 5 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK: [skin]

Arab Republic of Egypt: TWA 0.5 mg/m^3, [skin], 1993; Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: MAK 0.07 ppm, 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, [skin], 2003; Norway: TWA 0.5 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Switzerland: MAK-W 0.07 ppm (0.5 mg/m^3), KZG-W 0.14 ppm, [skin], 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg/m^3, [skin], 1993; United Kingdom: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m^3 [skin]. Several states have set guidelines or standards for nicotine in ambient air[60] ranging from 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2544, #2551.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.17$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Nicotine affects the nervous system and the heart. Exposure to relatively small amounts can rapidly be fatal.[NIOSH]

Short Term Exposure: Irritates the eyes and skin. Even small exposures can cause increased heart rate, increased blood fat levels, and change vital hormone levels. May affect the cardiovascular system and central nervous system, resulting in convulsions and respiratory failure. Nicotine is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150 lb) person. It may be assumed that ingestion of 40−60 mg of nicotine is lethal to humans. There is a fundamental difference between acute toxicity from use of nicotine as an insecticide instead of from ingestion and chronic toxicity that may be caused by prolonged exposure to small doses as occurs in smoking. Maternal smoking during pregnancy is associated with increased risk of spontaneous abortion, low birth weight, and stillbirth. Acute exposure to nicotine may result in headache, dizziness, confusion, agitation, restlessness, lethargy, seizures, and coma. Victims may experience hypertension (high blood pressure), tachycardia (rapid heart rate), and tachypnea (rapid respirations), followed by hypotension (low blood pressure), bradycardia (slow heart rate), and respiratory depression. Cardiac arrhythmias may also occur. Gastrointestinal effects include nausea, vomiting, abdominal pain, or burning sensation, and diarrhea. Increased salivation, lacrimation (tearing), and sweating may be noted. High levels, far above the OEL, may result in death.

Long Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction. Nicotine was found as a co-carcinogen in animals.

Points of Attack: Central nervous system, cardiovascular system, lungs, GI tract, reproduction system. Has been shown to be a teratogen in animals; may be a teratogen in humans. Causes fat deposits in the arteries (reducing blood supply to many body organs). This increases the risk of heart attack, stroke, and many other poor circulation problems. Chronic high blood pressure can also result.

Medical Surveillance: NIOSH lists the following tests: blood plasma, during exposure, pre- and postshift, urine (chemical/metabolite). Before beginning employment and at regular times after that, the following is recommended: blood test for nicotine (only accurate shortly after exposure); consider test to evaluate typical exposures as well as for suspected overexposure or if symptoms are present. Even those who have smoked for a long time can reduce the risk of developing health problems by stopping.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nicotine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nicotine is a combustible liquid. Extinguish with foam, dry chemical, or carbon dioxide extinguishers. Poisonous gases, including oxides of nitrogen and carbon monoxide, are produced in fire. Water may cause frothing if it gets below surface of liquid and turns to steam. However, water fog gently applied to surface will cause frothing which will extinguish the fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 84−85 (1981) and 5, No. 4, 82−85 (1985)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nicotine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Nicotine*. Trenton, NJ

Nicotine sulfate N:0310

Molecular Formula: $C_{10}H_{18}N_2O_8S_2$
Common Formula: $C_{10}H_{14}N_2 \cdot {}_2H_2SO_4$
Synonyms: ENT 2,435; 1-1-Methyl-2-(3-pyridyl)-pyrrolidine sulfate; (S)-3-(1-Methyl-2-pyrrolidinyl)pyridine sulfate (2:1); 1-3-(1-Methyl-2-pyrrolidinyl)pyridine sulfate; Nicotine sulfate (2:1); Nicotine sulphate; Nicotine sulphate (2:1); Nikotinsulfat (German); Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, sulfate (2:1); Pyrrolidine, 1-methyl-2-(3-pyridyl)-, sulfate; Sulfate de nicotine (French); Sulfato de nicotina (Spanish)
CAS Registry Number: 65-30-5
RTECS® Number: QS9625000
UN/NA & ERG Number: UN1658/151
EC Number: 200-606-7
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Banned or Severely Restricted (in agriculture) (East Germany, New Zealand, former USSR) (UN).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations (*nicotine salts*): Hazard Symbol: T+, N; Risk phrases: R26/27/28; Safety phrases: S1/2; S13; S28; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Nicotine sulfate is a white crystalline solid. Molecular weight = 420.58; Autoignition temperature = 244°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. It is used as an insecticide and in veterinary medicine as an anthelmintic and external parasiticide.
Incompatibilities: Oxidizing materials.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 9 mg/m^3
PAC-2: 9 mg/m^3
PAC-3: 9 mg/m^3
Russia: STEL 0.1 mg/m^3, 1993.
Russia set a MAC in ambient air in residential areas of 0.005 mg/m^3 on a once-daily basis and 0.001 mg/m^3 on a daily average basis.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: The liquid irritates the eyes and skin. Inhalation irritates nose and throat. May affect the central nervous system, causing convulsions and respiratory failure. Exposure at high concentrations may result in death. Onset of acute poisoning is rapid. Symptoms include nausea, salivation, abdominal pain, vomiting, diarrhea, cold sweat, headache, dizziness, disturbed hearing and vision, mental confusion, marked weakness, faintness and prostration, lowered blood pressure, difficult breathing, and weak, rapid and irregular pulse. It is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg (less than 7 drops) for a 70-kg (150 lb) person. Death is possible from respiratory failure caused by paralysis of the respiratory muscles.
Long Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solution: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. To clean up, do not touch spilled material; stop leak if possible. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for disposal. *Small dry spill:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: As for nicotine, extinguish with alcohol foam, dry chemical, or carbon dioxide. Large fires can be extinguished with water spray, fog, or foam. Wear positive pressure breathing apparatus and special protective clothing. Dike fire control water; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 88−90

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nicotine Sulfate*. Washington, DC: Chemical Preparedness Program

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Nicotine Sulfate*. Trenton, NJ

Nitrapyrin N:0320

Molecular Formula: $C_6H_3Cl_4N$

Synonyms: 2-Chloro-6-(trichloromethyl)pyridine; 2-Chloro-6-trichloromethylpyridine; 4-Chloro-6-(trichloromethyl)-pyridine; Dowco-163®; Nitrapyrine; *N*-Serve®; *N*-Serve nitrogen stabilizer®; Pyridine, 2-chloro-6-(trichloromethyl)-

CAS Registry Number: 1929-82-4

RTECS® Number: US7525000

UN/NA & ERG Number: UN3077/171

EC Number: 217-682-2 [*Annex I Index No.:* 006-057-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: (Animal Positive) NCI.[9]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 10/5/05; Developmental/Reproductive toxin 4/30/99.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R51/53; Safety phrases: S2; S24; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Nitrapyrin is a colorless crystalline solid with a mild, sweet odor. Molecular weight = 230.90; Freezing/Melting point = 62.8°C; Vapor pressure = 0.0028 mmHg at 22.8°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. Nitrapyrin is used as a fertilizer additive; to stabilize nitrogen.

Incompatibilities: Aluminum, magnesium.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA (total dust); 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3 TWA (total dust); 5 mg/m^3 TWA, respirable fraction TWA; 20 mg/m^3 respirable fraction STEL.

ACGIH TLV®[1]: 10 mg/m^3 TWA; 20 mg/m^3 STEL; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 400 mg/m^3

Austria: MAK 10 mg/m^3; STEL 20 mg/m^3, 1993; Belgium: TWA 10 mg/m^3; STEL 20 mg/m^3, 1993; France: VME 10 mg/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 20 mg/m^3. Several states have set guidelines for nitrapyrin in ambient air[60] ranging from 100 to 200 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Determination in water: Fish Tox = 314.70281000 ppb (LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nitrapyrin can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. High levels may cause you to feel dizzy, lightheaded, and to pass out. Contact can irritate and may damage the eyes and skin. No adverse effects noted in ingestion studies with animals. Human Tox = 210.00000 ppb (VERY LOW).

Long Term Exposure: There may be damage to the liver and kidneys. Repeated exposure to nitrapyrin may cause symptoms of headaches, dizziness, loss of appetite, and trouble sleeping.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from aluminum, magnesium, or their alloys. Do not store in unlined containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nitrapyrin itself does not burn. Poisonous gases, including oxides of nitrogen and chloride ion, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The manufacturer of this nitrification inhibitor suggests that unwanted quantities can be disposed of by burial in a sanitary landfill. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Nitrapyrin*. Trenton, NJ

Nitrates N:0330

Molecular Formula: $N_vM_vO_{vx3}$

Common Formula: $M_v(NO_3)_v$

Synonyms: Vary with specific compounds

CAS Registry Number: 14797-55-8

RTECS® Number: WC5600000 (sodium nitrate)

UN/NA & ERG Number: UN3218 (nitrates, inorganic, aqueous solution, n.o.s.)/140; UN1477 (nitrates, inorganic, n.o.s.)/140

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Nitrate and nitrite:

Safe Drinking Water Act: MCL, 10 mg/L as nitrogen; MCLG, 10 mg/L as nitrogen.

Nitrate compounds (water dissociable).

EPCRA Section 313: Reportable only when in aqueous solution. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), as nitrates, inorganic, n.o.s.

WGK (German Aquatic Hazard Class): No value assigned (CAS: 14797-55-8). May vary by compound.

Description: Nitrates are salts with varying properties depending on the specific compounds. Organic nitrates are called "nitro" compounds. Hazard Identification (based on NFPA-704 M Rating System): Hazard Identification (based on NFPA-704 M Rating System) (*estimated*): Health 2, Flammability 0, Reactivity 0. Oxidizers.

Potential Exposure: Among the major point sources of nitrogen entry into water bodies are municipal and industrial wastewaters, septic tanks, and feedlot discharges. Diffuse sources of nitrogen include farm-site fertilizer and animal wastes, lawn fertilizer, leachate from waste disposal in dumps or sanitary landfill, atmospheric fallout, nitric oxide and nitrite discharges from automobile exhausts and other combustion processes, and losses from natural sources, such as mineralization of soil organic matter.

Incompatibilities: Nearly all nitrates are powerful oxidizers. Possible violent reactions with reducing agents, combustible materials, organic materials, finely divided (powdered) metals, may form explosive mixtures or cause fire and explosions. Many nitrates are flammable by spontaneous chemical reaction. Some may explode by spontaneous chemical reaction, when exposed to elevating temperatures and/or shock. Some nitrates are high explosives, especially when confined and/or exposed to heat and/or fire.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) *nitrate(s)*

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Permissible Concentration in Water: Nitrite in water at concentrations less than 1000 mg/L is not of serious concern as a direct toxicant. It is a health hazard because of its conversion to nitrite. Nitrite is directly toxic when it reacts with hemoglobin to form methemoglobin which causes methemoglobinemia. It also reacts readily under appropriate conditions with secondary amines and similar nitrogenous compounds to form *N*-nitroso compounds, many of which are potent carcinogens. Epidemiological evidence on the occurrence of methemoglobinemia in infants tends to confirm a value near 10 mg/L nitrate as nitrogen as a maximum concentration level for water with no observed adverse health effects, but there is little margin of safety in this value. The EPA[49] has published a health advisory for nitrate/nitrite which confirms the 10 mg/L level. The state of Maine[61] has set a guideline at 10 mg/L as well. EPA[62] has recently set a guideline for drinking water of 10 mg/L also.

Determination in Water: A variety of methods for determination of nitrate exists, but none is particularly precise, accurate, or sensitive in the milligram per liter concentration range. Further development and standardization of analytical methodology will be required if standard routine determinations are to be considered reliable within the range required for proper control and assessment of health effects.

Most standard procedures for nitrate determination in the milligram per liter range are spectrophotometric. Traditionally, three types of fractions of nitrate have been used as bases: nitration of a phenolic substance to a colored derivative, oxidation of an organic substance to a colored product, and reduction of the nitrate to nitrite or ammonia, followed by reaction of the reduced nitrogenous materials to give colored substances. In addition, direct spectrophotometric determination based on ultraviolet absorption of nitrate at 273 nm is possible and becoming established. Electrochemical determination with the use of a nitrate electrode may also be feasible but is subject to numerous interferences.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: High dosages, if swallowed, may lead to serious and possibly fatal effects. Symptoms of exposure include headache, dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, collapse, and death.

Long Term Exposure: Two health hazards are related to the consumption of water containing large concentrations of nitrate (or nitrite): induction of methemoglobinemia, particularly in infants, and possible formation for carcinogenic nitrosamines. Acute toxicity of nitrate occurs as a result of reduction to nitrite, a process that can occur under specific conditions in the stomach, as well as in the saliva. Nitrite acts in the blood to oxidize the hemoglobin to methemoglobin, which does not perform as an oxygen carrier to the tissues. Consequently, anoxia and death may ensue. According to Sax/Lewis, "... small, repeated doses may lead to weakness, general depression, headache, and mental impairment. Also, there is some implication of increased cancer incidence among those exposed." Acute nitrate toxicity is almost always seen in infants rather than adults. This increased susceptibility of infants has been attributed to high intake per unit weight, to the presence of nitrate-reducing bacteria in the upper gastrointestinal tract, to the condition of the mucosa, and to greater ease of oxidation of fetal hemoglobin."

Points of Attack: Blood.

First Aid: See specific entries.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: See specific entries.

Respirator Selection: See specific entries.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with nitrates chemicals you should be trained on its proper handling and storage. See statement about incompatibilities above and specific entries. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Nitrates, inorganic, n.o.s. and Nitrates, inorganic, aqueous solution, n.o.s. require a shipping label of "OXIDIZER." They fall in DOT Hazard Class 5.1 and Packing Group II or III.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nitrates will increase the activity of an existing fire. Many will explode spontaneously. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Sodium nitrate:* the material is diluted to the recommended provisional limit in water.

(The pH is adjusted to between 6.5 and 9.1 and then the material can be discharged into sewers or natural streams.)

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 29−32

National Academy of Sciences. (1978). *Medical and Biologic Effects of Environmental Pollutants: Nitrates*. Washington, DC

World Health Organization. (1978). *Nitrates, Nitrites and N-Nitroso Compounds*, Environmental Health Criteria No. 5. Geneva

Nitric acid N:0340

Molecular Formula: HNO_3

Synonyms: Acide nitrique (French); Acido nitrico (Spanish); Aluminum etch 16-1-1-2; Aluminum etch 82-3-15-0; Aluminum etch II; Aluminum etch III; Aqua fortis; Aqua regia; Azotic acid; Chrome etch KTI; Copper, brass brite dip 1127; Copper, brass brite dip 127; Copperlite RD-25; C-P 8 solution; Doped poly etch; Freckle etch; Hydrogen nitrate; Kovar bright dip (412X); Kovar bright dip (RDX-555); KTI aluminum etch I; KTI chrome etch; MAE etchants; Mixed acid etch (5-2-2); Mixed acid etch (6-1-1); NF solder stripper 3114-B; Nital; Nitraline; Nitric acid, red fuming; Nitric acid, white fuming; Nitrous fumes; Nitryl hydroxide; Passivation solution; Patclin 958; Poly etch 95%; Red fuming nitric acid; RFNA; RT-2 stripping solution; Salpetersaure (German); Silicon etch solution; Solder strip NP-A; Stress relief etch; Wet K-etch; WFNA; White fuming nitric acid

CAS Registry Number: 7697-37-2

RTECS® Number: QU5775000

UN/NA & ERG Number: UN2031 (other than red fuming, with >70% nitric acid)/157; UN2032 (fuming)/157

EC Number: 231-714-2 [*Annex I Index No.*: 007-004-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥80.00% concentration); *Theft hazard* 400 (≥68.00% concentration).

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg) (≥94.5%).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, C; Risk phrases: R8; R35; Safety phrases: S1/2; S26; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Nitric acid is a colorless to light brown fuming liquid with an acrid, suffocating odor. Fuming nitric acid is a reddish fuming liquid. Fumes in moist air. Often used in an aqueous solution. Fuming nitric acid is concentrated nitric acid that contains dissolved nitrogen dioxide. Nitric acid is a solution of nitrogen dioxide, NO_2, in water and so-called fuming nitric acid contains an excess of NO_2 and is yellow to brownish-red in color. Molecular weight = 63.02; Specific gravity (H_2O:1) = 1.50 at 25°C; Boiling point = 82.8°C; Freezing/Melting point = −42°C (monohydrate); −19°C (trihydrate); Vapor pressure = 48 mmHg. Soluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data. Nitric acid is the second most important industrial acid and its production represents the sixth largest chemical industry in the United States. Nitric acid is used in chemicals, explosives, fertilizers, steel pickling, metal cleaning. The largest use of nitric acid is in the production of fertilizers. Almost 15% of the production goes into the manufacture of explosives, with the remaining 10% distributed among a variety of uses, such as etching, bright-dipping, electroplating, photoengraving, production of rocket fuel, and pesticide manufacture.

Incompatibilities: A strong oxidizer and strong acid. Reacts violently with combustible and reducing agents, carbides, hydrogen sulfide, turpentine, charcoal, alcohol, powdered metals, strong bases. Heat causes decomposition producing nitrogen oxides. Attacks some plastics. Corrosive to metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.58 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 2 ppm/5 mg/m^3 TWA.

NIOSH REL: 2 ppm/5 mg/m^3 TWA; 4 ppm/10 mg/m^3 STEL.

ACGIH TLV®[1]: 2 ppm/5.2 mg/m^3 TWA; 4 ppm/10 mg/m^3 STEL.

NIOSH IDLH: 25 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.53 ppm

PAC-1: **0.53** ppm

PAC-2: **24** ppm

PAC-3: **92** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/5.2 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D.

Arab Republic of Egypt: TWA 2 ppm (5 mg/m^3), 1993; Australia: TWA 2 ppm (5 mg/m^3); STEL 4 ppm, 1993;

Austria: MAK 2 ppm (5 mg/m^3), 1999; Belgium: TWA 2 ppm (5.2 mg/m^3); STEL 4 ppm (10 mg/m^3), 1993; Denmark: TWA 2 ppm (5 mg/m^3), 1999; Finland: TWA 2 ppm (5 mg/m^3); STEL 5 ppm (13 mg/m^3), [skin], 1999; France: VME 2 ppm (5 mg/m^3), VLE 5 ppm (10 mg/m^3), 1999; Hungary: STEL 5 mg/m^3, 1993; Japan: 2 ppm (5.2 mg/m^3), 1999; Norway: TWA 2 ppm (5 mg/m^3), 1999; the Philippines: TWA 2 ppm (5 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Russia: TWA 2 ppm; STEL 2 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (5 mg/m^3), KTV 5 ppm (13 mg/m^3), 1999; Thailand: TWA 2 ppm (5 mg/m^3), 1993; Turkey: TWA 2 ppm (5 mg/m^3), 1993; United Kingdom: LTEL 2 ppm (5 mg/m^3); STEL 4 ppm (10 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 4 ppm. Russia set a MAC of 0.4 mg/m^3 for nitric acid in ambient air in residential areas on a once-daily basis and 0.15 mg/m^3 on a daily average basis. Several states have set guidelines or standards for nitric acid in ambient air[60] ranging from 50−100 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut, Florida, New York and South Dakota) to 119 μg/m^3 (Nevada) to 125 μg/m^3 (South Carolina) to 1000 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #7903, acids, inorganic; OSHA Analytical Methods ID-127 and ID-165SG.

Permissible Concentration in Water: The EEC set a MAC of 50 mg NO_3/L in drinking water and a guideline level of 25 mg NO_3/L.[35] Russia[43] set a MAC of 0.4 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive if ingested. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This compound is a primary irritant, and causes burns and ulceration of all tissues and membranes that it contacts. This includes burns to the eyes and skin by contact; burns to the mouth, throat, esophagus, and stomach by ingestion; and the entire respiratory tract by inhalation. Circulatory collapse and shock are often the immediate causes of death. The approximate minimum lethal dose is 5 mL for a 150-lb person. Persons with skin, eye, or cardiopulmonary disorders are at a greater risk. Signs and symptoms of acute ingestion of nitric acid may be severe and include increased salivation, intense thirst, difficulty in swallowing, chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of nitric acid. Acute inhalation exposure may result in sneezing, hoarseness, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation, and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, chronic bronchitis, and pneumonia may also occur. If the eyes have come in contact with nitric acid, irritation, pain, swelling, corneal erosion, and blindness may occur. Dermal exposure may result in severe burns, pain, and dermatitis (red, inflamed skin).

Long Term Exposure: The mists or vapors may cause erosion of the teeth. May affect the lungs.

Points of Attack: Eyes, skin, respiratory system, teeth.

Medical Surveillance: NIOSH recommends that workers subject to nitric acid exposure have comprehensive preplacement and annual medical examinations including a 14″ × 17″ posterior−anterior chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); and a visual examination of the teeth for evidence of dental erosion.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitric acid: Neoprene™ (Up to 30%); Natural rubber or polyvinyl chloride (Up to 70%); Neoprene™/natural rubber or Saranex™ (more than 70%). For fuming nitric acid the following are recommended: Viton™, nitrile, Neoprene™, natural rubber, chlorobutyl, or Neoprene™/natural rubber. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Possibility of skin contact with liquids of $pH < 2.5$ or repeated or prolonged contact with liquids of $pH > 2.5$. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash if liquids of $pH < 2.5$ are involved.

Respirator Selection: *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: SCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection. Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Nitric acid must be stored to avoid contact with metallic powders, carbides, hydrogen sulfide, turpentine, or strong bases because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Heat may cause containers to burst and result in an escape of poisonous gases.

Shipping: Nitric acid other than red fuming, with >70% nitric acid or Nitric acid other than red fuming, with not >70% nitric acid require a shipping label of "CORROSIVE." They fall in DOT Hazard Class 8. Packing Groups are as follows: (with >70% nitric acid) is Group I; (with not >70% nitric acid) is Group II.

Nitric acid, red fuming, requires a shipping label of "CORROSIVE, OXIDIZER, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I. Red fuming nitric acid carries a plus sign (+) symbol, indicating that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Keep unnecessary people away. Do not touch spilled material; stop leak if you can do so without risk. Isolate the hazard area and deny entry. Stay upwind and keep out of low areas. Ventilate closed spaces before entering them. Ventilate area of spill or leak. Remove all ignition sources. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Use water spray to reduce vapors; do not get water inside container. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Flush with copious quantities of water and neutralize with alkaline material (such as soda ash, lime, etc.). Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances (UN 2032 fuming nitric acid)

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

Nitric acid, fuming and red fuming

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 0.7/1.2

Fire Extinguishing: Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Nitric acid is noncombustible. However, it can increase the flammability of combustible, organic, and readily oxidizable materials, or even cause ignition of some of these with water. Poisonous gases, including nitrogen oxides, are produced in fire. Use water spray. *Small fires:* water, dry chemical, or soda ash. *Large fires:* flood fire area with water. Move container from fire area if you can do so without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Soda ash-slaked lime is added to form the neutral solution of nitrate of sodium and calcium. This solution can be discharged after dilution with water.[22] Also, nitric acid can be recovered and reused in some cases as with acrylic fiber spin solutions. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Nitric Acid*, NIOSH Document No. 76−141

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 71−72 (1981) and 5, No. 3, 64−67 (1985)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nitric Acid.* Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nitric Acid.* Version 2. NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Nitric Acid.* Trenton, NJ

Nitric oxide N:0350

Molecular Formula: NO

Synonyms: Bioxyde d'azote (French); Monoxido de nitrogeno (Spanish); Nitric oxide; Nitrogen monoxide; NO (military designation); Oxido nitrico (Spanish); Oxyde nitrique (French); Stickmonoxyd (German)

CAS Registry Number: 10102-43-9; *(alt.)* 51005-21-1; *(alt.)* 90452-29-2; *(alt.)* 90880-94-7

RTECS® Number: QX525000

UN/NA & ERG Number: UN1660/124

EC Number: 233-271-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration); *Theft hazard* 15 (≥3.83% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): P076.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Nitric oxide is a colorless gas with a sharp, sweet odor; brown at high concentration in air. Odor threshold = 0.3−1.0 ppm. Shipped as a nonliquefied compressed gas. Molecular weight = 30.01; Boiling point = −151.6°C; Freezing/Melting point = −163.9°C; Relative vapor density (air = 1) = 1.04; Vapor Pressure = 34.2 atm. Slightly soluble in water; solubility = 5%.

Potential Exposure: Nitric oxide is used in the manufacture of nitric acid; it is also used in the bleaching of rayon; it is a raw material for nitrosyl halide preparation.

Incompatibilities: Explosive reaction with nitrogen trichloride, ozone, carbon disulfide, pentacarbonyl iron, chlorine monoxide. Incompatible with halogens, combustibles, metals, oil, alcohols, chlorinated hydrocarbons (e.g., trichloroethylene), reducing agents (such as NH_3), oxygen, fluorine, metals. Reacts with water to form nitric acid. Rapidly converted in air to nitrogen dioxide.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.88 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/30 mg/m^3 TWA.

NIOSH REL: 25 ppm/30 mg/m^3 TWA.

ACGIH TLV®[1]: 25 ppm/31 mg/m^3 TWA; BEI$_M$ issued for Methemoglobin inducers.

NIOSH IDLH: 100 ppm

Protective Action Criteria (PAC)*

TEEL-0: 0.5 ppm

PAC-1: **0.50** ppm

PAC-2: **12** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.5 ppm/0.63 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Austria: MAK 25 ppm (30 mg/m^3), 1999; Denmark: TWA 25 ppm (30 mg/m^3), 1999; France: VME 25 ppm (30 mg/m^3), 1999; Norway: TWA 25 ppm (30 mg/m^3), 1999; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 10 mg/m^3, 1999;

Sweden: NGV 25 ppm (30 mg/m^3), KTV 50 ppm (60 mg/m^3), 1999; Thailand: TWA 25 ppm (30 mg/m^3), 1993; the Netherlands: MAC-TGG 30 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. Several states have set guidelines or standards for nitric oxide in ambient air[60] ranging from 0.3 mg/m^3 (North Dakota) to 0.5 mg/m^3 (Virginia) to 0.6 mg/m^3 (Connecticut) to 0.714 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6014, Nitric oxide and nitrogen dioxide, 6014; OSHA Analytical Method #ID-109.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin. Strong respiratory tract irritant. High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia). Nitric oxide forms acids in the respiratory system which are irritating and can cause congestion in the lungs or pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Nitric oxide can cause death or permanent injury after a very short exposure to small quantities. Can cause unconsciousness. Concentrations of 60−150 ppm cause immediate irritation of the nose and throat with coughing and burning in the throat and chest 6−24 h after exposure; labored breathing and unconsciousness may result. Concentrations of 100−150 ppm are dangerous for a short exposure of 30−60 min. Concentrations of 200−700 ppm may be fatal after very short exposure. Nitric oxide can cause death due to blockage of gas exchange in lungs. Initially, symptoms include slight coughing, fatigue, and nausea at high concentrations; coughing, choking, headache, nausea, abdominal pain, and shortness of breath are seen. Latent symptoms are uneasiness, restlessness, rapid and shallow breathing, bluing of skin, lips and fingernail beds, anxiety, mental confusion; and finally loss of consciousness.

Long Term Exposure: Can irritate the lungs; bronchitis may develop. Can cause headache, nausea, vomiting, fatigue, mental confusion, unconsciousness, and death. Increased blood methemoglobin levels.

Points of Attack: Eyes, skin, respiratory system, blood, central nervous system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, on workers over 40 years, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Consider the points of attack in preplacement and periodic physical examinations. Blood methemoglobin levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant, gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash; pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit.

Respirator Selection: NIOSH/OSH: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Nitric oxide requires a shipping label of "POISON GAS, OXIDIZER, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Nitric oxide or nitric oxide, compressed

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Fire Extinguishing: Nitric oxide itself does not burn. Will react with water or steam to produce heat and corrosive fumes. When heated to decomposition, highly toxic fumes of nitrogen oxides are emitted. May ignite other combustible materials (wood, paper, oil, etc.). Mixture with fuels may explode. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapor explosion and poison hazard indoors, outdoors, or in sewers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added hydrocarbon fuel, controlled so as to produce elemental nitrogen, CO_2, and water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Oxides of Nitrogen*, NIOSH Document No. 76-149. Washington, DC

World Health Organization. (1977). *Oxides of Nitrogen, Environmental Health Criteria No. 4*. Geneva, Switzerland

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 73–74

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nitric Oxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August, 1999). *Hazardous Substances Fact Sheet: Nitric Oxide*. Trenton, NJ

Nitrilotriacetic acid N:0360

Molecular Formula: $C_6H_9NO_6$
Common Formula: $N(CH_2COOH)_3$
Synonyms: Acetic acid, nitrilotri-; Acido nitrilotriacetico (Spanish); Aminotriacetic acid; *N*,*N*-Bis(carboxymethyl) glycine; Chel 300; Complexon I; Glycine, *N*,*N*-Bis(carboxymethyl)-; Hampshire NTA acid; Komplexon I; NCI-C02766; Nitrilo-2,2′,2″-triacetic acid; NTA; Titriplex I; Tri (carboxymethyl)amine; Triglycine; Triglycollamic acid; Trilon A; α,α′,α″-Trimethylaminetricarboxylic acid; Versene NTA acid
CAS Registry Number: 139-13-9; *(alt.)* 26627-44-1; *(alt.)* 26627-45-2; *(alt.)* 80751-51-5
RTECS® Number: AJ0175000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 205-355-7
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999.
US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Negative: *D. melanogaster* sex-linked lethal.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer 1/1/88.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Nitrilotriacetic acid is a crystalline compound. Molecular weight = 191.16; Boiling point = 167°C; Freezing/Melting point = 242°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen. Nitrilotriacetic acid (NTA) was used as a phosphate replacement in laundry detergents in the late 1960s. In 1971, the use of NTA was discontinued. The possibility of resumed use arose in 1980. NTA is now used in laundry detergents in states where phosphates are banned. NTA is also used as a boiler feed-water additive at a maximum use level of 5 ppm of trisodium salt. Currently, the remaining nondetergent uses of NTA are for water treatment, textile treatment; metal plating and cleaning; and pulp and paper processing.
Incompatibilities: Aqueous solution is an acid. Violent reaction with strong bases.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 35 mg/m^3
PAC-1: 100 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: avoid simultaneous exposure to Iron (Fe) compounds.
Permissible Concentration in Water: No criteria set for drinking water; NTA addition to boiler feed-water is limited to 5 ppm by FDA. NTA levels in the US drinking water prior to NTA's discontinued use in detergents was estimated by EPA to have ranged from 0.20 to 24.5 μg/L. NTA is rapidly degraded under aerobic conditions at temperatures above 5°C, and biodegradation does not lead to the formation of persistent intermediates.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = -3.75$.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes and skin. This material is moderately toxic. The LD50 (oral-rat) is 1470 mg/kg.
Long Term Exposure: A Confirmed Human Carcinogen.
First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52] *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered:
At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that

has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust. Or, use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

5-Nitroacenaphthene N:0370

Molecular Formula: $C_{12}H_9O_2$

Synonyms: 1-Amino-2-methoxy-5-nitrobenzene; 2-Amino-1-methoxy-4-nitrobenzene; 3-Amino-4-methoxynitrobenzene; 2-Amino-4-nitroanisole; *o*-Anisidine nitrate; *o*-Anisidine, 5-nitro-; Azoamine scarlet; Azoamine scarlet K; Azogene Ecarlate R; Azoic diazo component 13 base; Benzenamine, C.I. 37130; Benzenamine, 2-methoxy-5-nitro-; C.I. 37130; C.I. Azoic diazo component 13; Fast scarlet R; 1-Methoxy-2-amino-4-nitrobenzene; 2-Methoxy-5-nitro-; 2-Methoxy-5-nitroaniline; 2-Methoxy-5-nitrobenzenamine; NCI-C01934; 3-Nitro-6-methoxyaniline; 5-Nitro-2-methoxyaniline

CAS Registry Number: 602-87-9

RTECS® Number: AB1060000

EC Number: 210-025-0 [*Annex I Index No.:* 609-037-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1987

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 4/1/88.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 5-Nitroacenaphthene is a yellow crystalline solid. Molecular weight = 199.22; Freezing/Melting point = 103−104°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: Used in organic synthesis.

Incompatibilities: 5-Nitroacenaphthene is an aromatic hydrocarbon (nitro compound). It may be flammable or explosive. Incompatible with strong oxidizers, alkalis which may increase the thermal sensitivity of the substance.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: Carcinogen Category 2.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: May reduce the blood's ability to carry oxygen (methemoglobinemia) with cyanosis, fatigue, dizziness, headache. May affect the central nervous system.

Long Term Exposure: Little is known aside from the fact that it is a carcinogen. May cause liver and kidney damage. Poisoning may cause anemia, cyanosis, fatigue, insomnia, weight loss.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52] *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™, Silvershield™, Viton™, Viton™/chlorobutyl rubber, chlorinated polyethylene, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with acetone. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Careful incineration in an incinerator equipped with afterburner and scrubbers.[22]

p-Nitroaniline N:0380

Molecular Formula: $C_6H_6N_2O_2$

Common Formula: $H_2NC_6H_4NO_2$

Synonyms: *p*-Aminonitrobenzene; 1-Amino-4-nitrobenzene; Aniline, *p*-nitro-; Aniline, 4-nitro-; Azoamine red ZH; Azofix red GG salt; Azoic diazo component 37; Benzenamine, 4-nitro-; C.I. 37035; C.I. azoic diazo component 37; C.I. Developer 17; Developer P; Devol red GG; Diazo fast red GG; Fast red 2G base; Fast red 2G salt; Fast red base; Fast red base 2J; Fast red base GG; Fast red GG base; Fast red GG salt; Fast red MP base; Fast red P base; Fast red P salt; Fast red salt 2J; Fast red salt GG; Naphtoelan red GG base; NCI-C60786; Nitoraniline-*p*; 4-Nitranbine; *p*-Nitraniline; Nitrazol CF extra; *p*-Nitroanilina (Spanish); *p*-Nitroaniline; 4-Nitroaniline; 4-Nitrobenzenamine; *p*-Nitrophenylamine; PNA; Red 2G base; Shinnippon fast red GG base

CAS Registry Number: 100-01-6

RTECS® Number: BY7000000

UN/NA & ERG Number: UN1661/153

EC Number: 202-810-1 [*Annex I Index No.:* 612-012-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); equivocal evidence: rat.

US EPA Gene-Tox Program, Negative: Sperm morphology—mouse.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): P077.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 28.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*all isomers*): Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R52/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *p*-Nitroaniline consists of yellow crystals with a pungent, faint ammonia-like odor. Molecular weight = 138.14; Specific gravity (H_2O:1) = 1.42; Boiling point = 332.2°C; Freezing/Melting point = 146.1°C; Vapor pressure = 0.000002 mmHg at 20°C; Flash point = 198.9°C; Autoignition temperature = 510°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. *p*-Nitroaniline is used as an intermediate in the manufacture of dyes, antioxidants, pharmaceuticals, and pesticides.

Incompatibilities: A combustible liquid. A strong oxidizer. Violent reaction with reducing agents, strong acids, combustibles, strong oxidizers. May explode on heating. May result in spontaneous heating of organic materials in the presence of moisture or strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 1 ppm/6 mg/m^3 TWA [skin].

NIOSH REL: 3 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 3 mg/m^3 TWA [skin]; not classifiable as a human carcinogen; BEI$_M$ issued for Methemoglobin inducers.

DFG MAK: [skin]; Carcinogen Category 3A.

NIOSH IDLH: 300 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 6 mg/m^3

PAC-1: 9 mg/m^3

PAC-2: 300 mg/m^3

PAC-3: 300 mg/m^3

Arab Republic of Egypt: TWA 1 ppm (6 mg/m^3), [skin], 1993; Australia: TWA 3 mg/m^3, [skin], 1993; Austria: MAK 1 ppm (6 mg/m^3), [skin], 1999; Belgium: TWA 3 mg/m^3, [skin], 1993; Denmark: TWA 0.5 ppm (3 mg/m^3), [skin], 1999; Finland: TWA 1 ppm (6 mg/m^3); STEL 3 ppm (18 mg/m^3), [skin], 1993; France: VME 3 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 6 mg/m^3, [skin], 2003; Japan: 3 mg/m^3, [skin], 1999; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 1 ppm (6 mg/m^3), [skin], 1993; Poland: MAC (TWA) 3 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.5 ppm (3 mg/m^3), [skin], 1999; Turkey: TWA 1 ppm (6 mg/m^3), [skin], 1993; United Kingdom: TWA 6 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for *p*-nitroaniline in ambient air[60] ranging from zero (Connecticut) to 6.0 μg/m^3 (New York) to 7.143 μg/m^3 (Kansas) to 15 μg/m^3 (South Carolina) to 30 μg/m^3 (Florida and North Dakota) to 50 μg/m^3 (Virginia) to 71 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5033.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *p*-Nitroaniline can affect you when breathed in and by passing through your skin. Exposure by skin contact or breathing can interfere with the ability of the blood to carry oxygen (metheglobinemia) and kidney impairment. This can cause headaches, dizziness, cyanosis (a blue color to the skin and lips), trouble breathing, and even collapse and death.

Long Term Exposure: Because this is a mutagen, handle it as a possible cancer-causing substance with extreme caution. May affect the blood, causing the formation of methemoglobin, low blood count (anemia), kidney and liver damage. People with "G-6-P-D deficiency" may be at higher risk for developing health problems following exposure.

Points of Attack: Respiratory system, blood, heart, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Methemoglobin; Complete blood count; liver function tests. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: kidney function tests. Also, tests for the condition called "G-6-P-D deficiency."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobine in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 mg/m^3:* Sa (APF = 10) (any supplied-air respirator).* *Up to 75 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 150 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 300 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp; ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. *p*-Nitroaniline must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), reducers, and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Wherever *p*-nitroaniline is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nitroanilines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including sulfur dioxide and nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) with scrubbing for nitrogen oxides abatement. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: p-Nitroaniline*. Trenton, NJ

5-Nitro-*o*-anisidine N:0390

Molecular Formula: $C_7H_8N_2O_3$

Common Formula: $C_6H_3(OCH_3)(NH_2)(NO_2)$

Synonyms: 1-Amino-2-methoxy-5-nitrobenzene; 2-Amino-1-methoxy-4-nitrobenzene; 3-Amino-4-methoxynitrobenzene; 2-Amino-4-nitroanisole; *o*-Anisidine nitrate; *o*-Anisidine, 5-nitro-; Azoamine scarlet ; Azoamine scarlet K; Azogene Ecarlate R; Azoic diazo component 13 base; Benzenamine, C.I. 37130; Benzenamine, 2-methoxy-5-nitro-; C.I. 37130; C.I. azoic diazo component 13; Fast scarlet R; 1-Methoxy-2-amino-4-nitrobenzene; 2-Methoxy-5-nitro-; 2-Methoxy-5-nitroaniline; 2-Methoxy-5-nitrobenzenamine; NCI-C01934; 3-Nitro-6-methoxyaniline; 5-Nitro-2-methoxyaniline

CAS Registry Number: 99-59-2

RTECS® Number: BZ7175000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

EC Number: 202-770-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1978. 5-Nitro-*o*-anisidine was removed from the NTP 6th Report on Carcinogens as a substance "reasonably anticipated to be a human carcinogen" in 1991, when NTP concluded there was insufficient evidence of carcinogenicity. Delisted from the California Proposition 65 list as of December 8, 2006.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 10/1/89; Delisted 12/8/06.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 5-Nitro-*o*-anisidine is an orange-red crystalline compound. Molecular weight = 168.17; Freezing/Melting point = 118°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0.

Potential Exposure: 5-Nitro-*o*-anisidine is a chemical intermediate in the production of C.I. Pigment red 23, which is used as a colorant for commodities, such as printing inks, interior latex paints; lacquers, rubber, plastics, floor coverings; paper coating; and textiles. It is also used with other C.I. coupling components to produce various hues of red, brown, yellow, and violet on cotton, silk, acetate, and nylon.

Permissible Exposure Limits in Air

No standards or TEEL available.

Incompatibilities: Strong acids, acid chlorides, acid anhydrides, chloroformates.

Permissible Exposure Limits in Air: No OELs have been established, but this chemical can be absorbed through the skin. Several states have set guidelines or standards for 5-nitro-*o*-ansidine in ambient air[60] ranging from zero (North Dakota) to 0.08 μg/m^3 (Rhode Island).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia) causing dizziness, cyanosis. Higher levels can cause trouble breathing, collapse, and even death.

Long Term Exposure: This compound is a proved carcinogen in experimental animals. Related chemicals can cause allergic skin rash, and irritate the nose, throat, and lungs. It is not known whether this substance can cause these effects.

Points of Attack: Blood. *Cancer site:* bladder.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Blood hemoglobin level. Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, acid chlorides, acid anhydrides, and chloroformates. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dye intermediates, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) with scrubbing for nitrogen oxides abatement.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: 5-Nitro-o-Anisidine*. Washington, DC

New Jersey Department of Health and Senior Services. (September 2004). *Hazardous Substances Fact Sheet: 5-Nitro-o-anisidine*. Trenton, NJ

Nitrobenzene N:0400

Molecular Formula: $C_6H_5NO_2$

Synonyms: Benzene, nitro-; Essence of mirbane; Essence of myrbane; Mirbane oil; NCI-C60082; Nitrobenceno (Spanish); Nitrobenzol; Nitrobenzol, L; Nitro, liquid; Oil of mirbane; Oil of myrbane

CAS Registry Number: 98-95-3

RTECS® Number: DA6475000

UN/NA & ERG Number: UN1662/152

EC Number: 202-716-0 [*Annex I Index No.:* 609-003-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Explosive hazard*; *Theft hazard* 100 (ACG concentration).

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1996; EPA: Likely to produce cancer in humans; NTP: Reasonably anticipated to be a human carcinogen.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0293-8703; 8EHQ-0293-8723; 8EHQ-0293-8724; 8EHQ-0892-9102; 8EHQ-0892-9103.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA)[6] (Russia)[35,43] (Maine, Kansas).[61]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U169.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.068; Nonwastewater (mg/kg), 14.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (40); 8270 (10).

Safe Drinking Water Act: Regulated chemical (47 FR 9352).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 8/26/97; Developmental/Reproductive toxin (male) 3/30/10.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R40; R48/23/24; R51/53; R62; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Nitrobenzene is a pale yellow to dark brown oily liquid whose odor resembles bitter almonds (or black paste shoe polish). The odor threshold is 0.044; 0.02 ppm (NJ). Molecular weight = 123.12; Specific gravity (H_2O:1) = 1.20; Boiling point = 210°C; Freezing/Melting point = 5.6°C; Vapor pressure = 0.3 mmHg at 25°C; Flash point = 88°C (cc); Autoignition temperature = 480°C. Explosive limits: LEL = 1.8% at 93°C; UEL: 40%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Practically insoluble in water; solubility = 0.2%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Nitrobenzene is used in the manufacture of explosives and aniline dyes and as solvent and intermediate. It is also used in floor polishes, leather dressings and polishing compounds, paint solvents, and to mask other unpleasant odors. Substitution reactions with nitrobenzene are used to form *m*-derivatives. Pregnant women may be especially at risk with respect to nitrobenzene as with many other chemical compounds, due to transplacental passage of the agent. Individuals with glucose-6-phosphate dehydrogenase deficiency may also be special risk groups. Additionally, because alcohol ingestion or chronic alcoholism can lower the lethal or toxic dose of nitrobenzene, individuals consuming alcoholic beverages may be at risk.

Incompatibilities: Concentrated nitric acid, nitrogen tetroxide, caustics, phosphorus pentachloride, chemically active metals, such as tin or zinc. Violent reaction with strong oxidizers and reducing agents. Attacks many plastics. Forms thermally unstable compounds with many organic and inorganic compounds.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.04 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/5 mg/m^3 TWA [skin].

NIOSH REL: 1 ppm/5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 1 ppm TWA [skin]; BEI: 5 mg[total *p*-nitrophenol]/g creatinine in urine/end-of-shift at end-of-work-week; 1.5% methemoglobin in blood, end-of-shift. Confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 2.5 ppm

PAC-2: 19.9 ppm

PAC-3: 200 ppm

DFG MAK: [skin] Carcinogen Category 3B; BAT: 100 μg [Aniline, released from aniline−hemoglobin conjugate]/L in blood, for long-term exposure, after several shifts (sampling time) [skin].

Arab Republic of Egypt: TWA 1 ppm (5 mg/m^3), [skin], 1993; Australia: TWA 1 ppm (5 mg/m^3), [skin], 1993; Austria: MAK 1 ppm (5 mg/m^3), [skin], 1999; Belgium: TWA 1 ppm (5 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (5 mg/m^3), [skin], 1999; Finland: TWA 1 ppm (5 mg/m^3); STEL 3 ppm (15 mg/m^3), [skin], 1999; France: VME 1 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 5 mg/m^3, [skin], 2003; Japan: 1 ppm (5 mg/m^3), [skin], 1999; Norway: TWA 1 ppm (5 mg/m^3), 1999; Poland: MAC (TWA) 3 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Russia: TWA 1 ppm; STEL 3 mg/m^3, [skin], 1993; Sweden: NGV 1 ppm (5 mg/m^3), KTV 2 ppm (10 mg/m^3), [skin], 1999; Switzerland: MAK-W 1 ppm (5 mg/m^3), KZG-W 2 ppm (10 mg/m^3), [skin], 1999; Turkey: TWA 1 ppm (5 mg/m^3), [skin], 1993; United Kingdom: TWA 1 ppm (5.1 mg/m^3); STEL 2 ppm (10 mg/m^3), [skin], 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic: TWA 1 ppm (5 mg/m^3).[35] Russia[43] has set 0.008 mg/m^3 (8 μg/m^3) as an MAC for ambient air in residential areas. Several states have set guidelines or standards for nitrobenzene in ambient air[60] ranging from 6.8 μg/m^3 (Massachusetts) to 16.7 μg/m^3 (New York) to 25 μg/m^3 (North Carolina and South Carolina) to 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2017. See also Method #2005.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 27,000 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 6680 μg/L on an acute toxicity basis. To protect humans—30 μg/L based on organoleptic considerations and 19,800 μg/L based on toxicity considerations.[6] Guidelines for nitrobenzene in drinking water have been set by Maine at 1.4 μg/L and by Kansas at 5.0 μg/L.[61]

Determination in Water: Methylene chloride extraction followed by exchange to toluene, gas chromatography with flame ionization detection (EPA Method 609) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 1.86.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Penetrates the skin.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Has caused headache and nausea at 3−6 ppm. 40 ppm may cause intoxication. Symptoms due to decreased ability of blood to carry oxygen may include blue coloration of lips, fingernails, and earlobes; headache, dizziness, loss of coordination; labored breathing; rapid heartbeat; vomiting, coma, and death. Symptoms may be delayed up to 4 h. *Skin:* Easily absorbed through the skin and contributes significantly to symptoms listed under inhalation. May also cause irritation and allergic sensitization. Death has been reported from skin absorption. *Eyes:* May cause irritation and damage to the cornea. *Ingestion:* May cause symptoms listed under inhalation and include burning of throat, abdominal pain, bloody diarrhea, and enlarged spleen and liver. Death has resulted from as little as 0.4 mL (0.05 liq. oz), about 8 drops. High levels of exposure can interfere with the blood's ability to carry oxygen (methemoglobinemia). Signs and symptoms of acute exposure to nitrobenzene may be severe and include cyanosis (blue tint to the skin and mucous membranes), tachycardia (rapid heart rate), Hypotension (low blood pressure), and cardiac arrhythmias. Respiratory depression and respiratory failure may also occur. Headache, lethargy, weakness, vertigo (dizziness), severe depression, and coma may be noted. Gastrointestinal symptoms include nausea and vomiting. Urine and vomitus may have the odor of bitter almonds.

Long Term Exposure: Occupational exposure to 40 ppm for 6 months has caused intoxication and anemia. Can cause skin allergy. Can cause jaundice, liver and spleen damage, fatigue, bladder distress, nerve damage. May affect the blood forming organs, causing anemia. Exposure may affect vision (acuity and contraction of fields).

Points of Attack: Blood, liver, kidneys, cardiovascular system, skin.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), carboxyhemoglobin; whole blood (chemical/metabolite), methemoglobin; whole blood (chemical/metabolite), methemoglobin, end-of-shift; complete blood count; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift at end-of-work-week; urine (chemical/metabolite), end-of-work-week. Preemployment and periodic examinations should be concerned particularly with a history of dyscrasias, reactions to medications, alcohol intake, eye disease, skin, and cardiovascular status. Liver and renal functions should be evaluated periodically, as well as blood and general health. Follow methemoglobin levels until normal in all cases of suspected cyanosis. The metabolites in urine, *p*-nitro- and *p*-aminophenol, can be used as evidence of exposure. Liver function tests.

Note: Alcohol ingestion increases the toxic effects of nitrobenzene. Persons with blood, heart, liver or lung diseases should not work with this substance.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Chlorinated polyethylene, polyvinyl alcohol, teflon, Viton™/chlorobutyl, and Silvershield™ are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nitrobenzene must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and chemically active metals (such as potassium, sodium, magnesium, and zinc) caustic nitrogen tetroxide or silver perchlorate, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) with scrubbing for nitrogen oxides abatement.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Nitrobenzene*. Washington, DC

US Environmental Protection Agency. (1980). *Nitrobenzene: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Nitrobenzene: Health and Environmental Effects Profile No. 134*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nitrobenzene*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 77−81

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nitrobenzene*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Nitrobenzene*. Trenton, NJ

4-Nitrobiphenyl N:0410

Molecular Formula: $C_{12}H_9NO_2$

Common Formula: $C_6H_5C_6H_4NO_2$

Synonyms: BA 2794; 1,1′-Biphenyl, 4-nitro-; Biphenyl, 4-nitro-; *p*-Nitrobiphenyl; *p*-Nitrodiphenyl; 4-Nitrodiphenyl; *p*-Nitrofenol (Spanish); 4-Nitrofenol (Spanish); 1-Nitro-4-phenylbenzene; *p*-Phenylnitrobenzene; 4-Phenylnitrobenzene; PNB

CAS Registry Number: 92-93-3

RTECS® Number: DV5600000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-204-7 [*Annex I Index No.:* 609-039-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; Cell transform.—SA7/SHE; Positive: Host-mediated assay; *E. coli* polA without S9; Positive: Histidine reversion—Ames test; Positive/limited: Carcinogenicity—mouse/rat; Negative: *N. crassa*—aneuploidy; *S. cerevisiae*—homozygosis.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1003).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 4/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R 45; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4-Nitrobiphenyl exists as yellow plates or needles. Molecular weight = 199.22; Boiling point = 340°C; Freezing/Melting point = 113.9°C; Flash point = 143.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. 4-Nitrobiphenyl was formerly used in the synthesis of 4-aminodiphenyl. It is presently used only for research purposes; there are no commercial uses.

Incompatibilities: Strong reducers, strong oxidizers.

Permissible Exposure Limits in Air

OSHA: Cancer Suspect Agent [skin], see Code of Federal Regulations 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: [skin] Suspected Human Carcinogen *as 4-nitrodiphenyl.*

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.25 mg/m^3

PAC-1: 0.75 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: [skin] Carcinogen Category 2.

Australia: carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; Norway: TWA 0.01 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for nitrobiphenyl in ambient air[60] ranging from zero (New York, North Dakota, South Carolina, Virginia) to 2.77 μg/m^3 (Pennsylvania).

Determination in Air: Collection on a glass fiber filter in series with silica gel, elution with 2-propanol, analysis by gas chromatography/flame ionization detection; NIOSH (II-4) P&CAM Method #273; OSHA Analytical Method PV-2082.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 890 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.8$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Percutaneous absorption.

Harmful Effects and Symptoms

Short Term Exposure: 4-Nitrobiphenyl can affect you when breathed in and by passing through your skin. Other health effects are not well known at this time, but contact with biphenyls can cause irritation of the skin and eyes; and may cause liver nerve damage, disturbed sleep, headache, lethargy (drowsiness or indifference), dizziness, dyspnea (breathing difficulty), ataxia, weakness, methemoglobinemia, urinary burning, acute hemorrhagic cystitis.

Long Term Exposure: 4-Nitrobiphenyl is a potential occupational carcinogen. Handle with extreme caution. May cause liver damage. Related compounds have caused damage to the nerves of the arms and legs.

Points of Attack: Bladder, blood, liver. Cancer site in animals: bladder.

Medical Surveillance: OSHA mandates tests and information on the following: *Increased Risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking. NIOSH lists the following tests: *increased risk:* reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking, urine (chemical/metabolite) placement, and periodic examinations should include an evaluation of exposure to other carcinogens, as well as an evaluation of smoking, or use of alcohol and medications and of family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations. Liver function tests. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and flame. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 s minimum) with scrubbing for nitrogen oxides abatement.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: 4-Nitrobiphenyl.* Trenton, NJ

Nitrocellulose N:0420

Molecular Formula: $C_{12}H_{16}(ONO_2)_4O_6$

Synonyms: Box toe gum; Celloidin; Cellulose nitrate solution; Collodion cotton; Gun cotton; Nitrocellulose; Nitrocellulose gum; Nitrocellulose solution; Nitrocellulose, with plasticizer; Nitrocotton; Nitron; Nixon N/C; NT; Pyroxylin solution; Synpor; Tsapolak 964; Xyloidin

CAS Registry Number: 9004-70-0

RTECS® Number: QW0970000

UN/NA & ERG Number: UN2059 [nitrocellulose, solution, flammable with not >12.6% nitrogen, by mass, and not >55% nitrocellulose]/127; UN2555 [nitrocellulose with water with not <25% water, by mass]/113; UN2556 [nitrocellulose with alcohol with not <25% alcohol by mass, and with not >12.6% nitrogen, by dry mass]/113; UN2557 [nitrocellulose, with not >12.6% nitrogen, by dry mass, or nitrocellulose mixture with pigment or nitrocellulose mixture with plasticizer or nitrocellulose mixture with pigment and plasticizer]/133; UN0340 [Nitrocellulose, dry or wetted with <25% water (or alcohol), by mass]/112; UN0341 [nitrocellulose, unmodified or plasticized with <18% plasticizing substance, by mass]/112; UN0343 [nitrocellulose, plasticized with not <18% plasticizing substance, by mass]/112; UN0342 [nitrocellulose, wetted with not <25% alcohol, by mass]/112; 3270 (Nitrocellulose membrane filters)/133.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard: explosives* 5000 commercial grade); *Theft hazard* 400 (commercial grade).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrocellulose is a pulpy, cotton-like solid, or a colorless liquid solution. Molecular weight = 504.31; Boiling point = about 34°C; Flash point = 13–27°C (wet with alcohol); Autoignition temperature = 170°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 3 (Oxidizer). Insoluble in water.

Potential Exposure: It is used in making explosives, rocket propellants, and celluloid.

Incompatibilities: Strong acids, alkaline materials, oxidizers. Do not allow to become dry. Dry material is a shock-sensitive explosive.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 20 mg/m^3
PAC-1: 60 mg/m^3
PAC-2: 400 mg/m^3
PAC-3: 500 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: Only those associated with the flammable and explosive nature of this flammable and reactive material. However, it may be wetted with alcohol, ether, or other dangerous liquid material that can be irritating to the eyes, nose, and throat. If inhaled will cause dizziness, difficult breathing, or loss of consciousness.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls must be effective to ensure that exposure to nitrocellulose does not occur. See respirator for solvent used as a wetting agent.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Nitrocellulose must be stored to avoid contact with oxidizers, strong acids (such as hydrochloric, sulfuric, and nitric) and alkaline materials (such as sodium hydroxide and potassium hydroxide), since violent reactions occur. Store nitrocellulose away from high temperatures and direct sunlight. Do not allow material to become dry. Sources of ignition, such as smoking and open flames, are prohibited where nitrocellulose is handled, used, or stored. Wherever nitrocellulose is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2555, UN2556, and UN2557 require a shipping label of "FLAMMABLE SOLID." They fall in DOT Hazard Class 4.1 and Packing Group II.

UN0342 and UN0343 require a shipping label of "EXPLOSIVE." They fall in DOT Hazard Class 1.3C and Packing Group II.

UN2059 requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group III.

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Immediately flood spill area with water, collect material, and deposit in sealed containers. Keep nitrocellulose out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing[17]***:*** Presents an unusually severe fire hazard; when dry, ignites readily and burns explosively. Should never be kept for any appreciable time in any dry fibrous state. Unstabilized product decomposes gradually at relatively low temperature, with evolution of copious volumes of toxic and flammable gases and rapid heat generation. In prolonged storage and aging of nitrocellulose plastics, camphor is lost with deterioration and the decomposition temperature may be lowered to 40°C. The resulting flameless decomposition is self-sustaining and accelerative, presenting the added hazard of dangerous pressures in building structures.

Use extreme caution in approaching fires involving this material as it may explode. No attempt should be made to fight advanced fires, except for remote activation of installed fire extinguishing equipment and/or with unmanned fixed turrets and hose nozzles. The surrounding areas should be evacuated. Fires should be approached from upwind and self-contained breathing apparatus used. Since cellulose nitrate supplies its own oxygen, prompt cooling with a large quantity of water is essential; water applied through spray nozzles is effective if fused quickly and in sufficient volume, in a manner to wet the entire exposed surface. Poisonous gases, including oxides of nitrogen (and possibly hydrogen cyanide and carbon monoxide), are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Nitrocellulose*. Trenton, NJ

p-Nitrochlorobenzene N:0430

Molecular Formula: $C_6H_4ClNO_2$

Common Formula: *p*-$ClC_6H_4NO_2$

Synonyms: Benzene, 1-chloro-4-nitro-; 1-Chlor-4-nitrobenzol (German); *p*-Chloronitrobenzene; 1-Chloro-4-nitrobenzene; 4-Chloro-1-nitrobenzene; 4-Chloronitrobenzene; *p*-Nitrochlorobenzol (German); *p*-Nitroclorobenzene; PNCB

CAS Registry Number: 100-00-5

RTECS® Number: CZ1050000

UN/NA & ERG Number: UN1578/152

EC Number: 202-809-6 [*Annex I Index No.*: 610-005-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1996; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 10/29/99.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R40; R48/20/21/22; R68; R51/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *p*-Nitrochlorobenzene is a yellow crystalline solid with a sweet odor. Molecular weight = 157.56; Specific gravity (H_2O:1) = 1.52; Boiling point = 242°C; Freezing/Melting point = 83.3°C; Vapor pressure = 0.2 mmHg at 20°C; Flash point = 127.2°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 3. Shock and heat sensitive. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. *p*-Nitrochlorobenzene (PNCB) is used as an intermediate in pesticide (parathion) manufacture, drug (phenacetin and acetaminophen) manufacture, in dye making, and in rubber and antioxidant manufacture.

Incompatibilities: A strong oxidizer. Reacts violently with oxidizers, combustibles, alkalis, sodium methoxide, and reducing materials.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA [skin].

NIOSH REL: A potential occupational carcinogen [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A. BEI_M issued for Methemoglobin inducers.

ACGIH TLV®[1]: 0.1 ppm/0.64 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: potential occupational carcinogen 100 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 0.1 ppm (0.6 mg/m^3), [skin], 1993; Austria Suspected: carcinogen, 1999; Belgium: TWA 0.1 ppm (0.64 mg/m^3), [skin], 1993; Denmark: TWA 0.1 ppm (0.64 mg/m^3), [skin], 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3, [skin], 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 1993; Japan: 0.1 ppm (0.64 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 1 mg/m^3, [skin], 1993; Switzerland: MAK-W 1 mg/m^3, KZG-W 2 mg/m^3, [skin], 1999; United Kingdom: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia[43] set a MAC of 0.004 mg/m^3 in ambient air of residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for 4-chloronitrobenzene in ambient air[60] ranging from 3.3 $\mu g/m^3$ (New York) to 5 $\mu g/m^3$ (South Carolina) to 10 $\mu g/m^3$ (Florida) to 20 $\mu g/m^3$ (Connecticut) to 24 $\mu g/m^3$ (Nevada) to 30 $\mu g/m^3$ (North Dakota) to 50 $\mu g/m^3$ (Virginia) to 83.33 $\mu g/m^3$ (Kansas).

Determination in Air: Use NIOSH Analytical Method (IV) #2005[18], Nitrobenzene.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.4$.

Permissible Concentration in Water: A limit of 0.05 mg/L has been set in the former USSR.[43]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin on contact. Inhalation can cause irritation of the respiratory tract with coughing and wheezing. High levels can interfere with the body's ability to carry oxygen (methemoglobinemia) causing cyanosis, headache, dizziness, fatigue. Can also cause nausea, vomiting, dyspnea. Higher levels can cause trouble breathing, collapse, and death.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Can affect the nervous system. May damage the liver and kidneys. May cause methemoglobinemia, hemoglobinuria, anemia, spleen, bone marrow changes, reproductive effects. Potential occupational carcinogen. In animals: hematuria (blood in the urine).

Points of Attack: Blood, liver, kidneys, cardiovascular system, spleen, bone marrow, reproductive system. Cancer site in animals: vascular and liver.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Methemoglobin; complete blood count. Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Liver and kidney function tests. Alcohol consumption may increase liver damage caused by PNCB.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator and protect from shock, heat sources, light, oxidizers, reducing agents, alkalis, and sodium methoxide. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chloronitrobenzenes [meta or para, solid] require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It does not readily ignite. Use dry chemical, carbon dioxide, water spray; alcohol foam or polymer foam extinguishers. Poisonous gases, including nitrogen oxides and hydrogen chloride, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 s for primary combustion; 1204°C, 1.0 s for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. Nitrogen oxides may be abated through the use of thermal or catalytic devices.

References

US Environmental Protection Agency. (June 13, 1983). *Chemical Hazard Information Profile Draft Report: 4-Chloronitrobenzene*. Washington, DC

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: p-Nitrochlorobenzene*. Trenton, NJ

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Chloronitrobenzenes (mixed isomers)*. Trenton, NJ

Nitrocyclohexane N:0440

Molecular Formula: $C_6H_{11}NO_2$

Synonyms: Cyclohexane, nitro-

CAS Registry Number: 1122-60-7

RTECS® Number: GV6600000

UN/NA & ERG Number: UN2810/153

EC Number: 214-354-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: not listed in Annex I (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrocyclohexane is a highly flammable, colorless liquid. Molecular weight = 129.18; Boiling point = 206°C (decomposition); Freezing/Melting point = −34°C; Flash point = 88°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2 (Oxidizer).

Potential Exposure: Used in organic synthesis.

Incompatibilities: A nitro compound; forms explosive mixture with air. Incompatible with strong oxidizers, alkalis, and metal oxides. This chemical is highly reactive and may be heat- and shock-sensitive and a fire and explosive hazard.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.3 mg/m^3
PAC-1: 0.75 mg/m^3
PAC-2: 1.5 mg/m^3
PAC-3: 60 mg/m^3

Russia[43] set a MAC of 1.0 mg/m^3 in work-place air.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

The LD_{50} = (oral-mouse) 250 mg/kg (moderately toxic).

Short Term Exposure: Insufficient data are available on the effect of this substance on human health; therefore, utmost care must be taken. May be absorbed through the skin. May be an irritant to the eyes, skin, and respiratory system. Similar chemical can cause cyanosis due to formation of methemoglobin.

Long Term Exposure: Similar chemicals can cause kidney and liver damage.

Points of Attack: Most of the above information is based on similar nitro compounds of aromatic hydrocarbons. May cause blood, liver, and kidney effects.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended. The following might be considered: blood methemoglobin level, complete blood count (CBC), liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash; pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, alkalis, metal oxides. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone B] requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if you can do so without risk. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Stay upwind; keep out of low areas. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nitrocyclohexane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Nitrocyclohexane*. Trenton, NJ

Nitroethane N:0450

Molecular Formula: $C_2H_5NO_2$

Common Formula: $CH_3CH_2NO_2$

Synonyms: Ethane, nitro-; Nitroetano (Spanish)

CAS Registry Number: 79-24-3

RTECS® Number: KI5600000

UN/NA & ERG Number: UN2842/129

EC Number: 201-188-9 [*Annex I Index No.:* 609-035-00-1]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20/22; Safety phrases: S2; S9; S25; S41 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Nitroethane is a colorless, oily liquid with a mild, fruity odor. The odor threshold is 163 ppm.[41] Molecular weight = 75.08; Specific gravity (H_2O:1) = 1.05; Boiling point = 113.9°C; Freezing/Melting point = −90°C; Vapor pressure = 21 mmHg at 25°C; Flash point = 28°C. Begins to decompose at 300°C; Autoignition temperature = 414°C. Explosive limits: LEL = 3.4%; UEL = Unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 3. Slightly soluble in water; solubility = 5%.

Potential Exposure: Compound Description: Mutagen; Human Data. Nitroethane is used as solvent for polymers, cellulose esters, vinyl, waxes, fats, dyestuffs, and alkyd resins, as a stabilizer. It has been used as a rocket propellant. It is used as an intermediate in pharmaceutical manufacture and in pesticide manufacture.

Incompatibilities: A nitroparaffin, nitroethane forms explosive mixture with air. Explodes when heated or when shocked; in confined area, with elevated temperatures. A strong reducing agent. Violent reaction with oxidizers, hydrocarbons, other combustibles, amines, metal oxides. Forms shock-sensitive compounds with strong acids, strong alkalis. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/310 mg/m^3 TWA.

NIOSH REL: 100 ppm/310 mg/m^3 TWA.

ACGIH TLV®[1]: 100 ppm/307 mg/m^3 TWA.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 200 ppm

PAC-3: 1000 ppm

DFG MAK: 100 ppm/310 mg/m^3 TWA; Peak Limitation Category II(4); Pregnancy Risk Group D.

Australia: TWA 100 ppm (310 mg/m^3), 1993; Austria: MAK 100 ppm (310 mg/m^3), 1999; Belgium: TWA 100 ppm (307 mg/m^3), 1993; Denmark: TWA 100 ppm (310 mg/m^3), 1999; Finland: TWA 100 ppm (310 mg/m^3); STEL 150 ppm (465 mg/m^3), 1999; France: VME 100 ppm (310 mg/m^3), 1999; the Netherlands: MAC-TGG 60 mg/m^3, 2003; the Philippines: TWA 100 ppm (310 mg/m^3), 1993; Poland: MAC (TWA) 30 mg/m^3, MAC (STEL) 240 mg/m^3, 1999; Russia: STEL 30 mg/m^3, 1993; Sweden: TWA 20 ppm (60 mg/m^3); STEL 50 ppm (150 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (310 mg/m^3), 1999; Turkey: TWA 100 ppm (310 mg/m^3), 1993; United Kingdom: TWA 100 ppm (312 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm. Several states have set limits in ambient air ranging from 3.1 mg/m^3 (North Dakota) to 5.2 mg/m^3 (Virginia) to 6.2 mg/m^3 (Connecticut) to 7.38 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2526.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.18.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. High exposure could cause headache, dizziness, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. LD_{50} = (oral-rat) 250 mg/kg (moderately toxic).

Long Term Exposure: May cause liver and kidney damage. Can cause dermatitis, drying, and cracking skin. Can cause lung irritation; bronchitis may develop.

Points of Attack: Skin, respiratory system, central nervous system, kidneys, liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator away from oxidizers, strong acids, amines, alkalis, hydrocarbons, combustibles, metal oxides, strong bases, and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material, and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Do not use dry chemical powder. Use carbon dioxide, or alcohol, or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes.[22]

Reference

New Jersey Department of Health and Senior Services. (June 1999). *Hazardous Substances Fact Sheet: Nitroethane*. Trenton, NJ

Nitrofen N:0460

Molecular Formula: $C_{12}H_7Cl_2NO_3$

Common Formula: $O_2NC_6H_4OC_6H_3Cl_3$

Synonyms: Benzenamine, 4-Ethoxy-*N*-(5-nitro-2-furanyl) methylene-; Benzene, 2,4-dichloro-1-(4-nitrophenoxy)-; 2′,4′-Dichloro-4′-nitrodiphenyl ether; 2,4-Dichloro-1-(4-nitrophenoxy)benzene; 4-(2,4-Dichlorophenoxy) nitrobenzene; 2,4-Dichlorophenyl-4-nirtophenylaether (German); 2,4-Dichlorophenyl *p*-nitrophenyl ether; 2,4-Dichlorophenyl 4-nitrophenyl ether; Ether, 2,4-dichlorophenyl *p*-nitrophenyl; FW 925; Mezotox; NCI-C00420; Niclofen; NIP; Nitrochlor; 4′-Nitro-2,4-dichlorodiphenyl ether; 4-Nitro-2′,4′-dichlorodiphenyl ether; Nitrofene (French); Nitrophen;

Nitrophene; Preparation 125; TOK; TOK-2; TOK E; TOK E 25; TOK E 40; Tokkom; Tokkorn; TOK WP-50; Trizilin

CAS Registry Number: 1836-75-5; *(alt.)* 51274-07-8

RTECS® Number: KN8400000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152

EC Number: 217-406-0 [*Annex I Index No.:* 609-040-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*technical grade*): Animal Sufficient Evidence; Human No Adequate Data*, possibly carcinogenic to humans*, Group 2B, 1987; NTP (*technical grade*): 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1978; (feed); clear evidence: mouse, 1979; (feed); no evidence: rat, 1979.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Inconclusive: Mammalian micronucleus.

Banned or Severely Restricted (many countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrofen is a crystalline solid. Molecular weight = 284.10; Freezing/Melting point = 70−71°C; Vapor pressure = 1.2×10^{-7} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Very slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Human Data. Nitrofen is a contact herbicide used for pre- and postemergency control of annual grasses and broadleaf weeds on a variety of food and ornamental crops. Occupational exposure to nitrofen, primarily through inhalation and dermal contact, may occur among workers at production facilities. Field handlers of the herbicide are subject to inhalation exposure during application procedures.

Permissible Exposure Limits in Air

No TEEL available.

Finland: carcinogen, 1999; Russia: STEL 1 mg/m^3, 1993; United Kingdom: carcinogen, TWA 1 ppm (7.1 mg/m^3), 2000. Russia set a MAC of 0.02 mg/m^3 in ambient air in residential areas on a once-daily basis and 0.01 mg/m^3 on an average daily basis. Pennsylvania has set a guideline for nitrofen in ambient air[60] of 0.75 μg/m^3.

Permissible Concentration in Water: Nitrofen presumably falls under the EPA Priority Toxic Pollutant category of haloethers[6] but specific limits have not been set. Russia has set a limit of 4.0 mg/L in surface water.

Determination in water: Fish Tox = 92.54948000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Toxic by ingestion. Severe eye irritant. Causes skin irritation on contact. Inhalation can cause irritation to the respiratory tract. May cause difficult breathing; fatigue, and loss of appetite.

Long Term Exposure: Long term exposure may cause damage to the blood cells, causing low white cell (leukocyte) count, reduced hemoglobin, and reduced serum cholinesterase and erythrocyte catalase activities. May cause liver damage. May affect the nervous system.

Points of Attack: Blood, liver, kidneys, nervous system.

Medical Surveillance: Complete blood count (CBC). Liver function tests. Examination of the nervous system and interview for brain effects.

First Aid: *Skin Contact*: Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower that his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Phenoxy pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid airborne dust. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides and chlorine, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be landfilled but large quantities should be incinerated.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Nitrofen*. Trenton, NJ

Nitrogen N:0470

Molecular Formula: N_2

Synonyms: Liquid nitrogen; Nitrogen, compressed; Nitrogen, cryogenic liquid; Nitrogen gas; Nitrogen, refrigerated liquid

CAS Registry Number: 7727-37-9

RTECS® Number: QW9700000

UN/NA & ERG Number: UN1066 (compressed)/121; UN1977 (refrigerated liquid)/120

EC Number: 231-783-9

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Active registration.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Nitrogen is a nonflammable, stable, odorless, cryogenic liquid or a compressed gas. Molecular weight = 28.02; Boiling point = −196°C; Freezing/Melting point = −210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Nitrogen is present in the air we breathe. Health effects may occur at concentrations above 80%. It has many medical and industrial uses including the quick freezing of food. The gas is used for purging, heat treating, food freezing, annealing, cooling, oil recovery, in the inert blanketing of sensitive materials and as a reactant in chemical synthesis of ammonia.

Incompatibilities: Containers may explode when heated.

Permissible Exposure Limits in Air: Before entering an enclosed space where nitrogen may be present, oxygen content should be tested to ensure that it is at least 19% by volume.

Determination in Air:

OSHA PEL: Simple asphyxiant—inert gases and vapors.

NIOSH REL: Simple asphyxiant—inert gases and vapors.

ACGIH TLV®[1]: Simple asphyxiant.

Protective Action Criteria (PAC)

TEEL-0: 796,000 ppm

PAC-1: 796,000 ppm

PAC-2: 832,000 ppm

PAC-3: 869,000 ppm

United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Simple asphyxiant: nitrogen is a simple asphyxiant inert gas or vapor; *oxygen* content should be at least 19%.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* No significant toxic effects except as an asphyxiant; that is, it may threaten life if levels are so high as to reduce oxygen levels below 19%. Since nitrogen is odorless, colorless, and tasteless, there may not be adequate warning of high levels. Symptoms of lack of oxygen may include nausea, drowsiness, blue coloration of skin and lips, unconsciousness, and death. *Skin, Eyes, Ingestion:* Liquid may cause frostbite and freezing burns

Long Term Exposure: No information is known at this time.

First Aid: *Inhalation:* Move person to fresh air. Give oxygen or artificial respiration as necessary. *Skin:* Remove liquid-soaked clothing after allowing to thaw. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention. *Eyes:* Seek immediate medical attention if contact with liquid occurs. *Ingestion:* Seek medical attention as necessary.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Respirator Selection: Exposure to nitrogen is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where nitrogen is handled, used, or stored. Store liquid containers and cylinders in cool, well-ventilated areas. Use only in well-ventilated areas. Cylinders must be secured and protected against damage. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Nitrogen, *compressed*, or nitrogen, *refrigerated liquid [cryogenic liquid]*, requires a shipping label of "NONFLAMMABLE GAS." They fall in DOT Hazard Class 2.2.

Spill Handling: If liquid nitrogen is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate the area of spill or leak. Stop the leak or move the container to a safe area and allow the liquid to evaporate. If nitrogen gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak, or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material, and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nitrogen itself does not burn. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nitrogen*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (September 2004). *Hazardous Substances Fact Sheet: Nitrogen*. Trenton, NJ

Nitrogen dioxide N:0480

Molecular Formula: NO_2,

Common Formula: N_2O_4 (nitrogen tetroxide)

Synonyms: Dinitrogen dioxide; Dinitrogen dioxide, di-; Dinitrogen tetroxide (N_2O_4); Dioxido de nitrogeno (Spanish); Nitrogen peroxide; Nitrogen tetroxide

CAS Registry Number: 10102-44-0; 10544-72-6 (dinitrogen tetroxide)

RTECS® Number: QW9800000

UN/NA & ERG Number: UN1067 (dinitrogen tetroxide)/124

EC Number: 233-272-6 [*Annex I Index No.:* 007-002-00-0]; 234-126-4 [*Annex I Index No.:* 007-002-00-0] (dinitrogen tetroxide)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥3.80% concentration) (*dinitrogen tetroxide*).

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P078.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*nitrogen dioxide*; *nitrogen tetroxide*): Hazard Symbol: T+, N; Risk phrases: R8; R26; R34; Safety phrases: S1/2; S9; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*nitrogen dioxide, nitrogen tetroxide*).

Description: Nitrogen dioxide (and nitrogen tetroxide, the solid dimer) is a dark brown gas (above 21°C) or a yellow, fuming liquid or colorless solid with a pungent, acrid odor. The solid form is colorless below about −11°C; it is found structurally as N_2O_4. The odor threshold is 5 pm. Molecular weight = 46.01; Specific gravity (H_2O:1) = 1.44 (liquid at 20°C); Boiling point = 21°C; Freezing/Melting point = −9.4°C; Vapor pressure = 720 mmHg. Decomposes at 160°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity ₩ (oxidizer). Decomposes (reacts) with water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Nitrogen dioxide is found in automotive and diesel emissions. Nitrogen dioxide is an industrial chemical used as an intermediate in nitric and sulfuric acid manufacture, in the nitration of organic compounds, and as an oxidizer in liquid propellant rocket fuel combinations. It is also used in fire-fighting, welding, and brazing.

Incompatibilities: A strong oxidizer. Reacts violently with combustible matter, chlorinated hydrocarbons, ammonia, carbon disulfide, reducing materials. Reacts with water, forming nitric acid and nitric oxide. Attacks steel in the presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.88 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/9 mg/m^3 Ceiling Concentration.

NIOSH REL: 1 ppm/1.8 mg/m^3 STEL.

ACGIH TLV®[1]: 3 ppm/5.6 mg/m^3 TWA; 5 ppm/9.4 mg/m^3 STEL, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)*

TEEL-0: 0.5 ppm

PAC-1: **0.50** ppm

PAC-2: **12** ppm

PAC-3: **20** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

10544-72-6 (dinitrogen tetroxide)

TEEL-0: 0.3 ppm

PAC-1: **0.94** ppm

PAC-2: **23** ppm

PAC-3: **38** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.5 ppm/0.95 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group D; Carcinogen Category 3B.

NIOSH IDLH: 20 ppm.

Arab Republic of Egypt: TWA 3 ppm (6 mg/m^3), 1993; Austria: MAK 3 ppm (6 mg/m^3), 1999; Denmark: TWA 3 ppm (5.6 mg/m^3), 1999; Finland: TWA 3 ppm (6 mg/m^3); STEL 6 ppm (12 mg/m^3), 1999; France: VLE 3 ppm (6 mg/m^3), 1999; Japan: pending, 1999; the Netherlands: MAC-TGG 4 mg/m^3, 2003; the Philippines: TWA 5 ppm (9 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Sweden: NGV 2 ppm (4 mg/m^3), TGV 5 ppm (13 mg/m^3), 1999; Switzerland: MAK-W 3 ppm (6 mg/m^3), KZG-W 6 ppm (12 mg/m^3), 1999; Thailand: TWA 5 ppm (9 mg/m^3), 1993; Turkey: TWA 5 ppm (9 mg/m^3), 1993; United Kingdom: TWA 3 ppm (5.7 mg/m^3); STEL 5 ppm (9.6 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 5 ppm. Russia[43] set a MAC of 0.085 mg/m^3 (85 μg/m^3) for ambient air in residential areas. Several states have set guidelines or standards for nitrogen dioxide in ambient air[60] ranging from 100 μg/m^3 (Arizona and Connecticut) to 143 μg/m^3 (Nevada).

Protective Action Criteria (PAC)*

10544-72-6 (dinitrogen tetroxide)

TEEL-0: 0.3 ppm

PAC-1: **0.94** ppm

PAC-2: **23** ppm

PAC-3: **38** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: Use NIOSH Analytical Method (IV) #6014, Nitric oxide and nitrogen dioxide; OSHA Analytical Methods ID-109 and ID-182.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nitrogen dioxide and its vapors irritate the eyes, skin, and respiratory tract. Inhalation exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Acute exposure to nitrogen dioxide may be severe and result in a weak, rapid pulse; cyanosis (blue tint to the skin and mucous membranes); and circulatory collapse. Cough, dyspnea (shortness of breath), bronchitis, pneumonitis, and pulmonary edema may occur following inhalation exposure. Gastrointestinal symptoms include nausea and abdominal pain. Fatigue, lethargy, restlessness, fever, anxiety, headache, mental confusion, and loss of consciousness may also occur. Contact with the skin and mucous membranes may result in severe irritation and burns. When liquid nitrogen dioxide contacts the skin, frostbite will result. *Inhalation:* 10−20 ppm can cause mild irritation of the nose and throat. 25−50 ppm can cause an inflammation of the lungs, such as bronchitis or pneumonia. Levels above 100 ppm can cause death. Only highly concentrated fumes cause immediate symptoms, such as coughing, choking, headache, nausea, and stomach or chest pain. However, exposures to less concentrated fumes may produce these symptoms after 5−72 h. Rapid and shallow breathing, bluish coloration in skin, and unconsciousness may develop along with lung irritation or congestion. *Skin:* Can cause severe irritation and burns. *Eyes:* Levels of 10−20 ppm can cause irritation. Higher vapor concentration can cause eye injury. Contact with liquid can cause severe chemical burns. *Ingestion:* Can cause burns in mouth, throat, and stomach.

Long Term Exposure: Can cause headache, weakness, loss of sleep and appetite, sores in nose and mouth, nausea, and erosion of teeth. Exposure to 0.4−2.7 ppm for 4−6 years has been associated with emphysema and bronchitis. Genetic changes have been shown in experimental animals; possibly causes toxic effects on human reproduction. Nitrogen dioxide may affect the immune system, resulting in a decreased resistance to infection.

Points of Attack: Respiratory system, lungs, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: Electrocardiogram, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. Preplacement and periodic examinations should be concerned particularly with the skin, eyes, and with significant pulmonary and heart diseases. Smoking history should be known. Methemoglobin studies may be of interest if exposure to nitric oxide is present. In the case of nitric acid vapor mist exposure, dental effects may be present.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis. Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Individuals should be equipped with supplied air respirators with full-face-piece or chemical goggles, and enclosed areas should be properly ventilated before entering. An observer equipped with appropriate respiratory protection should be outside the area and standing by to supply any aid needed. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash, where nitrogen oxides may accumulate (for example, silos).

Respirator Selection: NIOSH: *20 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Only nonoxidizable sorbents are allowed (NOT charcoal).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Protect containers from physical damage. Store separately from combustible, organic, and readily oxidizable materials. Transfer facilities should be outdoors.

Shipping: Nitrogen dioxide, liquefied, requires a shipping label of "POISON GAS, OXIDIZER." It falls in Hazard Class 2.3 and Packing Group I. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Evacuate area endangered by gas. For water spills, neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. For an air spill, apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Stop leak if you can do so without risk. Use water spray to reduce vapor but do not put water on leak or spill area. Isolate area until gas has dispersed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

Dinitrogen tetroxide nitrogen dioxide

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400

Then: Protect persons downwind (miles/kilometers)

Day 0.7/1.1

Night 1.9/3.1

Dinitrogen tetroxide and nitric oxide mixture; nitric oxide and dinitrogen tetroxide mixture; nitric oxide and nitrogen dioxide mixture; nitric oxide and nitrogen tetroxide mixture; nitrogen dioxide and nitric oxide mixture; nitrogen tetroxide and nitric oxide mixture

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day 0.4/0.6

Night 1.4/2.3

Fire Extinguishing: NO_2 is nonflammable but supports combustion. Wearing proper equipment, shut off flow of gas. Use water spray to keep containers cool and to also direct escaping gas away from personnel attempting to shut off leak. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destroy this chemical by incineration with the addition of hydrocarbon fuel, controlled in such a way that combustion products are elemental nitrogen, CO_2, and water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard:*

Occupational Exposure to Oxides of Nitrogen. NIOSH Document No. 76-149

World Health Organization. (1977). *Oxides of Nitrogen, Environmental Health Criteria No. 4*. Geneva, Switzerland

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 74−76 (1981) and 5, No. 6, 81−83 (1985)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Nitrogen Dioxide*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Nitrogen Dioxide*. Version 30. Albany, NY: Bureau of Toxic Substance Assessment

Nitrogen oxides N:0490

Molecular Formula: NO (nitric oxide); NO_2 (nitrogen dioxide); N_2O_3 (nitrogen trioxide); N_2O_4 (dinitrogen tetroxide); N_2O_5 (nitrogen pentoxide)

Synonyms: nitrogen oxides; Oxides of nitrogen

CAS Registry Number: 10024-97-2 (nitrous oxide); 10102-43-9 (nitric monoxide); 10544-73-7 (nitrogen trioxide); 10102-03-1 (dinitrogen pentoxide)

UN/NA & ERG Number: UN1660 (nitric oxide)/124; UN2201 (Nitrous oxide, refrigerated liquid)/122; UN2421 (Nitrogen trioxide)/124; UN1067 (dinitrogen tetroxide)/124

EC Number: 233-032-0 (nitrous oxide); 233-271-0 9 (nitrogen monoxide); 234-128-5 (dinitrogen trioxide); 233-264-2 (dinitrogen pentoxide)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade). (*Nitrogen trioxide*).

See entries for specific compound.

US DOT 49CFR172.101, Inhalation Hazardous Chemical (nitrogen dioxide, nitric oxide, nitrogen tetroxide, nitrogen trioxide).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (for above CAS number except dinitrogen pentoxide; no hazard value assigned).

Description: Nitrogen oxides are colorless (NO, N_2O) to brick red (NO_2) gases with little or no odor or an irritating odor (NO_2). When frozen they appear to be white to bluish-white snow. Molecular weight- = varies by entry; Boiling point = −52°C (*nitric oxide*); 21°C (*nitrogen dioxide*); 47°C (*nitrogen pentoxide*); Freezing/Melting point = −164°C (*nitric oxide*); − 9°C (*nitrogen dioxide*); 30°C (*nitrogen pentoxide*). Hazard Identification (based on NFPA-704 M Rating System) (*nitric oxide*): Health 4, Flammability 0, Reactivity 1; (*nitrogen dioxide*): Health 2, Flammability 0, Reactivity 0. They decompose in water.

Potential Exposure: See entries for specific compound.

Incompatibilities: Stability and reactivity are variable depending on specific compound. All are strong oxidizers that enhance the combustion of easily oxidizer materials, reducing agents, combustibles, organics.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) *see also nitrous oxide* entry

TEEL-0: 50 ppm
PAC-1: 150 ppm
PAC-2: 10,000 ppm
PAC-3: 20,000 ppm

Nitric oxide; nitrogen dioxide; nitrogen tetroxide

TEEL-0: 0.5 ppm
PAC-1: 0.5 ppm
PAC-2: 12 ppm
PAC-3: 20 ppm

Nitrogen trioxide

TEEL-0: 5 ppm
PAC-1: 15 ppm
PAC-2: 100 ppm
PAC-3: 500 ppm

See entries for specific compound. The US EPA has set national ambient air quality standards of 0.05 ppm (100 $\mu g/m^3$) for nitrogen oxides as an annual arithmetic mean value.

Harmful Effects and Symptoms

Short Term Exposure: Serious health hazards. Corrosive to the eyes and skin. Harmful if inhaled. See “Nitric oxide,” “Nitrogen dioxide,” etc.

First Aid: If any of these chemicals gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with nitrogen oxides you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizable materials. Outside or detached storage is preferred. Do not put on wooden floors. See NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers.*

Shipping: See separate entries for specific compound.
See each chemical.

Spill Handling: See "Nitric oxide", "Nitrogen dioxide", etc. Runoff of less volatile nitrogen oxides may contain nitric acid.

Fire Extinguishing: See "Nitric oxide," "Nitrogen dioxide," etc. Nitrogen oxides enhance the activity of an existing fire.

References

National Academy of Sciences. (1977). *Medical and Biologic Effects of Environmental Pollutants: Nitrogen Oxides*. Washington, DC

US Environmental Protection Agency. (1993). *Air Quality Criteria for Oxides of Nitrogen*. Research Triangle Park, NC: Criteria and Assessment Office

Nitrogen trifluoride N:0500

Molecular Formula: F_3N

Common Formula: NF_3

Synonyms: Nitrogen fluoride; Trifluoramine; Trifluorammonia

CAS Registry Number: 7783-54-2

RTECS® Number: QX1925000

UN/NA & ERG Number: UN2451/122

EC Number: 232-007-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitrogen trifluoride is a colorless gas with a moldy odor. Shipped as a nonliquefied compressed gas. Molecular weight = 71.01; Boiling point = −129°C; Freezing/Melting point = −206.7°C; Relative vapor density (air = 1) 2.46 at 20°C; Vapor pressure = >1 atm; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity ₩. Slightly soluble in water (reactive).

Potential Exposure: This material has been used in chemical synthesis and as an oxidizer for high-energy fuels (as an oxidizer in rocket propellant combinations).

Incompatibilities: A powerful oxidizer. Reacts with oil, grease, reducing agents and other oxidizable materials, combustibles, organics, ammonia, carbon monoxide, methane, hydrogen, hydrogen sulfide, activated charcoal, diborane, water.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.90 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/29 mg/m^3 TWA.

NIOSH REL: 10 ppm/29 mg/m^3 TWA.

ACGIH TLV®[1]: 10 ppm/29 mg/m^3 TWA; BEI_M issued for Methemoglobin inducers.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 10 ppm

PAC-1: **200** ppm

PAC-2: **530** ppm

PAC-3: **860** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

United Kingdom: TWA 10 ppm (30 mg/m^3); STEL 15 ppm (44 mg/m^3), 2000; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; the Netherlands: MAC-TGG 29 mg/m^3, 2003. Several states have set guidelines or standards for NF_3 in ambient air[60] ranging from 0.3 mg/m^3 (North Dakota) to 0.5 mg/m^3 (Virginia) to 0.58 mg/m^3 (Connecticut) to 0.714 mg/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Permissible Concentration in Water: Fluoride guidelines are 1.8 mg/L in Arizona, 2.4 mg/L in Maine, and 4.0 mg/L according to EPA.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Insufficient data are available on the effect of this substance on human health; therefore, utmost care must be taken. May be corrosive to eyes, skin, and respiratory tract. In animals: anoxia, cyanosis, methemoglobinemia, weakness, dizziness, headache, liver, kidney injury. (NIOSH).

Long Term Exposure: However, a Japanese source[24] states that NF_3 is corrosive to tissue and that teeth and bones are affected on long inhalation. See also, "Fluoride," above.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; complete blood count. Liver and kidney function tests. Urine fluoride test (levels above 3–4 mg/L at the end of exposure represent increased exposure).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. No protective devices other than respirators are indicated by NIOSH. Rubber gloves, face shield, and overalls are suggested by others, however.[24] Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic fluorides*.

Respirator Selection: *Up to 100 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *Up to 500 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern]; or *SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or *SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SAF (any supplied-air respirator with a full face-piece). *Up to 1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Nitrogen trifluoride, compressed, requires a shipping label of "POISON GAS, OXIDIZER." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a nonflammable gas. Poisonous gases, including fluorine, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent into large volume of concentrated reducing agent (bisulfites, ferrous salts, or hypo) solution, then neutralize and flush to sewer with large volumes of water.

References

National Institute for Occupational Safety and Health. (1975). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides*. NIOSH Document No. 75-103. Washington, DC

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Nitrogen Dioxide*. Trenton, NJ

Nitroglycerin N:0510

Molecular Formula: $C_3H_5N_3O_9$

Common Formula: $C_3H_5(NO_3)_3$

Synonyms: Angibid; Anginine; Angiolingual; Angorin; Blasting gelatin; Blasting oil; Cardmist; Glonoin; Glucor nitro; Glycerol nitric acid triester; Glycerol (trinitrate de) (French); Glycerol trinitrate; Glyceryl nitrate; Glyceryl trinitrate; GTN; Klavi kordal; Lenitral; Myocon; Myoglycerin; NG; Niglycon; Niong; Nitora; Nitric acid triester of glycerol; Nitrin; Nitrine; Nitrine-TDC; Nitro-dur; Nitroglicerina (Spanish); Nitroglycerine; Nitroglycerol; Nitroglyn; Nitrol; Nitrolan; Nitrolent; Nitroletten; Nitrolingual; Nitrolowe; Nitronet; Nitrong; Nitrorectal; Nitro-Span; Nitrostabilin; Nitrostat; Nitrozell retard; NK-843; NTG; Perglottal; 1,2,3-Propanetriyl nitrate; 1,2,3-Propanetrol, trinitrate; Pyro-glycerine; SK-106N; SNG; Soup; Spirit of glonoin; Spirit of glyceryl trinitrate; Spirit of trinitroglycerin; Temponitrin; TNG; Trinitrin; Trinitroglycerin; Trinitroglycerol

CAS Registry Number: 55-63-0

RTECS® Number: QX2100000

UN/NA & ERG Number: UN1204 (solution in alcohol with not >1% nitroglycerin)/127; UN3064 (solution in alcohol, with >1% but not >5% nitroglycerin)/127; UN0144 (solution in alcohol, with >1% but not >10% nitrogylcerin)/112; UN0143 (desensitized with not <40% nonvolatile, water-insoluble phlegmatizer, by mass)/112; UN3319 (nitroglycerin mixture with more than 2% but not >10% Nitroglycerin, desensitized)/113; UN3343 (Nitroglycerin mixture, desensitized, liquid, flammable, n.o.s., with not >30% Nitroglycerin)/113; UN3357 (Nitroglycerin mixture, desensitized, liquid, n.o.s., with not >30% Nitroglycerin)/113

EC Number: 200-240-8 [*Annex I Index No.:* 603-034-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 commercial grade); *Theft hazard* 400 (commercial grade).

FDA—proprietary drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P081.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: E, T + , N; Risk phrases: R3; R26/27/28; R33; R51/53; Safety phrases: S1/2; S28; S33; S35; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nitroglycerin is a pale yellow liquid or crystalline solid (below 13°C). Molecular weight = 227.11; Specific gravity (H_2O:1) = 1.6; Boiling point = begins to decompose at 50−60°C; explodes at 261°C; Freezing/Melting point = 13.3°C; Vapor pressure = 0.0003 mmHg at 20°C; Flash point = explodes; Autoignition temperature = 261°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 4. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. An explosive ingredient in dynamite (20−40%) with ethylene glycol dinitrate (80−60%). It is also used in making other explosives, rocket propellants, and medicine (vasodilator).

Incompatibilities: Heat, ozone, shock, acids. An OSHA Class A Explosive (1910.109). Heating may cause violent combustion or explosion. May explosively decompose on shock, friction, or concussion. Reacts with ozone causing explosion hazard.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 9.29 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 0.2 ppm/2 mg/m^3 Ceiling Concentration [skin].
NIOSH REL: 0.1 mg/m^3 STEL [skin].
ACGIH TLV®[1]: 0.05 ppm/0.46 mg/m^3 [skin].
NIOSH IDLH: 75 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.1 ppm
PAC-2: 2 ppm
PAC-3: 75 ppm
DFG MAK: [skin] Carcinogen Category 3B.
Arab Republic of Egypt: TWA 0.02 ppm (0.2 mg/m^3), [skin], 1993; Australia: TWA 0.05 ppm (0.5 mg/m^3), [skin], 1993; Austria: MAK 0.05 ppm (0.5 mg/m^3), [skin], 1999; Belgium: TWA 0.05 ppm (0.46 mg/m^3), [skin], 1993; Denmark: TWA 0.02 ppm (0.2 mg/m^3), [skin], 1999; Finland: TWA 0.1 ppm (0.9 mg/m^3); STEL 0.3 ppm (3 mg/m^3), [skin], 1999; France: VME 0.1 ppm (1 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, [skin], 2003; Japan: STEL 0.05 ppm (0.46 mg/m^3), [skin], 1999; Norway: TWA 0.03 ppm (0.27 mg/m^3), 1999; the Philippines: TWA 0.2 ppm (2 mg/m^3), [skin], 1993; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 1 mg/m^3, 1999; Russia: STEL 0.5 ppm, 1993; Sweden: NGV 0.03 ppm (0.3 mg/m^3), KTV 0.1 ppm (0.9 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.5 mg/m^3), KZG-W 0.1 ppm (1 mg/m^3), [skin], 1999; Thailand: TWA 0.2 ppm (2 mg/m^3), 1993; Turkey: TWA 0.2 ppm (2 mg/m^3), [skin], 1993; United Kingdom: TWA 0.2 ppm (1.9 mg/m^3); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for nitroglycerin in ambient air[60] ranging from 1.67 μg/m^3 (Nevada) to 5.0 μg/m^3 (Florida, North Dakota and South Carolina) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2507. See also OSHA Analytical Method #43.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nitroglycerin can affect you when breathed and by passing through skin. Irritates the eyes. May affect the cardiovascular system and blood, causing lowered blood pressure, circulatory collapse, and interfere with the blood's ability to carry oxygen resulting in cyanosis, the formation of methemoglobin, trouble breathing, and even death. Exposure can cause headaches, nausea, and lightheadedness.

Long Term Exposure: After repeated exposure to nitroglycerin, a marked tolerance develops. Returning to work after a short absence from exposure can cause headaches and other symptoms, and may lead to sudden death. Angina (chest pain) and heart attacks can occur when exposure stops suddenly. Repeated or prolonged contact may cause skin sensitization and allergy.

Points of Attack: Cardiovascular system, blood, skin, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood plasma; complete blood count, electrocardiogram, EKG (immediately, if any chest discomfort is felt). Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #78-187 *Occupational Exposure to Nitroglycerin and Ethylene Glycol Dinitrate.*

Respirator Selection: NIOSH: *Up to 1 mg/m^3:* Sa (APF = 10) (any supplied-air respirator).* *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 5 mg/m^3:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or *SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 75 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Nitroglycerin must be stored to avoid contact with heat, flames, mechanical shock or ozone, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric). Sources of ignition, such as smoking and open flames, are prohibited where nitroglycerin is handled, used, or stored. Nitroglycerin has a special shipping regulation by DOT and therefore requires specific handling procedures. Metal containers involving the transfer of 5 gallons or more of nitroglycerin should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of nitroglycerin. Wherever nitroglycerin is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Nitroglycerin is often found mixed with ethylene glycol dinitrate. Also see entry on "Ethylene glycol dinitrate."

Shipping: Nitroglycerin, solution in alcohol, with >1% but not >5% nitroglycerin requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Nitroglycerin solution in alcohol with not >1% nitroglycerin requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Nitroglycerin, desensitized with not <40% nonvolatile, water-insoluble phlegmatizer, by mass. It falls in Hazard Class 1.1D (subsidiary hazard: 6.1) and Packing Group II.

Nitroglycerin, solution in alcohol, with >1% but not >10% nitrogylcerin falls in Hazard Class 1.1D.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Do not touch or disturb spilled material. Consult an expert trained for this kind of emergency. Do NOT wash away into sewer (extra personal protection: complete protective clothing including self-contained breathing apparatus). It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive and flammable liquid. In case of fire, evacuate area. Combustion in an enclosed space can result in explosion. Isolate area around fire and call for expert help. Consider letting fire burn. Poisonous gases, including nitrogen oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not wash into sewer. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 89−90

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Nitroglycerin*. Trenton, NJ

Nitromethane N:0520

Molecular Formula: CH_3NO_2

Synonyms: Methan, nitro-; Nitrocarbol

CAS Registry Number: 75-52-5

RTECS® Number: PA9800000

UN/NA & ERG Number: UN1261/129

EC Number: 200-876-6 [*Annex I Index No.:* 609-036-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (commercial grade).

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to* *humans*, Group 2B, 2000; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen;

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg).

Carcinogenicity: (New Jersey).

California Proposition 65 Chemical: Cancer 5/1/97.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R5; R10; R22; Safety phrases: S2; S41 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Nitromethane is a highly flammable and explosive colorless liquid with a strong, disagreeable odor. The odor threshold is below 200 ppm. Molecular weight = 671.05; Specific gravity (H_2O:1) = 1.14; Boiling point = 101.1°C; Freezing/Melting point = − 28.9°C; Vapor pressure = 28 mmHg at 20°C; Flash point = 35°C (cc); Autoignition temperature = 417°C. Explosive limits: LEL = 7.3%; UEL = 63%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 4 (Possible detonation). Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen. Nitromethane is used in the production of the fumigant, chloropicrin. It is best known as racing car fuel. It is also used as a solvent and as an intermediate in the pharmaceutical industry.

Incompatibilities: May explode from heat, shock, friction, or concussion. Reacts with alkalis, strong acids, metallic oxides. Detonates or reacts violently with strong oxidizers, strong reducing agents, formaldehyde, copper, copper alloys, lead, lead alloys, hydrocarbons, and other combustibles, causing fire and explosion hazard. Forms shock sensitive mixture when contaminated with acids, amines, bases, metal oxides, hydrocarbons, and other combustible materials.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.50 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/250 mg/m^3 TWA.

NIOSH REL: see *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV®[1]: 20 ppm/50 mg/m^3 TWA, confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 750 ppm.

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 60 ppm

PAC-2: 750 ppm

PAC-3: 750 ppm

DFG MAK: [skin] Carcinogen Category 3B.

Austria: MAK 100 ppm (250 mg/m^3), 1999; Denmark: TWA 100 ppm (250 mg/m^3), 1999; Finland: TWA 100 ppm (250 mg/m^3); STEL 150 ppm (375 mg/m^3), 1999; France: VME 100 ppm (250 mg/m^3), 1999; Norway: TWA 50 ppm (125 mg/m^3), 1999; the Philippines: TWA 100 ppm (250 mg/m^3), 1993; the Netherlands: MAC-TGG 50 mg/m^3, 2003; Sweden: NGV 20 ppm (50 mg/m^3), KTV 50 ppm (125 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (250 mg/m^3), 1999; Turkey: TWA 100 ppm (250 mg/m^3), 1993; United Kingdom: TWA 100 ppm (254 mg/m^3); STEL 150 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for nitromethane in ambient air[60] ranging from 2.5 mg/m^3 (North Dakota) to 4.0 mg/m^3 (Virginia) to 5.0 mg/m^3 (Connecticut) to 5.952 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2527, Nitromethane.

Permissible Concentration in Water: Russia[43] set a MAC of 0.005 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin and eyes on contact. Inhaling nitromethane irritates the nose and throat causing mild pulmonary irritation with coughing and wheezing. May affect the central nervous system, causing CNS depression, weakness, muscular incoordination, convulsions.

Long Term Exposure: Repeated or prolonged contact may cause dry and cracked skin. May affect or damage the peripheral nervous system. May cause kidney and liver damage. May cause anorexia, nausea, vomiting, and diarrhea.

Points of Attack: Eyes, skin, central nervous system, kidneys, liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber; Neoprene™, polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *750 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator and protect from heat, oxidizers, strong acids, strong bases, formaldehyde, amines, hydrocarbons, combustibles, metallic oxides, reducing agents, copper and its alloys, lead and its alloys, light. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well first with alcohol, then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Water may be ineffective. Alcohol foam is recommended.[17]

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes.[22]

References

National Institute for Occupational Safety and Health. (April 1978). *Information Profiles on Potential Occupational Hazards: Classes of Chemicals: Nitroparaffins*, NIOSH Publication No. TR-78-518. Rockville, MD. pp. 199−210

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Nitromethane*. Trenton, NJ

Nitrophenols N:0530

Molecular Formula: $C_6H_5NO_3$

Common Formula: $NO_2C_6H_4OH$

Synonyms: *(2-nitrophenol; o-isomer):* 2-Hydroxynitrobenzene; *o*-Nitrofenol (Spanish); *o*-Nitrophenol; Orthonitrophenol;

Phenol, *o*-nitro-; Phenol, 2-nitro- *(3-nitrophenol; m-isomer):* *m*-Hydroxynitrobenzene; 3-Hydroxynitrobenzene; *m*-Nitrofenol (Spanish); 3-Nitrophenol; Phenol, 3-nitro-
(4-nitrophenol; p-isomer): Degradation product of parathion; 4-Hydroxynitrobenzene; NCI-C55992; Niphen; *p*-Nitrofenol (Spanish); 4-Nitrofenol (Spanish); 4-Nitrophenol; Paranitrophenol (French, German); Phenol, *p*-nitro; Phenol, 4-nitro-; PNP

CAS Registry Number: 88-75-5 (2-nitrophenol; *o*-isomer); 554-84-7 (3-nitrophenol; *m*-isomer); 100-02-7 (4-nitrophenol; *p*-isomer); 25154-55-6 (mixed isomers)

RTECS® Number: SM2100000 (2-nitrophenol; *o*-isomer); SM1925000 (3-nitrophenol; *m*-isomer); SM2275000 (4-nitrophenol; *p*-isomer)

UN/NA & ERG Number: UN1663 (nitrophenols)/153

EC Number: 201-857-5 (2-nitrophenol); 209-073-5 (3-nitrophenol); 202-811-7 [*Annex I Index No.:* 609-015-00-2] (4-nitrophenol)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Mixed isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols.

Reportable Quantity (RQ): 100 lb (45.4 kg).

m-isomer:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols.

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, nitrophenols (*o-; m-; p-*).

p-isomer:

Carcinogenicity: NCI: Carcinogenesis Studies (derm); no evidence: mouse.

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion; Negative: Histidine reversion—Ames test; Inconclusive: Host-mediated assay.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U170.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), 29.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (10); 8270 (50).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

o-isomer:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations *(p-isomer)*: Hazard Symbol: Xn; Risk phrases: R20/21/22; R33; Safety phrases: S2; S28 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting *(p-isomer)*

Description: There are three isomers of nitrophenol. The isomer of greatest concern, and the subject of *ATSDR Toxicology Profile*, is the *p*-isomer (4-nitrophenol). The meta-form is produced from *m*-nitroaniline, and the *o*- and *p*-isomers are produced by nitration of phenol. They are colorless to slightly yellowish crystals with an aromatic to sweetish odor. Molecular weight = 139.12 (*p*-isomer); Boiling point = (*o*-isomer) 215°C; (*m*-isomer) 194°C; (*p*-isomer) 279°C (decomposes); Freezing/Melting point = (*p*-isomer) 113−115°C (sublimes); (*o*-isomer) 45°C; 97°C (*m*-isomer); Flash point = (*o*-, *m*-) 102°C; (*p*-isomer) 169°C; Autoignition temperature = (*p*-isomer) 283°C. NFPA 704 M Hazard Identification (*m*-, *o*-, *p*-): Health 3, Flammability 1, Reactivity 2. Not soluble in water.

Potential Exposure: Compound Description (*p*-isomer): Agricultural Chemical; Tumorigen, Mutagen. Nitrophenols are used as intermediates in production of dyes, photochemicals, pesticides, pharmaceuticals, and in leather tanning.

Incompatibilities: Nitrophenols are strong oxidizers. Reacts violently with combustible and reducing agents. Contact with potassium hydroxide forms an explosive mixture. May explode on heating.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

o-isomer and m-isomer

TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 150 mg/m^3

Protective Action Criteria (PAC)

p-isomer 100-02-7 and mixed isomers

TEEL-0: 6 mg/m^3
PAC-1: 20 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 75 mg/m^3

Russia set a MAC for 4-nitrophenols in ambient air in residential areas of 0.003 mg/m^3 on a once-daily basis. Guidelines for *p*-nitrophenol in ambient air[60] have been set by South Carolina at zero and by New York at 0.03 μg/m^3.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 230 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 4580 μg/L on an acute toxicity basis. *To protect humans:* 0.06 μg/L for 2- and 3-nitrophenol and 0.02 mg/L for 4-nitrophenol. In addition, guidelines for nitrophenols in drinking water have been set[61] by Maine at 83 μg/L and by Kansas at 290 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Percutaneous absorption of liquid.

Harmful Effects and Symptoms

Short Term Exposure: Nitrophenols can affect you when breathed in and by passing through your skin. Nitrophenols can irritate and burn the skin and eyes with possible eye damage. Vapors can cause irritation of the respiratory tract with coughing and/or shortness of breath. High levels of vapors may cause metabolism increase and rapid heartbeat. High levels can lower the ability of the blood to carry oxygen (methemoglobinemia), leading to cyanosis (a bluish color to the skin and lips), headaches, dizziness, and collapse. Higher levels can cause death. Exposure can cause headache, upset stomach, dizziness, weakness, confusion, fever, breathing trouble, a slow pulse, fall in blood pressure, convulsions (fits), and death.

Long Term Exposure: Nitrophenols may damage the kidney and liver. Nitrophenols can irritate the lungs; bronchitis may develop. High or repeated exposure may affect the nervous system.

Points of Attack: Liver, kidneys, blood.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: A blood test for methemoglobin level, liver function tests, kidney function tests, nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is recommended by a manufacturer and other authorities as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to nitrophenols, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Nitrophenols must be stored to avoid contact with reducing agents, oxidizers, combustibles, organic materials, and strong bases, since violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nitrophenols (*o-; m-; p-*) require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration—care must be taken to maintain complete combustion at all times. Incineration of large quantities may require scrubbers to control the emission of nitrogen oxides. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Nitrophenols*, Report No. PB-276, 678. Rockville, MD. pp. 212−226

US Environmental Protection Agency. (1980). *Nitrophenols: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *4-Nitrophenol: Health and Environmental Effects Profile No. 135*. Washington, DC: Office of Solid Waste

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Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 67−70 (1985) (2-Nitrophenol) and 1, No. 6, 89−90 (1981) and 6, No. 3, 63−66 (3-Nitrophenol) and 3, No. 3, 82−85 (1983) (4-Nitrophenol)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: 2-Nitrophenol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: 3-Nitrophenol*. Trenton, NJ

New Jersey Department of Health and Senior Services. (September 2004). *Hazardous Substances Fact Sheet: 4-Nitrophenol*. Trenton, NJ

1-Nitropropane N:0540

Molecular Formula: $C_3H_7NO_2$

Common Formula: $CH_3CH_2CH_2NO_2$

Synonyms: α-Nitropropane; Nitropropane; 1-Nitropropano (Spanish); 1-NP; Propane, 1-nitro-; Propane, nitro-

CAS Registry Number: 108-03-2

RTECS® Number: TZ5075000

UN/NA & ERG Number: UN2608/129

EC Number: 203-544-9 [*Annex I Index No.:* 609-001-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20/21/22; Safety phrases: S2; S9 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 1-Nitropropane is a colorless liquid with a mild, fruity odor. Odor threshold = 140 ppm. Molecular weight = 89.11; Specific gravity (H_2O:1) = 1.00; Boiling point = 131.7°C; Freezing/Melting point = − 107.8°C; Vapor pressure = 8 mmHg at 20°C; Flash point = 35.6°C (cc); Autoignition temperature = 421°C. Explosive limits: LEL = 2.2%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 2. Slightly soluble in water; solubility = 1%. *Note:* Technical products measurably contaminated with 2-Nitropropane.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. 1-Nitropropane is used as a solvent for polymers, as a stabilizer, and in organic synthesis. *Note:* Technical products measurably contaminated with 2-Nitropropane, see also “2-Nitropropane.”

Incompatibilities: 1-Nitropropane, a nitroparaffin is incompatible with reducing agents, nitrates, strong bases, amines, strong acids, oxidizers, hydrocarbons and other combustible materials, metal oxides. May explode on heating.

Permissible Exposure Limits in Air

OSHA PEL: 25 ppm/90 mg/m^3 TWA.

NIOSH REL: 25 ppm/90 mg/m^3 TWA.

ACGIH TLV®[1]: 25 ppm/91 mg/m^3 TWA, not classifiable as a human carcinogen.

NIOSH IDLH: 1000 ppm.

Temporary Emergency Exposure Limits (DOE)

TEEL-0: 25 ppm

PAC-1: 75 ppm

PAC-2: 125 ppm

PAC-3: 1000 ppm

DFG MAK: 25 ppm/92 mg/m^3 TWA; Peak Limitation Category I(4); Pregnancy Risk Group D.

Austria: MAK 25 ppm (90 mg/m^3), 1999; Denmark: TWA 5 ppm (18 mg/m^3), 1999; Finland: TWA 25 ppm (90 mg/m^3); STEL 40 ppm (150 mg/m^3), 1999; France: VME 25 ppm (90 mg/m^3), 1999; Norway: TWA 20 ppm (70 mg/m^3), 1999; the Philippines: TWA 25 ppm (90 mg/m^3), 1993; the Netherlands: MAC-TGG 90 mg/m^3, 2003; Switzerland: MAK-W 5 ppm (18 mg/m^3), carcinogen, 1999; Turkey: TWA 25 ppm (90 mg/m^3), 1993; United Kingdom: TWA 25 ppm (93 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for 1-nitropropane in ambient air[60] ranging from 0.3 mg/m^3 (New York) to 0.9 mg/m^3 (Florida and North Dakota) to 1.5 mg/m^3 (Virginia) to 1.8 mg/m^3 (Connecticut) to 2.143 mg/m^3 (Nevada) to 2.25 mg/m^3 (South Carolina).

Determination in Air: Use OSHA Analytical Method 46.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing, wheezing, and/or shortness of breath. High levels can interfere with the ability of the blood to carry oxygen (methemoglobinemia), causing cyanosis, headaches, fatigue, dizziness nausea, vomiting, diarrhea. Higher levels can cause collapse and death.

Long Term Exposure: In animals: liver, kidney damage.

Points of Attack: Eyes, central nervous system, liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber, Teflon™, and Silvershield™ are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 250 ppm:* Sa (APF = 10) (any supplied-air respirator).* *Up to 625 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 1000 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: 1-Nitropropane*. Trenton, NJ

2-Nitropropane N:0550

Molecular Formula: $C_3H_7NO_2$

Common Formula: $CH_3CH(NO_2)CH_3$

Synonyms: Dimethylnitromethane; Isonitropropane; Nipar S-20; Nipars-20 solvent; Nipar S-30 solvent; Nitroisopropane; β-Nitropropane; *sec*-Nitropropane; 2-Nitropropano (Spanish); 2-NP; Propane, 2-nitro-

CAS Registry Number: 79-46-9

RTECS® Number: TZ5250000

UN/NA & ERG Number: UN2608/129

EC Number: 201-209-1 [*Annex I Index No.*: 609-002-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U171.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R10; R20/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 2-Nitropropane is a colorless liquid. The odor threshold is 300 ppm. Molecular weight = 89.11; Specific gravity (H_2O:1) = 0.99; Boiling point = 120.5°C; Freezing/Melting point = −92.8°C; Vapor pressure: 13 mmHg at 20°C; Flash point = 23.9°C; Autoignition temperature = 428°C. Explosive limits: LEL = 2.6%; UEL = 11.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 2. Slightly soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. 2-Nitropropane is used as a solvent for polymers, organic compounds; cellulose, esters; gums, vinyl resins; waxes, epoxy resins, fats, dyes, and chlorinated rubber; as a stabilizer. Its combustion properties have made it useful as a rocket propellant and as a gasoline and diesel fuel additive. 2-Nitropropane also has limited use as a paint and varnish remover. It serves as an intermediate in organic synthesis of some pharmaceuticals, dyes, insecticides, and textile chemicals.

Incompatibilities: 1-Nitropropane, a nitroparaffinin, forms explosive mixture with air. Contact with heavy metal oxides may cause decomposition. Mixtures with hydrocarbons are extremely flammable. Attacks some plastics, rubber, and coatings. May explode on heating. Violent reaction with strong bases, strong acids, and metal oxides. Shock-sensitive compounds are formed with acids, amines, inorganic bases, and heavy metal oxides. Incompatible with strong oxidizers, combustible materials. 2-Nitropropane reacts with activated carbon causing decomposition. *This reaction may occur in activated carbon respirator filters.*

Permissible Exposure Limits in Air

OSHA PEL: 25 ppm/90 mg/m^3 TWA

NIOSH REL: A potential occupational carcinogen [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/36 ppm TWA, confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)
TEEL-0: 25 ppm
PAC-1: 25 ppm
PAC-2: 25 ppm
PAC-3: 100 ppm

DFG MAK: [skin] Carcinogen Category 2.

Austria carcinogen, 1999; Denmark: TWA 5 ppm (18 mg/m^3), 1999; France: carcinogen, 1993; Norway: TWA 10 ppm (35 mg/m^3), 1999; the Philippines: TWA 25 ppm (90 mg/m^3), 1993; Sweden: NGV 5 ppm (18 mg/m^3), TGV 10 ppm (35 mg/m^3), 1999; the Netherlands: MAC-TGG 0.036 mg/m^3, 2003; Turkey: TWA 25 ppm (90 mg/m^3), 1993; United Kingdom: TWA 5 ppm (19 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Brazil[35] has set a TWA of 20 ppm (70 mg/m^3). Several states have set guidelines or standards for 2-nitropropane in ambient air[60] ranging from zero in North Dakota to 0.2 μg/m^3 (Rhode Island) to 21.67 μg/m^3 (Pennsylvania) to 350 μg/m^3 (Virginia) to 360 μg/m^3 (Connecticut) to 2143 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2528; OSHA Analytical Method 46 (which supercedes Method 15).

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.9$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The vapor irritates the eyes and respiratory tract. 2-Nitropropane can affect you when breathed in. 2-Nitropropane may cause mutations. Handle with extreme caution. Exposure can cause headaches, dizziness, nausea, vomiting, and diarrhea. At levels, causing these symptoms, severe liver damage can occur that can cause death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may also damage the kidneys, heart, and may interfere with the ability of the blood to carry oxygen (methemoglobinemia); this can cause weakness, trouble breathing and cyanosis, a bluish color to the skin and lips. Exposure to high levels may cause liver damage. Exposure to very high levels may result in death.

Long Term Exposure: May affect the liver, kidneys, heart, and nervous system. Based on animal tests, this chemical is a potential occupational carcinogen. Animal tests show that this substance may cause mutations and affect human reproduction.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys, liver, heart. Cancer site in animals: liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber and polyvinyl chloride are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Nitropropane must be stored to avoid contact with strong bases and strong acids (such as hydrochloric, sulfuric, and nitric) and metal oxides, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 2-nitropropane. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes.[22] Dilute with pure kerosene and burn with care as it is potentially explosive. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (September 27, 1977). *Chemical Hazard Information Profile: 2-Nitropropane*. Washington, DC

National Institute for Occupational Safety and Health. (April 1978). *Information Profiles on Potential Occupational Hazards: Classes of Chemicals: Nitroparaffins*. NIOSH Publication No. RT 78-518. Rockville, MD. pp. 199−210

National Institute for Occupational Safety and Health. (April 25, 1977). *2-Nitropropane*, *Current Intelligence Bulletin No. 17*. Rockville, MD

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 58−59 (1982) and 4, No. 1, 92−94 (1984)

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: 2-Nitropropane*. Trenton, NJ

N-Nitrosodi-*n*-butylamine N:0560

Molecular Formula: $C_8H_{18}N_{20}$

Synonyms: 1-Butanamine, *n*-butyl-*N*-nitroso-; Butylamine, *N*-nitrosodi-; *n*-Butyl-*N*-nitroso-1-butamine; DBN; DBNA; Dibutylamine, *N*-nitroso-; Di-*n*-butylnitrosamin (German); *N*,*N*-Di-*n*-butylnitrosamine; Di-*n*-butylnitrosamine; Dibutylnitrosamine; *N*,*N*-Dibutylnitrosoamine; NDBA; *N*-Nitroso-di-*n*-butylamine; Nitrosodibutylamine

CAS Registry Number: 924-16-3

RTECS® Number: EJ4025000

UN/NA & ERG Number: UN3082/171

EC Number: 213-101-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Insufficient Evidence*, possibly carcinogenic to humans*, Group 2B, 1978; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U172.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 17.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitrosodi-*n*-butylamine is a yellow, oily liquid. Molecular weight = 158.28; Boiling point = 235°C; 116°C at 14 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: This chemical is a carcinogenic nitrosamine. It is primarily used in research.

Incompatibilities: Light sensitive.

Permissible Exposure Limits in Air

DFG MAK: [skin] Carcinogen Category 2.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 27.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin and respiratory tract. Some related nitrosamines can cause headaches, abdominal cramps, weakness, and dizziness. It is unknown if this chemical causes all of these same symptoms.

Long Term Exposure: May be a human carcinogen; causes urinary bladder, esophagus, and liver cancer in animals. This chemical is toxic to the fetus and causes fetal death in animals. Repeated exposure may cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations.

Reference

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: N-nitrosodi-N-butylamine*. Trenton, NJ

***N*-Nitrosodiethylamine N:0570**

Molecular Formula: $C_4H_{10}N_2O$

Synonyms: DANA; DEN; DENA; Diaethylnitrosamin (German); Diethylamine, *N*-nitroso-; Diethylnitrosamide; Diethylnitrosamine; *N*,*N*-Diethylnitrosoamine; Diethylnitrosoamine; Ethanamine, *n*-ethyl-*N*-nitroso-; *n*-Ethyl-*N*-nitrosoethanamine; NDEA; *N*-Nitrosodiaethylamin (German); *N*-Nitroso-*N*,*N*-diethylamine; Nitrosodiethylamine; *N*-Nitrosodietilamina (Spanish)

CAS Registry Number: 55-18-5

RTECS® Number: IA3500000

UN/NA & ERG Number: UN3082/171

EC Number: 200-226-1

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Insufficient Evidence, Group 2A, 1998; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat 1975.

US EPA Hazardous Waste Number (RCRA No.): U174.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitrosodiethylamine is a yellow liquid. Molecular weight = 102.16; Boiling point = 177°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: An additive in gasoline and lubricants; an antioxidant and stabilizer in plastics. Used in research.

Incompatibilities: Oxidizers, reducing agents (may form hydrazine), hydrogen bromide. Light sensitive; rapidly decomposes.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] Carcinogen Category 2.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 27.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin and eyes. The vapors cause respiratory tract irritation.

Long Term Exposure: Potential human carcinogen.

Prolonged or repeated exposure may cause liver damage. May damage the developing fetus.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Plastic, latex, or Neoprene™ gloves may be effective protection. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area away from light, oxidizers, reducing agents, hydrogen bromide. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: N-Nitrosodiethylamine*. Trenton, NJ

N-Nitrosodimethylamine N:0580

Molecular Formula: $C_2H_6N_2O$

Common Formula: $(CH_3)_2NN = O$

Synonyms: Dimethylamine, *N*-nitroso-; Dimethylnitrosamin (German); Dimethylnitrosamine; *N*,*N*-Dimethylnitrosoamine;

DMN; DMNA; Methanamine, *n*-methyl-*N*-nitroso-; *n*-Methyl-*N*-nitrosomethan amine; NDMA; *N*-Nitroso-*N*,*N*-dimethylamine; Nitrosodimethylamine; *N*-Nitrosodimetilamina (Spanish)

CAS Registry Number: 62-75-9

RTECS® Number: IQ0525000

UN/NA & ERG Number: UN2810/153

EC Number: 200-549-8 [*Annex I Index No.:* 612-077-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human No Adequate Data, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; OSHA: Potential human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: Host-mediated assay; L5178Y cells *in vitro*—TK test; Positive: Mammalian micronucleus; *N. crassa*—forward mutation; Positive: *N. crassa*—reversion; *E. coli* polA with S9; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *In vitro* UDS in rat liver; V79 cell culture-gene mutation; Positive: TRP reversion; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—forward mutation; *S. cerevisiae*—homozygosis; Positive: *S. pombe*—forward mutation; Positive/dose response: *In vitro* cytogenetics—nonhuman; Positive/dose response: *In vitro* SCE—nonhuman; *In vivo* SCE—nonhuman; Positive/dose response: *In vitro* UDS—human fibroblast; Negative: Cytogenetics—male germ cell; Sperm morphology—mouse; Negative: UDS in mouse germ cells; Inconclusive: SHE—clonal assay; Cell transform.—RLV F344 rat embryo; Inconclusive: Rodent dominant lethal; Mouse spot test; Inconclusive: *E. coli* polA without S9; Positive: CHO gene mutation.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1016).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P082.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 2.3.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/87.

California Proposition 65 Chemical: Cancer (methylhydrazine and its salts) 7/1/92.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R45; R25; R26; R48/25; R51/53; Safety phrases: S48/25; S51/53; S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: N-Nitrosodimethylamine is a yellow oily liquid with a faint, characteristic odor. Molecular weight = 74.10; Boiling point = 152°C; Flash point = 61°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Nitrosodimethylamine was formerly used in the production of rocket fuels. Presently used as an antioxidant, as an additive for lubricants, and as a softener of copolymers. It is used as an intermediate for 1,1-dimethylhydrazine.

Incompatibilities: Oxidants, especially peracids. Sensitive to UV light. Should be stored in dark bottles.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposure of workers to this chemical is to be controlled through the required use of engineering controls, work practice, and personal protective equipment, including respirators. See 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration.

ACGIH TLV®[1]: Exposures by all routes should be carefully controlled to levels as low as possible [skin]. Confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 19 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: [skin] Carcinogen Category 2

Austria: carcinogen, 1999; France: carcinogen, 1993; Switzerland: MAK-W 0.001 mg/m^3, carcinogen, 1999; United Kingdom: carcinogen, 2000; the Netherlands: MAC-TGG 0.001 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Methods 6 and 27.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5850 μg/L on an acute toxicity basis for nitrosamines as a class. *To protect saltwater aquatic life:* 3,300,000 μg/L on an acute toxicity basis for nitrosamines as a class. For protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.014 μg/L.[6] The states of Kansas and Minnesota have set guidelines for DMNA in drinking water[61], Kansas at 0.0014 μg/L and Minnesota at 0.014 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with nitrogen−phosphorus or reductive Hall detectors (EPA Method 607); or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Symptoms of exposure include nausea, vomiting, and malaise. Extremely high toxicity. The lowest lethal oral dose in humans has been reported at 10 mg/kg/80 week intermittent exposure.

Long Term Exposure: Chronic exposure may cause liver disease with jaundice and swelling with low platelet count and cirrhosis. The effects may be delayed. Based on animal tests, this substance may be a potential carcinogen in humans.

Points of Attack: Liver.

Medical Surveillance: OSHA mandates the following tests: *increased risk*: reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking. NIOSH lists the tests: *increased risk*: reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking, liver function tests, pulmonary function tests. Based on human experience and on animal studies, preplacement and periodic examinations should include a history of exposure to other carcinogens, alcohol and smoking habits, medications, and family history. Special attention should be given to liver size and function, and to any changes in lung symptoms or X-rays. Renal function should be followed. Sputum and urine cytology may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for because the symptoms of jaundice may be delayed. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus). See also Appendix E *NIOSH Pocket Guide*.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator in brown bottles, and protect from oxidizers and prolonged exposure to light. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic, liquids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." *N*-Nitrosodimethylamine falls in DOT Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in celite, vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour over soda ash, neutralize with HCl, then flush to drain with large volumes of water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: N-Nitroso Compounds.* Washington, DC

US Environmental Protection Agency. (1980). *Nitrosamines: Ambient Water Quality Criteria.* Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Dimethylnitrosamine: Health and Environmental Effects Profile No. 86*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 50−51 (1980) and 2, No. 6, 65−69 (1982)

US Public Health Service. (December 1988). *Toxicological Profile for N-Nitrosodimethylamine.* Atlanta, GA: Agency for Toxic Substances and Disease Registry

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: N-Nitrosodimethylamine*. Washington, DC: Chemical Emergency Preparedness Program

***N*-Nitrosodiphenylamine N:0590**

Molecular Formula: $C_{12}H_{10}N_2O$
Common Formula: $C_6H_5N(NO)C_6H_5$
Synonyms: Benzenamine, *N*-nitroso-*N*-phenyl-; Curetard A; Delac J; Diphenylamine, *N*-nitrosoamine; Diphenylnitrosamin (German); *N*,*N*-Diphenylnitrosamine; Diphenylnitrosamine; *N*,*N*-Diphenyl-*N*-nitrosoamine; NCI-C02880; NDPA; NDPHA; *N*-Nitrosodifenilamina (Spanish); *N*-Nitroso-*N*-diphenylamine; Nitrosodiphenylamine; *N*-Nitroso-*N*-phenylaniline; Nitrous diphenylamide; Redax; Retarder J; TJB; Valcatard; Vulcalent A; Vulcatard A; Vultrol
CAS Registry Number: 86-30-6
RTECS® Number: JJ9800000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 201-663-0
Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; Cell transform.—RLV F344 rat embryo; Positive/limited: Carcinogenicity—mouse/rat; Negative: Cell transform.—BALB/c-3T3; Host-mediated assay; Negative: *E. coli* polA with S9; Histidine reversion—Ames test; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast; Negative: *In vitro* UDS in rat liver; V79 cell culture—gene mutation; Negative: *S. cerevisiae*—homozygosis; Inconclusive: L5178Y cells *In vitro*—TK test; Mammalian micronucleus; Inconclusive: *E. coli* polA without S9; *In vitro* SCE—nonhuman; Inconclusive: *D. melanogaster* sex-linked lethal.

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA Land Ban Waste.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.92; Nonwastewater (mg/kg), 13.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 4/1/88.

As nitrosamines:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *N*-Nitrosodiphenylamine is a yellow to orange-brown crystalline solid. Molecular weight = 198.24; Boiling point = 268°C (estimated); Freezing/Melting point = 67°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. *N*-Nitrosodiphenylamine is not a naturally occurring substance; it is a man-made chemical that is no longer produced in the United States. It was used in the manufacture of plastics, resins, rubber, and synthetic textiles to help control processes involved in making rubber products, such as tires and mechanical goods; however, in the early 1980s, the US manufacturers stopped producing *N*-nitrosodiphenylamine because new and more efficient chemicals were found to replace its uses. In addition, the use of *N*-nitrosodiphenylamine had several undesirable side effects which do not occur with the replacement chemicals.

Incompatibilities: Oxidizing materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 7.5 mg/m^3
PAC-1: 25 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: Carcinogen Category 3 B.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use OSHA Analytical Method 23.

Permissible Concentration in Water: Russia set a MAC of 0.1 mg/L in surface water. Two states have set guidelines for nitrosodiphenylamine in drinking water.[60] They are Kansas at 71.0 μg/L, and Minnesota at 71.1 μg/L.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Information is not available regarding effects of brief exposures to *N*-nitrosodiphenylamine on human health. Very little is known about the health effects of brief exposures to *N*-nitrosodiphenylamine in experimental animals, other than that relatively high doses by ingestion are required to produce death. It is not known if exposure to *N*-nitrosodiphenylamine by breathing or skin contact can affect the health of humans or animals, but ingestion of *N*-nitrosodiphenylamine has been shown to have adverse health effects in animals. Exposure of humans to *N*-nitrosodiphenylamine should be minimized.

Long Term Exposure: Long-term exposure of experimental animals to *N*-nitrosodiphenylamine by ingestion produced inflammation and cancer of the bladder. It is not known whether these effects or birth defects would occur in humans if they were exposed to *N*-nitrosodiphenylamine.

Points of Attack: Cancer site in animals: bladder.

Medical Surveillance: Although the presence of the chemical in blood and urine can be detected by chemical analysis, this analysis has not been used as a test for human exposure or to predict potential health effects.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52] *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere for prolonged storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep[52]: remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent paper dampened with 60−70% acetone to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Burn in admixture with flammable solvent in furnace equipped with afterburner and scrubber.[22]

References

US Public Health Service. (October 1987). *Toxicological Profile for Nitrosodiphenylamine.* Atlanta, GA: Agency for Toxic Substances & Disease Registry

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: N-Nitrosodiphenylamine*. Trenton, NJ

p-Nitrosodiphenylamine N:0600

Molecular Formula: $C_{12}H_{10}N_2O$

Synonyms: Benzenamine, 4-nitroso-*N*-phenyl-; Diphenylamine, 4-nitroso-; Naugard TKB; NCI-C02244; *p*-Nitrosodifenilamina (Spanish); 4-Nitrosodiphenylamine; *p*-Nitroso-*N*-phenylaniline; 4-Nitroso-*N*-phenylaniline; *p*-Phenylaminonitrosobenzene; *N*-Phenyl-*p*-nitrosoaniline; TKB

CAS Registry Number: 156-10-5

RTECS® Number: JK0175000

UN/NA & ERG Number: UN3077/171

EC Number: 205-848-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Insufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1982, 1998.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 1/1/88.

European labeling: Hazard symbol: Xn (Harmful); Possible carcinogen; Risk Phrases: R40; Safety Phrases: S36/37; S45; S53 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: TKB is a black powder or a green plate-like material with a bluish luster. Molecular weight = 198.2; Freezing/Melting point = 145°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a chemical intermediate for dyes and pharmaceuticals, in making monomers, and vulcanizing rubber.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 150 mg/m^3

This chemical is a potential occupational carcinogen and all exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 27.

Permissible Concentration in Water: Russia set a MAC of 0.1 mg/L in surface water. Two states have set guidelines for nitrosodiphenylamine in drinking water.[60] They are Kansas at 71.0 μg/L and Minnesota at 71.1 μg/L.

Routes of Entry: Inhalation, ingestion, skin and/or eyes. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye irritation.

Long Term Exposure: There is limited evidence that this chemical causes bladder cancer in animals.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This material may be classed as an Environmentally hazardous solid, n.o.s. It falls in Hazard Class 9 and "CLASS 9." Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: p-Nitrosodiphenylamine*. Trenton, NJ

N-Nitrosodipropylamine N:0610

Molecular Formula: $C_6H_{14}N_2O$

Common Formula: $C_3H_7N(NO)C_3H_7$

Synonyms: Dipropylamine, *N*-nitroso-; Di-*N*-propylnitrosamine; Dipropylnitrosamine; DPN; DPNA; NDPA; *N*-Nitroso-*N*-dipropylamine; *N*-Nitrosodipropylamine; Nitrosodipropylamine; *N*-Nitroso-*N*-propylpropanamine; 1-Propanamine, *N*-nitroso-*N*-propyl-

CAS Registry Number: 621-64-7

RTECS® Number: JL9700000

UN/NA & ERG Number: UN3082/171

EC Number: 210-698-0 [*Annex I Index No.:* 612-098-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Insufficient Evidence*, possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; Cell transform.—RLV F344 rat embryo; Positive/limited: Carcinogenicity—mouse/rat; Negative: Cell transform.—BALB/c-3T3; Host-mediated assay; Negative: *E. coli* polA with S9; Histidine reversion—Ames test; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast; Negative: *In vitro* UDS in rat liver; V79 cell culture-gene mutation; Negative: *S. cerevisiae*—homozygosis; Inconclusive: L5178Y cells *In vitro*-TK test; Mammalian micronucleus; Inconclusive: *E. coli* polA without S9; *In* *vitro* SCE—nonhuman; Inconclusive: *D. melanogaster* sex-linked lethal.

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U111.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 14.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

As nitrosamines:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R51/53; Safety phrases: S53; S45; S61.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-nitrosodi-*N*-propylamine is a yellow liquid. Molecular weight = 198.24; Boiling point = 206°C; Freezing/Melting point = 144°C. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. *N*-nitrosodi-*N*-propylamine is used in the manufacture of plastics, resins, rubber, and synthetic textiles. There is no evidence that *N*-nitrosodi-*N*-propylamine exists naturally in soil, air, food, or water. Small quantities of *N*-nitrosodi-*N*-propylamine are inadvertently produced during some manufacturing processes as an impurity in some commercially available dinitroaniline based weed killers, and during the manufacture of some rubber products. However, according to Sax, some similar *N*-nitroso compounds are formed in the environment and absorbed from precursors in food, water, or air, from tobacco, and from naturally occurring compounds.

Incompatibilities: Oxidizers. Sensitive to UV light.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.06 mg/m^3

PAC-1: 0.2 mg/m^3

PAC-2: 1.25 mg/m^3

PAC-3: 200 mg/m^3

DFG MAK: [skin] Carcinogen Category 2.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use OSHA Analytical Method 23.

Routes of Entry: *N*-nitrosodi-*N*-propylamine can enter the body by breathing air that contains *N*-nitrosodi-*N*-propylamine or by eating food or drinking water contaminated with *N*-nitrosodi-*N*-propylamine. *N*-Nitrosodi-*N*-propylamine is not likely to get into your body unless you eat certain foods or drink alcoholic beverages, or are exposed to it at a waste disposal site by breathing *N*-nitrosodi-*N*-propylamine vapors. It is not known whether *N*-nitrosodi-*N*-propylamine can enter the body by direct skin contact with wastes, pesticides, or soil containing *N*-nitrosodi-*N*-propylamine. Experiments with animals suggest that if *N*-nitrosodi-*N*-propylamine enters the body, it will be broken down into other compounds and will leave the body in the urine.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. The effects of brief or long-term exposures to *N*-nitrosodi-*N*-propylamine on human health have not been studied in depth. Little is known about the health effects of brief exposures to *N*-nitrosodi-*N*-propylamine in experimental animals except that eating or drinking certain amounts of this chemical can cause liver disease and death.

Long Term Exposure: Long-term exposure of experimental animals to *N*-nitrosodi-*N*-propylamine in food or drinking water produces cancer of the liver, esophagus, and nasal cavities. Although human studies are not available, the animal evidence indicates that it is reasonable to expect that exposure to *N*-nitrosodi-*N*-propylamine by eating or drinking could cause liver disease and cancer in humans. It is not known whether other effects, such as birth defects, occur in animals or could occur in humans if they were exposed to *N*-nitrosodi-*N*-propylamine by eating or drinking.

Points of Attack: Liver.

Medical Surveillance: The presence of *N*-nitrosodi-*N*-propylamine in blood and urine can be detected by chemical analysis, but this analysis is not routinely available and has not been used as a test for human exposure or to predict potential health effects. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *N*-Nitrosodi-*N*-propylamine may be destroyed by high temperature incineration in an incinerator equipped with a nitrogen oxide scrubber. Chemical treatment methods may also be used to destroy *N*-nitrosodi-*N*-propylamine. These methods involve (a) denitrosation by reaction with 3% hydrobromic acid in glacial acetic acid; (b) oxidation by reaction with potassium permanganate-sulfuric acid; or (c) extraction of the nitrosamine from the waste using dichloromethane and subsequent reaction with triethyloxonium tetrafluoroborate (TOEF). Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Public Health Service. (December 1988). *Toxicological Profile for N-nitroso-di-N-Propylamine*. Atlanta, GA: Agency for Toxic Substances & Disease Registry

New Jersey Department of Health and Senior Services. (December 2006). *Hazardous Substances Fact Sheet: N-Nitrosodi-N-Phenylamine*. Trenton, NJ

N-Nitroso-*N*-ethyl urea N:0620

Molecular Formula: $C_3H_7N_3O_2$

Synonyms: AENH (German); Aethylnitroso-harnstoff (German); ENU; *N*-Ethyl-*N*-nitrosocarbamide; *N*-Ethyl-*N*-nitrosourea; 1-Ethyl-1-nitrosourea; Ethyl-1-nitrosourea; Ethylnitrosourea; NEU; Nitrosoethylurea; NSC 45403; Urea, *N*-ethyl-*N*-nitroso-; Urea, 1-ethyl-1-nitroso-

CAS Registry Number: 759-73-9

RTECS® Number: YT3150000

UN/NA & ERG Number: UN3077/171

EC Number: 212-072-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1998; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U176.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/87.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitroso-*N*-ethyl urea is a pale yellow, crystalline powder; Freezing/Melting point = 103−104°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used as an anti-cancer drug.

Possible Exposure Limits in Air:

DFG MAK: [skin]

No OELs have been established. However this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause irritation of the eyes and skin. Inhalation can cause respiratory tract irritation. Higher exposure can cause headache, drowsiness, fatigue, weakness, and loss of appetite.

Long Term Exposure: A potential occupational carcinogen. This chemical has been shown to be a teratogen in animals. High or repeated exposure may cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. A Class I, Type B, biological safety hood should be used for handling and mixing in a laboratory environment. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. See 21CFR210.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer this material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Environmentally hazardous substances, solid, n.o.s. It falls in Hazard Class 9 and “CLASS 9.” Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: N-Nitroso-N-Ethylurea*. Trenton, NJ

N-Nitrosomethylvinylamine N:0630

Molecular Formula: $C_3H_6N_2O$

Synonyms: Ethenamine, *N*-methyl-*N*-nitroso-; Ethylene, *N*-methyl-*N*-nitroso-; *N*-Methyl-*N*-nitrosovinylamine; Methylvinylnitrosamine; Methylvinylnitrosamine (German); MVNA; *N*-nitroso-*N*-methylvinyl amine; NMVA; Vinylamine, *N*-methyl-*N*-nitroso-

CAS Registry Number: 4549-40-0

RTECS® Number: YZ0875000

UN/NA & ERG Number: UN3082/171

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): P084.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitrosomethylvinylamine is a yellow liquid. Molecular weight = 86.11. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Decomposes in water.

Potential Exposure: This chemical is not manufactured but occurs as a chemical reaction byproduct found in the dye, automotive, rubber, and leather industries.

Incompatibilities: Strong oxidizers, light.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin].

There are no established numerical OELs. However this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: T-Sorb; Methanol/CH_2C_{l2}; Gas chromatography/Flame ionization detection; NIOSH IV; Method #2522. See also OSHA Analytical Method #27.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skins. Some related nitrosamines can cause headaches, abdominal cramps, weakness, and dizziness. It is unknown if this chemical causes all of these same symptoms.

Long Term Exposure: A potential occupational carcinogen. Has been shown to be a teratogen in animals. May cause liver and kidney damage.

Points of Attack: Liver and kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F

(APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. However, storage is not likely. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, light. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: N-Nitrosomethylvinylamine*. Trenton, NJ

N-Nitrosopiperidine N:0640

Molecular Formula: $C_5H_{10}N_2O$

Synonyms: Hexahydro-*N*-nitrosopyridine; Nitrosopiperidin (German); 1-Nitrosopiperidine; N.N-PIP; No-PIP; NPIP; Piperidine, 1-nitroso

CAS Registry Number: 100-75-4

RTECS® Number: TN2100000

UN/NA & ERG Number: UN3082/171

EC Number: 202-886-6

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U179.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.013; Nonwastewater (mg/kg), 35.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitrosopiperidine is a clear, yellow, oily liquid. Molecular weight = 114.17; Boiling point = 217°C; Flash point = 93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: It is found in some foods and tobacco smoke. Used as a research chemical.

Incompatibilities: Oxidizers. Light may cause decomposition.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] Carcinogen Category 2.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 27.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Can irritate and may cause permanent damage to the eyes; inflammation in the pigmented area and damage to the cornea with clouded patches of vision.

Long Term Exposure: A potential carcinogen. Prolonged exposure may cause liver damage.

Points of Attack: Eyes, liver.

Medical Surveillance: Examination of the eyes. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations.

Reference

New Jersey Department of Health and Senior Services. (March 2006). *Hazardous Substances Fact Sheet: N-Nitrosopiperidine*. Trenton, NJ

N-Nitrosopyrrolidine N:0650

Molecular Formula: $C_4H_8N_2O$

Synonyms: *N*-Nitrosopyrrolidin (German); 1-Nitrosopyrrolidine; N-N-PYR; No-PYR; NPYR; Tetrahydro-*N*-nitrosopyrrole

CAS Registry Number: 930-55-2

RTECS® Number: UY1575000

UN/NA & ERG Number: UN3082/171

EC Number: 213-218-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Hazardous Waste Number (RCRA No.): U180.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.013; Nonwastewater (mg/kg), 35.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 10/1/87.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-Nitrosopyrrolidine is a yellow liquid. Molecular weight = 100.14; Boiling point = 105°C at 20 mmHg; Flash point = 83°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: *N*-Nitrosopyrrolidine is a research chemical.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

No TEEL available.

DFG MAK: [skin] Carcinogen Category 2.

There are no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 27.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the skin and eyes.

Long Term Exposure: A potential occupational carcinogen. May cause damage to the liver and kidneys.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: N-Nitrosopyrrolidine*. Trenton, NJ

Nitrotoluenes N:0660

Molecular Formula: $C_7H_7NO_2$

Common Formula: $CH_3C_6H_4NO_2$

Synonyms: *m-isomer:* Benzene, 1-methyl-3-nitro-; *m*-Nitrotoluene; *m*-Methylnitrobenzene; 3-Methylnitrobenzene; MNT; 3-Nitrotoluene; Nitrotoluene, 3-; *m*-Nitrotolueno (Spanish); 3-Nitrotoluol

Mixed isomers: Mixo-nitrotoluene

ortho-isomer: Benzene, 1-methyl-2-nitro-; *o*-Methylnitrobenzene; 2-Methylnitrobenzene; 2-Nitrotoluene; Nitrotoluene, 2-; *o*-Nitrotolueno (Spanish); *o*-Nitrotoluol; ONT; Orthonitrotoluene

California Proposition 65 Chemical: Cancer 5/15/98

para-isomer: Benzene, 1-methyl-4-nitro-; *p*-Methylnitrobenzene; 4-Methylnitrobenzene; NCI-C60537; 4-Nitrotoluene; Nitrotoluene, 4-; *p*-Nitrotolueno (Spanish); *p*-Nitrotoluol; 4-Nitrotoluol; *p*-Nitrotoluene; PNT

CAS Registry Number: 88-72-2 (*o*-isomer); *(alt.)* 57158-05-1; 99-08-1 (*m*-isomer); 99-99-0 (*p*-isomer); 1321-12-6 (mixed isomers)

RTECS® Number: XT3150000 (*o*-isomer); XT2975000 (*m*-isomer); XT3325000 (*p*-isomer)

UN/NA & ERG Number: UN1664/152

EC Number: 201-853-3 [*Annex I Index No.:* 609-065-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: (*m*-isomer) IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996; NTP; NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat;

NTP: Carcinogenesis studies; on test (2-year studies), October 2000; (*p*-isomer) IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996; NCI: Carcinogenesis Studies (feed); equivocal evidence: rat; test completed (peer review), October 2000.

NTP: Toxicity studies, (all isomers) Report No: TOX-23, October 2000; (*o*-isomer) Report No: TOX-44, October 2000.

All isomers:

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% all isomers.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R46; R22; R62; R51/53; Safety phrases: S51/53 S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*o*-isomer); 2—Water polluting (*m*- and *p*-isomers).

Description: Nitrotoluene is formed in 3 isomeric forms. The *o*- and *m*- forms are yellow liquids or solids. The *p*-form is a pale yellow crystalline solid. All have weak aromatic odors. The odor thresholds are 0.05 mg/L (*o*-isomer); 1.74 ppm (*m*-isomer). Molecular weight = 137.15 (all isomers); Specific gravity (H_2O:1) = 1.16 (all isomer); Boiling point = 222°C (*o*-isomer); 232°C (*m*-isomer); 238° (*p*-isomer); Freezing/Melting point = − 4°C (*o*-isomer); 16°C (*m*-isomer); 52°C (*p*-isomer); Vapor pressure = 0.1 mmHg (all isomers); Flash point = 101−106°C (all isomers). Explosive limits: LEL = 2.2; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): (*o*-, *p*-) Health 3, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description (all isomers): Tumorigen, Mutagen; Reproductive Effector. The nitrotoluenes are used in the production of toluidines and other dye intermediates. All isomers are used in manufacture of agriculture and rubber chemicals and in various dyes.

Incompatibilities: Decomposes on contact with strong oxidizers, strong acids, reducing agents, strong bases, ammonia, amines producing toxic fumes, causing fire and explosion hazard. Heat above 190°C may cause explosive decomposition. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.61 mg/m^3 (all isomers) at 25°C & 1 atm.

m-isomer

OSHA PEL: 5 ppm/30 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/11 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/11 mg/m^3 TWA [skin]; BEI$_M$ issued for Methemoglobin inducers.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 40 ppm

PAC-3: 200 ppm

NIOSH IDLH: 200 ppm

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 2 ppm (11 mg/m^3), [skin], 1993; Austria: MAK 2 ppm (11 mg/m^3), [skin], 1999; Belgium: TWA 2 ppm (11 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (12 mg/m^3), 1999; France: VME 2 ppm (11 mg/m^3), [skin], 1999; Norway: TWA 1 ppm (5.5 mg/m^3), 1999; Poland: MAC (TWA) 3 mg/m^3; MAC (STEL) 9 mg/m^3, 1999; the Netherlands: MAC-TGG 6 mg/m^3, [skin], 2003; Switzerland: MAK-W 2 ppm (11 mg/m^3), KZG-W 4 ppm (22 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (29 mg/m^3); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin].

o-isomer

OSHA PEL: 5 ppm/30 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/11 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/11 mg/m^3 TWA [skin]; BEI$_M$ issued for Methemoglobin inducers.

NIOSH IDLH: 200 ppm.

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 2 ppm (11 mg/m^3), [skin], 1993; Austria: MAK 2 ppm (11 mg/m^3), [skin], 1999; Belgium: TWA 2 ppm (11 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (12 mg/m^3), 1999; Norway: TWA 1 ppm (5.5 mg/m^3), 1999; Sweden: NGV 1 ppm (6 mg/m^3), KTV 2 ppm (11 mg/m^3), [skin], 1999; Switzerland: [skin], carcinogen, 1999; United Kingdom: TWA 5 ppm (29 mg/m^3); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin].

p-isomer

OSHA PEL: 5 ppm/30 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/11 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 2 ppm/11 mg/m^3 TWA [skin]; BEI$_M$ issued for Methemoglobin inducers.

DFG MAK: [skin] Carcinogen Category 3B.

NIOSH IDLH: 200 ppm.

Australia: TWA 2 ppm (11 mg/m^3), [skin], 1993; Austria: MAK 2 ppm (11 mg/m^3), [skin], 1999; Belgium: TWA 2 ppm (11 mg/m^3), [skin], 1993; Denmark: TWA 2 ppm (12 mg/m^3), 1999; Norway: TWA 1 ppm (5.5 mg/m^3), 1999; Poland: MAC (TWA) 3 mg/m^3; MAC (STEL) 9 mg/m^3, 1999; Sweden: NGV 1 ppm (6 mg/m^3), KTV 2 ppm (11 mg/m^3), [skin], 1999; Switzerland: MAK-W 2 ppm (11 mg/m^3), KZG-W 4 ppm (22 mg/m^3), [skin], 1999; United Kingdom: TWA 5 ppm (29 mg/m^3); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm [skin]. In addition, Several states have set guidelines or standards for *p*-nitrotoluene in ambient air[60] ranging from 5.5 μg/m^3 (South Carolina) to 36.7 μg/m^3 (New York) to 110.0 μg/m^3 (Florida). Further, Several states have set guidelines or standards for *m*-nitrotoluene in ambient air[60] ranging from 37.0 μg/m^3 (New York) to 110.0 μg/m^3 (North Dakota) to 220.0 μg/m^3 (Connecticut) to 262.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2005, Nitrobenzenes.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 414 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.3-2.5$ (all isomers).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. Exposure can cause headache, flushing of the skin, rapid heartbeat, nausea, vomiting, weakness, irritability, convulsions, coma, and death. High levels may affect the blood, causing formation of methemoglobinemia. Symptoms include anoxia, cyanosis, headache, weakness, dizziness, ataxia, dyspnea (breathing difficulty), tachycardia, vomiting.

Long Term Exposure: May damage the liver, kidneys, and blood; anemia may develop. May cause damage to the testes.

Points of Attack: Blood, skin, gastrointestinal tract, cardiovascular system, central nervous system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests (all isomers): whole blood (chemical/metabolite), Methemoglobin, complete blood count, urinalysis (chemical/metabolite). Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For *p*-nitrotoluene, Butyl rubber and polycarbonate are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *20 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBA (any self-contained breathing apparatus). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *100 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from combustibles, reducing agents, strong oxidants, strong bases, strong acids. Where possible, automatically transfer materials from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nitrotoluenes, *liquid* (*o*-; *m*-; *p*-) require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II. Nitrotoluenes, *solid* (*m*- or *p*-) require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. With the solid (*p*-isomer) isomer, dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Solid:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. *Liquid:* This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration—care must be taken to maintain complete combustion at all times. Incineration of large quantities may require scrubbers to control the emission of nitrogen oxides.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Nitrotoluenes*, Report PB-276-678. Rockville, MD. pp. 227−240

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 85−88 (*p*-Nitrotoluene)

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Nitrotoluenes*. Trenton, NJ

5-Nitro-*o*-toluidine N:0670

Molecular Formula: $C_7H_8N_2O_2$

Synonyms: AI3-01557; Amarthol fast scarlet G base; Amarthol fast scarlet G salt; 1-Amino-2-methyl-5-nitrobenzene; 2-Amino-4-nitrotoluene; Azoene fast scarlet GC base; Azoene fast scarlet GC salt; Azofix scarlet G salt; Azogene fast scarlet G; Azoic diazo component 12; Benzenamine, 2-methyl-5-nitro-; C.I. 37105; C.I. azoic diazo component 12; Dainichi fast scarlet G base; Daito scarlet base G; Devol scarlet B; Devol scarlet G salt; Diabase scarlet G; Diazo fast scarlet G; Fast red SG base; Fast scarlet base G; Fast scarlet base J; Fast scarlet G; Fast scarlet G base; Fast scarlet GC base; Fast scarlet G salt; Fast scarlet J salt; Fast scarlet M 4NT base; Fast scarlet T base; Hiltonil fast scarlet G base; Hiltonil fast scarlet GC base; Hiltonil fast scarlet G salt; Kayaku scarlet G base; Lake scarlet G base; Lithosol orange R base; 2-Methyl-5-nitroaniline; 6-Methyl-3-nitroaniline; 2-Methyl-5-nitrobenzenamine; 2-Methyl-5-nitrobenzeneamine; Mitsui scarlet G base; Naphthanil scarlet G base; Naphtoelan fast scarlet G base; Naphtoelan fast scarlet

G salt; NCI-C01843; 4-Nitro-2-aminotoluene; 3-Nitro-6-methylaniline; 5-Nitro-2-methylaniline; *p*-Nitro-*o*-toluidina (Spanish); *p*-Nitro-*o*-toluidine; 5-Nitro-2-toluidine; NSC 8947; PNOT; scarlet base Ciba II; scarlet base IRGA II; scarlet base NSP; scarlet G base; Sugai fast scarlet G base; Symulon scarlet G base; *o*-Toluidine, 5-nitro-

CAS Registry Number: 99-55-8

RTECS*® *Number: XU8225000

UN/NA & ERG Number: UN2660/153

EC Number: 202-765-8 [*Annex I Index No.*: 612-210-00-5]

Regulatory Authority and Advisory Bodies

IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3.

US EPA Hazardous Waste Number (RCRA No.): U181.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 28.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/24/25; R40; 52/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 5-Nitro-*o*-toluidine is a yellow, crystalline solid. Molecular weight = 152.17; Freezing/Melting point = 107°C.

Incompatibilities: Oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 1 mg/m^3 inhalable fraction TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 250 mg/m^3

DFG MAK: Carcinogen Category 2

Determination in Air: Use NIOSH Analytical Method (IV) #2005, Nitrobenzenes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may irritate the skin and eyes. High levels of exposure may interfere with the blood's ability to carry oxygen (methemoglobinemia) causing headache, fatigue, dizziness, and cyanosis (a blue color to the skin and lips). Higher levels can cause trouble breathing, collapse, and death.

Long Term Exposure: There is limited evidence that this chemical causes liver cancer in animals.

Points of Attack: Liver, blood.

Medical Surveillance: Blood methemoglobin levels. Complete blood count (CBC). Liver function disease.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Nitrotoluidines (mono) require a label of “POISONOUS/TOXIC MATERIALS.” They fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, alcohol foam, or polymer foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: 5-Nitro-o-toluidine*. Trenton, NJ

Nitrous oxide N:0680

Molecular Formula: N_2O

Synonyms: Dinitrogen monoxide; Factitious air; Hyponitrous acid anhydride; Laughing gas; Nitrogen Oxide

CAS Registry Number: 10024-97-2

RTECS® Number: QX1350000

UN/NA & ERG Number: UN1070 (compressed)/122; UN2201 (refrigerated liquid)/122

EC Number: 233-032-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: V79 cell culture—gene mutation; Negative: Sperm morphology—mouse; Inconclusive: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

California Proposition 65 Developmental/Reproductive toxin 8/1/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Nitrous oxide is a colorless gas with a slightly sweet odor. Shipped as a liquefied compressed gas. Molecular weight = 44.02; Boiling point = −88°C; Freezing/Melting point = −91.1°C; Relative density of the vapor/air mixture (air = 1) = 1.53 at 20°C; Vapor pressure = 51.3 atm. Slightly soluble in water; solubility = 0.1% at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data. Used as an anesthetic in dentistry and surgery, as a gas in food aerosols, such as whipped cream, in the manufacture of nitrites, in rocket fuels, firefighting, and diesel emissions. Large amounts of nitrous oxide will decrease the amount of available oxygen. Oxygen should be routinely tested to ensure that it is at least 19% by volume.

Incompatibilities: Violent reactions with organic peroxides, hydrazine, hydrogen, hydrogen sulfide, lithium, boron, lithium hydride, sodium, aluminum, phosphine. This chemical is a strong oxidizer above 300°C and self-explodes at high temperature. May form explosive mixtures with ammonia, carbon monoxide, hydrogen sulphide, oil, grease and fuels.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.80 mg/m^3 at 25°C & 1 atm.

OSHA PEL: none.

NIOSH REL: 25 ppm/46 mg/m^3 TWA over the time exposed; [*Note:* REL for exposure to waste anesthetic gas].

ACGIH TLV®[1]: 50 ppm TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 50 ppm

PAC-1: 150 ppm

PAC-2: 10,000 ppm

PAC-3: 20,000 ppm

DFG MAK: 100 ppm/180 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Denmark: TWA 50 ppm (90 mg/m^3), 1999; Finland: TWA 100 ppm, 1999; Norway: TWA 100 ppm (180 mg/m^3), 1999; Sweden: NGV 100 ppm (180 mg/m^3), KTV 500 ppm (900 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (200 mg/m^3), KZG-W 200 ppm (400 mg/m^3), 1999; United Kingdom: TWA 100 ppm (183 mg/m^3), 2000; the Netherlands: MAC-TGG 152 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The recommended ACGIH TLV is 50 ppm. Connecticut[60] has set a guideline for nitrous oxide in ambient air of 1.34 mg/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #6600, Nitrous oxide; OSHA Analytical Methods ID-166.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause dizziness and difficult breathing. Excessive exposure may cause headaches, nausea, fatigue, and irritability. Loss of consciousness may result from exposure to concentrations of 400,000−800,000 ppm. Anesthetic grades are composed of 80% nitrous oxide with 20% oxygen. High concentrations may cause a deficiency of oxygen in the air. *Skin, Eyes:* Liquid may cause frostbite and freezing burns. Vapors are nonirritating. *Ingestion:* Liquid may cause frostbite and freezing burns of the mouth and throat.

Long Term Exposure: Increased incidence of liver and kidney disease, neurological disease, and spontaneous abortion have been reported. Nitrous oxide has been shown to cause birth defects in rats. Repeated exposure can damage the nervous system, causing numbness and weakness in the arms and legs. May damage the bone marrow and affect blood cell production. May be a teratogen in humans.

Points of Attack: Respiratory system, central nervous system, blood, reproductive system.

Medical Surveillance: Before beginning employment and regular times after that, for those with frequent or potentially high exposures, the following is recommended: examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: consider nerve conduction studies, complete blood count (CBC), examination of the nervous system. Check the work-place air to make certain that the oxygen level is at least 19%.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to nitrous oxide is dangerous because it can replace oxygen and lead to suffocation. Where there is potential for exposure *over 25 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/ MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Nitrous oxide must be stored to avoid contact with organic peroxides, ammonia, carbon monoxide, hydrogen, hydrogen sulfide, and phosphine, since violent reactions occur. Cylinders of nitrous oxide should be stored in a cool, preferably fire-resistant area, away from heat sources.

Shipping: Nitrous oxide requires a shipping label of "NONFLAMMABLE GAS, OXIDIZER." Nitrous oxide, *refrigerated liquid*, requires a shipping label of "NONFLAMMABLE GAS." Both fall in DOT Hazard Class 2.2.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place and repair leak or allow cylinder to empty. If flow cannot be stopped, allow it to flow into a mixture of caustic soda and slaked lime and dispose of the resulting material in a hood. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nitrous oxide is an oxidizer and will increase the intensity of any fire. Nitrous oxide self-explodes at high temperature. Extinguish fire using an agent suitable for type of surrounding fire. Nitrous oxide itself does not burn. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disperse in atmosphere or spray on dry soda ash/lime with great care; then flush to sewer.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 66−67

New Jersey Department of Health and Senior Services. (September 2004). *Hazardous Substances Fact Sheet: Nitrous Oxide*. Trenton, NJ

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Nitrous Oxide*. Albany, NY: Bureau of Toxic Substance Assessment

Nonane N:0685

Molecular Formula: C_9H_{20}
Common Formula: $CH_3(CH_2)_7CH_3$
Synonyms: *N*.Nonane; Nonyl hydride; Shellsol 140
CAS Registry Number: 111-84-2
RTECS® Number: RA6115000
UN/NA & ERG Number: UN1920/128
EC Number: 203-913-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Nonane is a colorless liquid. Odor threshold = 47 ppm. Molecular weight = 128.29; Specific gravity (H_2O:1) = 0.72; Boiling point = 150.6°C; Freezing/Melting point = −51°C; Vapor pressure 3 mmHg at 20°C; Flash point = 31°C; Autoignition temperature = 205°C. Explosive limits: LEL = 0.8%; UEL = 2.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Drug, Primary Irritant. Nonane is used in the synthesis of biodegradable detergents as a distillation chaser and as an ingredient in Stoddard solvent and gasoline.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.25 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 200 ppm/1050 mg/m^3 TWA.

ACGIH TLV®[1]: 200 ppm TWA.

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 200 ppm

PAC-2: 350 ppm

PAC-3: 350 ppm

Denmark: TWA 200 ppm (1050 mg/m^3), 1999; Finland: TWA 200 ppm (1050 mg/m^3); STEL 250 ppm (1315 mg/m^3), 1999; France: VME 200 ppm (1050 mg/m^3), 1999; Japan: 200 ppm (1050 mg/m^3), 1999; Norway: TWA 100 ppm (525 mg/m^3), 1999; Sweden: NGV 150 ppm (800 mg/m^3), KTV 200 ppm (1100 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (1050 mg/m^3), 1999; the Netherlands: MAC-TGG 1050 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 200 ppm. Several states have set guidelines or standards for nonane in ambient air[60] ranging from 10.5−13.0 mg/m^3 (North Dakota) to 17.5 mg/m^3 (Virginia) to 21.0 mg/m^3 (Connecticut) to 25.0 mg/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nonane can affect you when breathed in. Narcotic at high concentrations; may affect the central nervous system. Exposure to high levels can cause headache, drowsiness, dizziness, confusion, nausea, tremor, lack of coordination, and unconsciousness. Irritates the eyes, skin, respiratory tract. Swallowing the liquid may cause chemical pneumonitis.

Long Term Exposure: Prolonged contact can cause drying and cracking of the skin. Repeated exposure can affect the liver.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Respirator Selection: Where there is potential for exposures *over 200 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with an organic vapor cartridge/canister. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where nonane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of nonane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Wherever nonane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Use only nonsparking tools and equipment, especially when opening and closing containers of nonane.

Shipping: Nonanes require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*. NIOSH Document No. 77-151. Washington, DC

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Nonane*. Trenton, NJ

Nonyl trichlorosilane N:0690

Molecular Formula: $C_9H_{19}Cl_3Si$

Common Formula: $C_9H_{19}SiCl_3$

Synonyms: Silane, nonyltrichloro-; Silane, trichlorononyl-; Trichlorononylsilane

CAS Registry Number: 5283-67-0

RTECS® Number: VV4660000

UN/NA & ERG Number: UN1799/156

EC Number: 226-113-7

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Nonyl trichlorosilane is a clear fuming liquid with an irritating odor. Molecular weight = 261.73. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Reacts with water.

Potential Exposure: Used in silicone (polysiloxane) manufacture.

Incompatibilities: Chlorosilanes can self-ignite in air. They react with water or steam, producing heat and fumes of HCl. Forms a self-igniting compound with ammonia.

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.60** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Nonyl trichlorosilane can affect you when breathed in. Nonyl trichlorosilane is a corrosive chemical and can cause severe eye burns leading to permanent damage. Contact can cause severe skin burns. Exposure can irritate the eyes, nose, and throat. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause lung irritation; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to nonyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard

EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood, paper, or oil.

Shipping: Nonyl trichlorosilane requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.0/1.5

Fire Extinguishing: Nonyl trichlorosilane may burn but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers. Poisonous gases, including hydrogen chloride and chlorine, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Nonyl Trichlorosilane*. Trenton, NJ

Norbormide N:0700

Molecular Formula: $C_{33}H_{25}N_3O_3$

Synonyms: Compound S-6,999; ENT 51,762; 5 (α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norborene-2,3-dicarboxide; MCN 1025; Norbormida (Spanish); Raticate®; Raticide®; S-6,999; Shoxin

CAS Registry Number: 991-42-4

RTECS® Number: RB8750000

UN/NA & ERG Number: UN2588/151

EC Number: 213-589-6 [*Annex I Index No.:* 650-004-00-7]

Regulatory Authority and Advisory Bodies

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Norbormide is a white crystalline powder. Molecular weight = 511.61; Freezing/Melting point = 190−198°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used as a selective rat poison.

Incompatibilities: Alkalis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.75 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 3.8 mg/m^3
PAC-3: 3.8 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Moderately to highly toxic to humans. Probable human lethal dose is 50−500 mg/kg, or 1 teaspoon to 1 pint for a 150-lb person. Exposure may cause a transient decrease in temperature and blood pressure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small wet spills:* Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be treated with alkali and then landfilled. Large amounts should be incinerated.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Norbormide.* Washington, DC: Chemical Emergency Preparedness Program

O

Octafluorocyclobutane O:0100

Molecular Formula: C_4F_8
Synonyms: Cyclobutane, cyclooctafluorobutane; Freon C-318®; Octafluoro-; Perfluorocyclobutane
CAS Registry Number: 115-25-3
RTECS® Number: GU1779500
UN/NA & ERG Number: UN1976/126
EC Number: 204-075-2
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Octafluorocyclobutane is a colorless gas. Molecular weight = 200.03; Boiling point = −6°C; Freezing/Melting point = −41°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble (slight hydrolysis).
Potential Exposure: This material is used as a refrigerant.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 25,000 ppm
PAC-1: 65,000 ppm
PAC-2: 230,000 ppm
PAC-3: 300,000 ppm
Routes of Entry: Inhalation, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Octafluorocyclobutane can affect you when inhaled. Inhalation can irritate the lungs, causing coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause death.
Long Term Exposure: Similar chemicals can cause irregular heartbeat, which could lead to death. Highly irritating chemicals may affect the lungs; may cause bronchitis and lung damage.
Points of Attack: Lungs, heart.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: special 24-h EKG (Holter Monitor) to look for irregular heartbeat. Consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures to octafluorocyclobutane, use NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with the full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potential high heat sources. Protect cylinders from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.
Shipping: This compound requires a shipping label of "NONFLAMMABLE GAS." Octafluorocyclobutane falls in DOT Hazard Class 2.2.
Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00014-X

Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Octafluorocyclobutane itself does not burn. Poisonous gases, including fluorine, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Octafluorocyclobutane*. Trenton, NJ

Octamethyl diphosphoramide O:0110

Molecular Formula: $C_8H_{24}N_4O_3P_2$

Common Formula: $C_8H_{24}N_4P_2O_3$

Synonyms: Bis(bisdimethylamino)phosphonousanhydride; Bis(bisdimethylaminophosphonous)anhydride; Bis-bisdimethylaminophosphonous anhydride; Bis(bisdimethylamino) phosphoric anhydride; Bis-*N*,*N*,*N*′,*N*′-tetramethylphosphorodiamidic anhydride; Diphosphoramide, octamethyl-; ENT 17,291; Letha laire G-59; Octamethyl-diphosphorsaeuretetramid (German); Octamethylpyrophosphoramide; Octamethyl pyrophosphortetramide; Octamethyl tetramido pyrophosphate; Octametilpirofosforamida (Spanish); OMPA; Ompacide; Ompatox; Ompax; Pestox; Pestox 3; Pestox III; Pyrophosphoric acid octamethyltetraamide; Pyrophosphorytetrakisdimethylamide; Schradan; Schradane (French); Systam; Systophos; Sytam; Tetrakisdimethylaminophosphonous anhydride; Tetrakisdimethylaminophosphoric anhydride

CAS Registry Number: 152-16-9

RTECS® Number: UX5950000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 205-801-0 [*Annex I Index No.*: 015-026-00-8]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (in agriculture) (Russia, USA) (UN).[13]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA Hazardous Waste Number (RCRA No.): P085.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+; Risk phrases: R27/28; Safety phrases: S1/2; S36/37; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: OMPA is a dark brown viscous liquid. Molecular weight = 286.30; Boiling point = 120−125°C at 0.5 mmHg; Freezing/Melting point = 14−20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Material is used as a systemic insecticide for plants and as an acaricide. Not registered as a pesticide in the United States.

Incompatibilities: Acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.15 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 0.8 mg/m^3

PAC-3: 3.5 mg/m^3

Russia[35, 43] set a MAC of 0.02 mg/m^3 in work-place air and a MAC of 0.002 mg/m^3 for ambient air in residential areas on a momentary basis and 0.0004 mg/m^3 on an average daily basis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Acute exposure to OMPA may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) and chest pain may be noted. Hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea, respiratory depression, and respiratory paralysis. Psychosis may occur. This material is extremely toxic; probable oral lethal dose in humans is 5−50 mg/kg, between 7 drops and

1 teaspoonful for a 150-lb person. It is highly toxic when inhaled. Material is a cholinesterase inhibitor. It is similar in action to other organophosphorus pesticides in its toxicity. It is slightly less toxic than parathion. Gastrointestinal, neurologic, and respiratory symptoms may accompany poisoning with this material. High doses may cause a toxic psychosis similar to acute alcoholism.

Note: Persons taking the following drugs may be at greater risk: Phenobarbital and phenaglycodol together; glutethimide, chlorpromazine hydrochloride; or mepromabate. These drugs appear to enhance the toxicity of the material markedly.

Long Term Exposure: A cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Note to physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash; pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: This chemical is technically Organophosphorus pesticides, liquid, toxic; its effects are very similar and requires a shipping label of "POISONOUS/TOXIC MATERIALS." This falls in DOT Hazard Class 6.1 and Packing Group I.

Spill Handling: Use water spray to knock down vapors. Attempt to stop leak if it can be done without hazard. Avoid breathing vapors. Keep upwind. Avoid bodily contact with material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they

must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Poisonous gases, including nitrogen oxides and potassium oxides, are produced in fire. Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use alcohol foam, carbon dioxide, or dry chemical. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Octamethyl Phosphoramide*. Washington, DC: Chemical Emergency Preparedness Program

Octane O:0120

Molecular Formula: C_8H_{18}

Synonyms: n-Octane; normal-Octane

CAS Registry Number: 111-65-9 (n-); 540-84-1 (iso-)

RTECS® Number: RG8400000

UN/NA & ERG Number: UN1262/128

EC Number: (*n*-) 203-892-1 [*Annex I Index No.:* 601-009-00-8]; (*iso*-) 208-759-1[*Annex I Index No.:* 601-009-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (*isooctane; oral*): Inadequate Information to assess carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (n- and *iso*-): Hazard Symbol: F, Xn, N; Risk phrases: R11; R38; R65; R67; R50/53; Safety phrases: S2; S9; S16; S29; S33; S60; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*octane and isomers*).

Description: Octane is a colorless liquid with a gasoline-like odor. The odor threshold is 4 ppm[41] and 48 ppm (New Jersey Fact Sheet). Molecular weight = 114.26; Specific gravity (H_2O:1) = 0.70; Boiling point = 125.6°C; Freezing/Melting point = −56.7°C; Vapor pressure = 10 mmHg at 20°C; Flash point = 13°C (cc); Autoignition temperature = 206°C. Explosive limits: LEL = 1.0%; UEL = 6.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 7×10^{-5}.

Potential Exposure: Octane is used as a solvent; as a fuel; as an intermediate in organic synthesis; and in azeotropic distillations.

Incompatibilities: Reacts with strong oxidizers, causing fire and explosion hazard. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.67 mg/m^3 at 25°C & 1 atm.

OSHA PEL (*n-octane only*): 500 ppm/2350 mg/m^3 TWA; *Construction Industry:* 400 ppm/1900 mg/m^3 TWA.

NIOSH REL (*n-octane only*): 75 ppm/350 mg/m^3 TWA; 385 ppm/1800 mg/m^3 [15-min] Ceiling Concentration.

ACGIH TLV®[1] (*all isomers*): 300 ppm/1401 mg/m^3 TWA.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)

n-isomer

TEEL-0: 300 ppm
PAC-1: 300 ppm
PAC-2: 385 ppm
PAC-3: 1000 ppm

iso-isomer

TEEL-0: 300 ppm
PAC-1: 300 ppm
PAC-2: 300 ppm
PAC-3: 1000 ppm

DFG MAK (*n-isomer*): 500 ppm/2400 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Australia: TWA 300 ppm (1450 mg/m^3); STEL 375 ppm, 1993; Austria: MAK 300 ppm (1400 mg/m^3), 1999; Belgium: TWA 300 ppm (1400 mg/m^3); STEL 375 ppm (1750 mg/m^3), 1993; Denmark: TWA 200 ppm (935 mg/m^3), 1999; Finland: TWA 300 ppm (1400 mg/m^3); STEL 375 ppm (1750 mg/m^3), 1999; France: VME 300 ppm (1450 mg/m^3), 1999; Japan: 300 ppm (1400 mg/m^3), 1999; the Netherlands: MAC-TGG 1450 mg/m^3, 2003; Norway: TWA 150 ppm (725 mg/m^3), 1999; the Philippines: TWA 500 ppm

(2350 mg/m^3), 1993; Poland: MAC (TWA) 1000 mg/m^3; MAC (STEL) 1800 mg/m^3, 1999; Russia: TWA 300 ppm, 1993; Sweden: NGV 200 ppm (900 mg/m^3), KTV 300 ppm (1400 mg/m^3), 1999; Switzerland: MAK-W 300 ppm (1400 mg/m^3), KZG-W 600 ppm (2800 mg/m^3), 1999; Turkey: TWA 400 ppm (1900 mg/m^3), 1993; United Kingdom: LTEL 300 ppm (1450 mg/m^3); STEL 375 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 300 ppm. Several states have set guidelines or standards for octane in ambient air[60] ranging from 7.0 mg/m^3 (Connecticut) to 14.5−18.0 mg/m^3 (North Dakota) to 24.0 mg/m^3 (Virginia) to 34.524 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for Hydrocarbons, BP 36-126°C; #2549, Volatile organic compounds; OSHA Analytical Method 7.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 4.5$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Octane can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Skin contact can cause rash and a burning sensation. Swallowing the liquid may cause aspiration into the lungs and chemical pneumonitis. Exposure to high concentrations of vapor can cause lightheadedness, dizziness, confusion, and may cause you to pass out.

Long Term Exposure: Repeated or prolonged contact can result in dry, cracked skin.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do NOT induce vomiting. Give victim nothing to drink.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, Nitrile/PVC, and Nitrile are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 750 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 1000 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Octane must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where octane is used, handled, or stored. Metal containers used in the transfer of 5 gallons or more of octane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of octane.

Shipping: Octanes require a shipping label of "FLAMMABLE LIQUID." It falls in DOT Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Document No. 77-151. Washington, DC

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Octane*. Trenton, NJ

Octyl phenol O:0130

Molecular Formula: $C_{14}H_{22}O$
Common Formula: $C_8H_{17}C_6H_4OH$
Synonyms: Diisobutyl phenol
CAS Registry Number: 1322-69-6; 27193-28-8
RTECS® Number: SM5775000
EC Number: 248-310-7

Regulatory Authority and Advisory Bodies

FDA: 21CFR§175.105

WGK (German Aquatic Hazard Class): No value assigned.

Description: Octyl phenol is a white to pink crystalline solid. Molecular weight = 206.36; Boiling point = 280−302°C; Freezing/Melting point = 72−74°C; Flash point = about 149°C. Insoluble in water.

Potential Exposure: As a fuel oil stabilizer; as an intermediate for resins; in fungicides, bactericides, dyestuffs, adhesives, antioxidants, nonionic surfactants; in plasticizers and rubber; in adhesives; and in food packaging.

Incompatibilities: Oxidizers, such as chlorine and dichromate.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to lungs and throat. *Skin:* May cause irritation. *Eyes:* May cause severe irritation. *Ingestion:* Moderately toxic; may cause digestive upset. LD_{50} = (ip-mouse) 25 mg/kg.

Long Term Exposure: May cause liver and/or kidney damage. May be a mutagenic.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a

full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Will ignite at about 149°C. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Octyl Phenol*. Albany, NY: Bureau of Toxic Substance Assessment

Osmium & Osmium tetroxide O:0140

Molecular Formula: Os; O_4Os

Synonyms: Milas' reagent; Osmic acid anhydride; Osmium oxide (OsO_4); Osmium(IV) oxide; Tetroxido de osmio (Spanish)

CAS Registry Number: 7440-04-2 (elemental); 20816-12-0 (tetroxide)

RTECS® Number: RN1100000 (elemental); RN1140000 (tetroxide)

UN/NA & ERG Number: UN2471 (tetroxide)/154

EC Number: 231-114-0; 244-058-7 [*Annex I Index No.:* 076-001-00-5] (tetroxide)

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program (*tetroxide*), Positive: *B. subtilis* rec assay; Inconclusive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: Dropped From Listing In 1988.

US EPA Hazardous Waste Number (RCRA No.): P087.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (tetroxide).

European/International Regulations (*tetroxide*): Hazard Symbol: T+, N; Risk phrases: R26/27/28; R34; Safety phrases: S1/2; S7/9; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent. (metal); no value assigned to the tetroxide.

Description: Osmium is a blue-white metal. It is found in platinum ores and in the naturally occurring alloy osmiridium. Osmium when heated in air or when the finely divided form is exposed to air at room temperature, oxidizes to form the tetroxide (OsO_4), osmic acid.

Osmium tetraoxide is a colorless, crystalline solid or pale-yellow mass with an unpleasant, acrid, chlorine-like odor. A liquid above 41°C. Odor threshold = 0.0019 ppm. Molecular weight = 190.20; 254.20 (OsO_4); Specific gravity (H_2O:1) = 5.10 (OsO_4); Boiling point = 130°C (sublimes well below the BP) (OsO_4); Freezing/Melting point = 41°C (OsO_4); Vapor pressure = 7 mmHg at 20°C (OsO_4). Slightly soluble in water; solubility = 6% at 25°C (OsO_4). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3 (Oxidizer).

Potential Exposure: Compound Description (tetroxide): Drug, Mutagen; Reproductive Effector; Human Data. Osmium may be alloyed with platinum metals, iron, cobalt, and nickel, and it forms compounds with tin and zinc. The alloy with iridium is used in the manufacture of fountain pen points, engraving tool, record player needles, electrical contacts, compass needles, fine machine bearings, and parts for watch and lock mechanisms. The metal is a catalyst in the synthesis of ammonia and in the dehydrogenation of organic compounds. It is also used as a stain for histological examination of tissues. Osmium tetroxide is used as an oxidizing agent, catalyst, and as a fixative for tissues in electron microscopy. Other osmium compounds find use in photography. Osmium no longer is used in incandescent lights or in fingerprinting.

Incompatibilities: Osmium tetroxide is a strong oxidizer. Reacts with combustibles and reducing materials. Reacts with hydrochloric acid to form toxic chlorine gas. Forms unstable compounds with alkalis.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.40 mg/m^3 (tetroxide) at 25°C & 1 atm.

OSHA PEL: 0.002 mg[Os]/m^3 TWA.

NIOSH REL: 0.0002 ppm/0.002 mg[Os]/m^3 TWA; 0.006 mg[Os]/m^3/0.0006 ppm STEL.

ACGIH TLV®[1]: 0.0002 ppm/0.0016 mg[Os]/m^3 TWA; 0.0047 mg[Os]/m^3/0.0006 ppm STEL.

NIOSH IDLH: 1 mg[Os]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.25 mg/m^3
PAC-1: 0.75 mg/m^3
PAC-2: 6 mg/m^3
PAC-3: 30 mg/m^3

Tetroxide

TEEL-0: 0.0002 ppm
PAC-1: 0.0006 ppm
PAC-2: 0.0084 ppm
PAC-3: 4 ppm

Arab Republic of Egypt: TWA 0.0002 ppm (0.002 mg[Os]/m^3), 1993; Australia: TWA 0.0002 ppm (0.002 mg[Os]/m^3); STEL 0.0006 ppm, 1993; Austria: MAK 0.0002 ppm (0.002 mg[Os]/m^3), 1999; Belgium: TWA 0.0002 ppm (0.0016 mg[Os]/m^3); STEL 0.0006 ppm, 1993; Denmark: TWA 0.0002 ppm (0.002 mg[Os]/m^3), 1999; Finland: TWA 0.0002 mg[Os]/m^3; STEL 0.002 mg[Os]/m^3, 1999; France: VME 0.0002 ppm (0.002 mg[Os]/m^3), 1999; the Netherlands: MAC-TGG 0.002 mg[Os]/m^3, 2003; Norway: TWA 0.0002 ppm (0.002 mg[Os]/m^3), 1999; the Philippines: TWA 0.002 mg[Os]/m^3, 1993; Switzerland: MAK-W 0.0002 ppm (0.002 mg[Os]/m^3), KZG-W 0.0004 ppm, 1999; United Kingdom: TWA 0.0002 ppm (0.002 mg[Os]/m^3); STEL 0.0006 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.0006 (Os) ppm. There is presently no PEL for elemental, metallic osmium. Several states have set guidelines or standards for osmium tetroxide in ambient air[60] ranging from zero in North Dakota to 0.04 μg/m^3 (Connecticut) to 1.0 μg/m^3 (Nevada) to 3000 μg/m^3 (Virginia).

Determination in Air: No NIOSH Analytical Method available.

Determination in Water: Osmium tetraoxide may be hazardous to the environment; crustacea, in particular, may be at risk.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Osmium metal is innocuous, but persons engaged in the production of the metal may be exposed to acids and chlorine vapors. By contrast, osmium tetroxide vapors are poisonous and extremely irritating to the eyes; even in low concentrations they may cause weeping and persistent conjunctivitis. Longer exposure can cause redness, swelling of the eye tissue, blurred vision, and may result in damage to the cornea and permanent loss of vision. Contact with skin may cause discoloration (green or black), dermatitis and ulceration. *Inhalation*: fumes are extremely irritating to the respiratory system, causing tracheitis, bronchitis, bronchial spasm, and difficulty in breathing which may last several hours. Longer exposures can cause serious inflammatory lesions of the lungs (bronchopneumonia with suppuration and gangrene). Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure to high concentrations may result in death. Slight kidney damage was seen in rabbits inhaling lethal concentrations of vapor for 30 min. Some fatty degeneration of renal tubules was seen in one fatal human case along with bronchopneumonia following an accidental overexposure.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the kidneys. Repeated exposure may cause lung irritation; bronchitis may develop. There is limited evidence that osmium tetroxide may cause mutations.

Points of Attack: Eyes, respiratory system, lungs, skin, kidneys.

Medical Surveillance: Consider the skin, eyes, respiratory tract, and renal function in preplacement or periodic examinations. Lung function tests. Complete eye examination. Urinalysis. Chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give nothing to drink. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Avoid all contact. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 mg/m^3:* CcrFS100 (APF = 50) [Any air-purifying full-face-piece respirator equipped with cartridge(s) providing protection against the compound of concern in combination with an N100, R100, or P100 filter] or GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1 mg/m^3*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison (*osmium tetroxide*): Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store refrigerated in tightly closed containers away from hydrochloric acid, reducing agents and easily oxidized materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Osmium tetroxide requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Osmium tetraoxide may burn but does not easily ignite. *Small fires:* dry chemical, carbon dioxide, water spray, or foam extinguishers. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Contact with easily oxidized organic materials may cause fires and explosions. Poisonous gases, including osmium, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (Oct. 31, 1985). *Chemical Hazard Information Profile: Osmium Tetroxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Osmium Tetroxide*. Trenton, NJ

Ouabain O:0150

Molecular Formula: $C_{29}H_{44}O_{12}$
Synonyms: Acocantherin; Astrobain; Gratibain; Gratus strophanthin; G-Strophanthin; Ouabagenin-l-rhamnosid (German); Ouabaine; Oubain; Purostrophan; Quabagenin-l-rhamnoside; Strophanthin G; Strophoperm
CAS Registry Number: 630-60-4; 11018-89-6 (octahydrate)
RTECS® Number: RN3675000
UN/NA & ERG Number: UN1544 (Alkaloids, solid, n.o.s.)/151
EC Number: 211-139-3 [*Annex I Index No.*: 614-025-00-5]
Regulatory Authority and Advisory Bodies
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
Canada: WHMIS, Class D1A; Not on DSL or NDSL lists.
European/International Regulations (*630-60-4*): Hazard Symbol: T; Risk phrases: R23/25; R33; Safety phrases: S1/2; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Ouabain is a white crystalline solid. Molecular weight = 584.652; Freezing/Melting point = 190−200°C. Slightly soluble in waer.
Potential Exposure: Compound Description: Drug, Mutagen, Natural Product. Ouabain, similar to digitoxin, is used to produce rapid digitalization in acute congestive heart failure. Also recommended in treatment of atrial or nodal paroxysmal tachycardia and atrial flutter; enzyme inhibitor.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1.5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 8.3 mg/m^3
PAC-3: 12.5 mg/m^3
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Upon exposure to ouabain, symptoms of heart failure occur, with marked increase in serum potassium. Signs may include confusion, vomiting, coma, convulsions, and respiratory failure. It is classified as extremely toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150 lb) person. Exposure may result in respiratory and cardiac failure; and/or hyperalkemia. LD_{50} = (oral-mouse) ≥ 500 mg/kg.
Note: Patients with frequent premature ventricular heartbeat or who have received any preparation of digitalis during preceding 3 weeks are prone to toxicity.
Points of Attack: Heart.
Medical Surveillance: EKG.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: For emergency situations, wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash; pressure, pressure-demand, full face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.
Shipping: Alkaloids, solid, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and ergotamine tartrate in Packing Group I.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch spilled material. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover;

move container from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fires use unmanned hose holder or monitor nozzles; if this is impossible, withdraw and let fire burn. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ouabain*. Washington, DC: Chemical Emergency Preparedness Program

Oxalic acid O:0160

Molecular Formula: $C_2H_2O_4$; $C_2H_6O_6$

Common Formula: $HOOCCOOH \cdot {}_2H_2O$

Synonyms: Acide oxalique (French); Ethanedioic acid; NCI-C55209; Oxalic acid dihydrate; Oxalsaeure (German)

CAS Registry Number: 144-62-7

RTECS® Number: RO2450000

UN/NA & ERG Number: UN1759/154

EC Number: 205-634-3 [*Annex I Index No.*: 607-006-00-8]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R21/22; Safety phrases: S2; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Oxalic acid is a colorless, odorless powder or granular solid. The anhydrous form $(COOH)_2$ is an odorless, white solid; the solution is a colorless liquid. Molecular weight = 90.04; Specific gravity (H_2O:1) = 1.90; Sublimation point = 150−157°C; Freezing/Melting point (decomposes): 101.7°C; 190°C (anhydrous). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Moderately soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Human Data; Primary Irritant. Oxalic acid is used in textile finishing, paint stripping; metal and equipment cleaning; as an intermediate; as an analytic reagent and in the manufacture of dyes, inks, bleaches, paint removers; varnishes, wood, and metal cleansers; dextrin, cream of tartar, celluloid, oxalates, tartaric acid, purified methyl alcohol, glycerol, and stable hydrogen cyanide. It is also used in the photographic, ceramic, metallurgic, rubber, leather, engraving, pharmaceutical, paper, and lithographic industries.

Incompatibilities: The aqueous solution is a medium strong acid. Incompatible with strong oxidizers, silver compounds, strong alkalis, chlorites. Contact with some silver compounds forms explosive materials.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg/m^3 TWA; 2 mg/m^3 STEL.

ACGIH TLV®[1]: 1 mg/m^3 TWA; 2 mg/m^3 STEL.

NIOSH IDLH: 500 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

Arab Republic of Egypt: TWA 1 mg/m^3, 1993; Australia: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3, 1999; France: VME 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 2 mg/m^3, 1999; Sweden: NGV 1 mg/m^3, KTV 2 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, 1999; United Kingdom: TWA 1 mg/m^3; STEL 0.2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2 mg/m^3. Several states have set guidelines or standards for oxalic acid in ambient air[60] ranging from 3.3 μg/m^3 (New York) to 10.0 μg/m^3 (Florida and South Carolina) to 10−20 μg/m^3 (North Dakota) to 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = <-1$ (estimated).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Also, very high exposure (far above the OEL) can cause death. *Inhalation:* Contact with dust or mist can cause irritation, burns, and sores of the nose and throat. *Skin:* Contact with solid or solution may cause severe burns. *Eyes:* Contact with solid or solution may cause severe burns and eye damage. *Ingestion:* Onset of symptoms is usually rapid and includes burning and erosion of mouth, throat, and stomach tissue; nausea; vomiting, including vomiting blood; abdominal pain; diarrhea and bloody stools; numbness of fingers and toes; shock; collapse and convulsions; and kidney damage. Ingestion of 5 g (1/6 oz) can be fatal.

Long Term Exposure: Prolonged skin contact can cause irritation and slowly healing sores, pain, and discoloration (blue color) in fingers and localized tissue damage; gangrene may develop. Contact with dust or mist may cause inflammation and irritation of the nose and throat. May affect the kidneys and urinary stone formation. Repeated exposure may cause irritability, headache, and weakness.

Points of Attack: Eyes, skin, respiratory system, kidneys.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Examination of the blood vessels in exposed areas. For an acute overexposure, consider testing serum calcium level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene™, Nitrile/PVC, nitrile, and polyethylene are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *25 mg/m³:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PAPRDM* (any powered, air-purifying respirator with a dust and mist filter). *50 mg/m³:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *500 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Oxalic acid must be stored to avoid contact with silver or strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where oxalic acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Corrosive solids, n.o.s. require a shipping label of "CORROSIVE." Oxalic acid falls in DOT Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wearing proper protective clothing and equipment, cover with soda ash or sodium bicarbonate. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, or water spray, or alcohol foam extinguishers. Poisonous gases, including carbon monoxide and formic acid, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves chemical reaction with limestone or calcium oxide forming calcium oxalate. This may then be incinerated utilizing particulate collection equipment to collect calcium oxide for recycling.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Hazards: Oxalic Acid*, Report PB-276,678. Rockville, MD, pp. 42−46

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Oxalic Acid*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Oxalic Acid*. Trenton, NJ

Oxamyl O:0170

Molecular Formula: $C_7H_{13}N_3O_3S$

Common Formula: $(CH_3)_2NCOC(SCH_3) = NOCONHCH_3$

Synonyms: D-1410; 2-(Dimethylamino)-*N*([(methylamino) carbonyl]oxy)2-oxoethanimidothioic acid methyl ester; 2-Dimethylamino-1-(methylamino)glyoxal-*O*-methylcarbamoyl monoxime; *N*,*N*-Dimethyl-α-methylcarbamoyloxyimino-α-(methylthio)acetamide; *N*,*N*-Dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidic acid methyl ester; DPX 1410; Insecticide-nemacide 1410; Methyl 2-(dimethylamino)-*N*-[((methylamino)carbonyl)oxy]-2-oxoethanimidothioate; *S*-Methyl 1-(dimethylcarbamoyl)-*N*-[(methylcarbamoyl)oxy]thioformimidate; Methyl 1-(dimethylcarbamoyl)-*N*-(methylcarbamoyloxy)thioformimidate; Methyl *N*,*N*′-dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidate; Oxamyl carbamate insecticide; Thioxamyl; Vydate; Vydate 10G; Vydate insecticide/nematicide; Vydate L; Vydate Oxamyl insecticide/nematocide

CAS Registry Number: 23135-22-0

RTECS® Number: RP2300000

UN/NA & ERG Number: UN2757/151; 2991/151

EC Number: 245-445-3 [*Annex I Index No.:* 006-059-00-9]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P194.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] Reportable Quantity (RQ): 100 lb (45.4 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 0.28.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R21; R26/28; R51; 53; Safety phrases: S1/2; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Oxamyl is a white crystalline solid with a sulfur- or garlic-like odor. Molecular weight = 219.29; Freezing/Melting point = 101°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an insecticide, nematicide, and acaricide on many field crops, vegetables, fruits, and ornamentals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1.7 mg/m^3

PAC-3: 15 mg/m^3

Permissible Concentration in Water: A lifetime health advisory of 175 μg/L has been developed by EPA.[47] In addition, Massachusetts has set a guideline of 50 μg/L for oxamyl in drinking water.[61]

Determination in Water: Fish Tox = 707.10678000 ppb MATC (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause skin and eye irritation. Acute exposure to oxamyl usually leads to a cholinergic crisis. Signs and symptoms may include increased salivation, lacrimation (tearing), perspiration, spontaneous defecation, and spontaneous urination. Pinpoint pupils, blurred vision, tremor, muscle twitching, mental confusion, convulsions, and coma may occur. Gastrointestinal symptoms include abdominal pain, diarrhea, nausea, and vomiting. Bradycardia (slow heart rate) is common. Dyspnea (shortness of breath) and pulmonary edema may also occur. Classified by the World Health Organization as highly hazardous. Has also been rated as extremely to super-toxic. Acute oral exposure (ingestion) to oxamyl has caused death. Oxamyl is a potent cholinesterase inhibitor.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system causing numbness and/or weakness in the hands and feet. Repeated exposure may cause personality changes with depression, anxiety, and irritability. May cause liver damage. Human Tox = 200.00000 ppb MCL (VERY LOW).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, liver, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Consider liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a the health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and light. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Carbamate pesticide, solid, toxic, n.o.s. requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire, as the material itself does not burn or burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide, or dry chemical. Move container from fire area. Fight fire from maximum distance. Dike fire control water for later disposal do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases, including nitrogen oxides and sulfur oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Small quantities may be treated with alkali and buried in a landfill.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Oxamyl.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Oxamyl.* Trenton, NJ

4,4′-Oxydianiline O:0180

Molecular Formula: $C_{12}H_{12}N_2O$

Common Formula: $H_2NC_6H_4OC_6H_4NH_2$

Synonyms: *p*-Aminophenyl ether; 4-Aminophenyl ether; Aniline, 4,4′-oxydi-; Benzenamine, 4,4′-oxybis-; Bis(*p*-aminophenyl) ether; Bis(4-aminophenyl) ether; 4,4-Diaminodiphenyl ether; Diaminodiphenyl ether; 4,4′-Diaminofenol eter (Spanish); 4,4′-Diaminophenyl ether; NCI-C50146; Oxybis(4-aminobenzene); *p,p*′-Oxybis(aniline); 4,4′-Oxybis(aniline); *p,p*′-Oxydianiline; 4,4′-Oxydianiline; 4,4′-Oxydiphenylamine; Oxydi-*p*-phenylenediamine

CAS Registry Number: 101-80-4

RTECS® Number: BY7900000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-977-0 [*Annex I Index No.:* 612-199-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat; NTP: Reasonably anticipated to be a human carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R46; R 23/24/25; R62; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 4,4′-Oxydianiline is a white crystalline solid, or a beige powder. Molecular weight = 200.26; Boiling point ≥300°C (sublimes); Freezing/Melting point = 186−187°C; Flash point = 219°C. Very slightly soluble in water.

Potential Exposure: Intermediate in the manufacture of high-temperature-resistant, straight polyimide and poly (esterimide) resins capable of withstanding temperatures of up to 480°C for short periods or 260°C for prolonged periods of time. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 300 mg/m^3

DFG MAK: Dangerous skin sensitization; Carcinogen Category 2.

Russia set a MAC of 5.0 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of the skin and/or eyes. Poisonous. LD_{50} = (oral-rat) 725 mg/kg.

Long Term Exposure: It has caused liver disease and retinopathy in rats. A potential occupational carcinogen.

Points of Attack: Liver.

Medical Surveillance: Liver tests.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52] *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere. Protect from exposure to light and oxidizing agents. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid airborne dust and collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with provision for nitrogen oxides removal from flue gases.

9,10-Oxydiphenoxarsine O:0190

Molecular Formula: $C_{24}H_{16}As_2O_3$

Synonyms: Bis(10-phenoxarsinl) oxide; Bis(phenoxarsin-10-yl) ether; Bis(10-phenoxarsyl) oxide; 10,10′-Bis(phenoxyarsinyl) oxide; Bis(10-phenoxyarsinyl) oxide; DID 47; Diphenoxarsin-10-yl oxide; OBPA; 10-10′-Oxidiphenoxarsine; 10-10′-Oxybisphenoxyarsine; Phenoxaksine oxide; PXO; SA 546; Vinadine; Vinyzene; Vinyzene BP 5; Vinyzene BP 5-2; Vinyzene (Pesticide); Vinyzene SB 1

CAS Registry Number: 58-36-6

RTECS® Number: SP6800000

UN/NA & ERG Number: Not regulated

EC Number: 200-377-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

As arsenic compound:

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: organics 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides, liquid, toxic, flammable, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as arsenic, water-soluble compounds, n.o.s.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 10-10′-Oxidiphenoxarsine is a colorless crystalline, organometallic solid or a dense yellow liquid. Molecular weight = 502.23; Boiling point = 233°C; Freezing/Melting point = 185°C. Decomposition temperature = 380°C. Flash point = <32°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Practically insoluble in water.

Incompatibilities: A reducing agent; reacts violently with strong oxidizers. Keep away from strong acids and strong bases.

Potential Exposure: This material is used primarily for fungicidal and bactericidal protection of plastics. It is an organoarsenic and a heavy metal compound.

Permissible Exposure Limits in Air

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA.

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

Protective Action Criteria (PAC)

TEEL-0: 1.68 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 14 mg/m^3

PAC-3: 14 mg/m^3

Permissible Concentration in Water: While not specifically citing the compounds, EPA[6] gives a desirable level of zero for arsenic in water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. Contact with eyes may be severe. Ingestion causes nausea, vomiting, and diarrhea. Arsenic compounds are acutely poisonous by ingestion. In severe cases, there may be bloody vomitus and stools and the victim may suffer collapse and shock with weak, rapid pulse; cold sweats; coma; and death. LD_{50} = (oral-rat) 40 mg/kg.

Long Term Exposure: Arsenic compounds are recognized carcinogens of the skin, lungs, and liver. Ingestion or inhalation may result in chronic poisoning. Symptoms may include disturbances of the digestive system, loss of appetite, cramps, nausea, constipation, diarrhea. May cause liver damage, resulting in jaundice. May cause disturbances of the blood, kidneys, and nervous system. May cause skin abnormalities including itching, pigmentation, and even cancerous changes.

Points of Attack: Blood, kidneys, skin, nervous system.

Medical Surveillance: Kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-plate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard (*dissolved in a flammable carrier solvent*): Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue (*carcinogen*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Poisonous gases, including arsenic, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: 10,10-Oxydiphenoxarsine*. Washington, DC: Chemical Emergency Preparedness Program

Oxydisulfoton O:0200

Molecular Formula: $C_8H_{19}OsPS_3$

Synonyms: BAY 23323; *O,O*-Diethyl *S*-[2-(ethylsulfinyl) ethyl] phosphorodithioate; *O,O*-Diethyl *S*-[(ethylsulfinyl) ethyl] phosphorodithioate; Disulfoton disulfide; Disulfoton sulfoxide; Disyston sulfoxide; Ethylthiomelton sulfoxide

CAS Registry Number: 2497-07-6

RTECS® Number: TD8600000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 219-679-1 [*Annex I Index No.:* 015-096-00-X]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24; R28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; 60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Oxydisulfoton is a liquid. Molecular weight = 290.42. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0.

Potential Exposure: This material is an agricultural insecticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 3.5 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms include the following: *mild exposure:* headache, loss of appetite, nausea, dizziness; *moderate exposure:* abdominal cramps, diarrhea, salivation, excessive tearing, muscular cramps; *severe exposure:* fever, blue lips, lack of sphincter control, coma, heart shock, difficult breathing.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases may be generated from the fire or runoff water. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank

discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Oxydisulfoton*. Washington, DC: Chemical Emergency Preparedness Program

Oxygen O:0210

Molecular Formula: O_2

Synonyms: Liquid oxygen; LOX; Oxygen, liquid

CAS Registry Number: 7782-44-7

RTECS® Number: RS2060000

UN/NA & ERG Number: UN1072 (compressed)/122; UN1073 (refrigerated liquid)/122

EC Number: 231-956-9 [*Annex I Index No.:* 008-001-00-8]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: V79 cell culture-gene mutation.

European/International Regulations: Hazard Symbol: O; Risk phrases: R8; Safety phrases: S2; S17 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Oxygen is a colorless odorless gas or a bluish cryogenic liquid. Molecular weight = 32.00; Boiling point = −183°C; Freezing/Melting point = −219°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Oxidizer. Slightly soluble in water. Liquid sinks and boils in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data. Compressed oxygen is used in various oxidation processes, for feedstock; and enrichment purposes; as a medicinal gas; a chemical intermediate; in oxyacetylene welding; in metallurgy. Liquid oxygen is used as a rocket fuel. Oxygen is naturally present at a concentration of 21% in breathing air.

Incompatibilities: A strong oxidizer. Reacts violently with nearly every element, combustibles, organics, and reducing materials.

Permissible Exposure Limits in Air

No standards or TEEL available. Minimum acceptable breathing air contains 19% oxygen.

Determination in Air: Use NIOSH Analytical Method #6601, Oxygen.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Note:* Increased pressure speeds up the toxic effects of oxygen. Drugs and chemical can also effects toxicity either positively or negatively. *Inhalation:* The air we breathe contains 21% oxygen. Normal activity requires a minimum of 19% oxygen. Breathing up to 50% oxygen at normal pressure produced no symptoms. Breathing 100% oxygen at normal pressure produced no symptoms after 12 h, but after 24 h has caused weakness, dizziness, burning in the nose and throat; fatigue, pain in joints and muscles; numbness and tingling in the arms and legs; palpitations, headache, cough, nasal congestion; ear disturbances; nausea, vomiting, loss of appetite; sore throat, fever, and swelling of the mucous membranes. Pressure levels greater than 3 times normal may cause convulsions and coma. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Contact with liquid oxygen may cause freezing burns and tissue damage. *Eyes:* Liquid oxygen may cause freezing burns and tissue damage. *Ingestion:* Liquid oxygen may cause freezing burns in the mouth and throat.

Long Term Exposure: Breathing of 50−100% oxygen at normal pressure even intermittently, over a prolonged period can cause lung damage.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures to pure oxygen, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure to pure oxygen.

First Aid: *Eye Contact:* With liquid oxygen—immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. *Skin Contact*: with liquid oxygen—if frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention. *Breathing Pure Oxygen or Gases >40%* O_2; Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquefied oxygen. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Specific engineering controls are required by OSHA. See OSHA Standard 1910.104.

Respirator Selection: Entering into oxygen enriched atmospheres (greater than 21% oxygen) is highly dangerous. Consult *NFPA Code 53M.*

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Liquid oxygen must be stored to avoid contact with organic and combustible materials (such as oil, grease, and coal dust) since violent reactions occur. Open storage is preferred. Oxygen gas evaporating from liquid or from oxygen enriched environments is easily absorbed into clothing and any source of ignition (such as a static spark) can cause flash burning. Compressed oxygen cylinders must be securely stored separately from fuel cylinders. Liquid oxygen tanks should be stored outdoors. Sources of ignition, such as smoking and open flames, are prohibited where oxygen is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Oxygen, *compressed*, or oxygen, *refrigerated liquid* (*cryogenic liquid*), requires a shipping label of "NONFLAMMABLE GAS, OXIDIZER." They fall in DOT Hazard Class 2.2.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Liquid:* Do NOT absorb liquid in saw-dust or similar combustible absorbents. This is an oxidizer and a dangerous fire and explosion risk. Use only water. Do not use chemical or carbon dioxide extinguishers. NEVER direct water jet on liquid. Allow liquid oxygen spills to evaporate. *Gas:* Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid oxygen is spilled or leaked, take the following steps: Keep combustibles (wood, paper, oil, etc.) away from spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Oxygen is not flammable but supports combustion and greatly increases the intensity of any fire. Mixtures of liquid oxygen and any fuel are highly explosive. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. For a large fire, evacuate danger area and consult an expert. For small fire, extinguish using an agent suitable for type of surrounding fire. Oxygen itself does not burn. Do not use chemical or carbon dioxide on *liquid* oxygen. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere.

References

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Oxygen*. Trenton, NJ

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Oxygen (compressed or liquefied)*. Albany, NY: Bureau of Toxic Substance Assessment

Oxygen difluoride O:0220

Molecular Formula: F_2O

Common Formula: OF_2

Synonyms: Difluorine monoxide; Fluorine monoxide; Fluorine oxide; Oxygen fluoride

CAS Registry Number: 7783-41-7
RTECS® Number: RS2100000
UN/NA & ERG Number: UN2190/124
EC Number: 231-996-7

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥0.09% concentration).

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Oxygen difluoride is a colorless gas with a foul, peculiar odor. Shipped as a nonliquefied compressed gas. Molecular weight = 54.00; Boiling point = −145.6°C; Freezing/Melting point = −223.9°C; Vapor pressure = >1 atm at 20°C; Relative vapor density (air = 1) = 1.88. Slightly soluble in water (slowly reactive); solubility = 0.02%.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. Oxygen difluoride may be used as an oxidant in missile propellant systems.

Incompatibilities: A strong oxidizer. Explodes on contact with steam. Violent reaction with reducing agents, combustible materials, chlorine, bromine, iodine, platinum, metal oxides, moist air, hydrogen sulfide (explosive in ambient air), hydrocarbons, water. Attacks mercury.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.21 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.05 ppm/0.1 mg/m^3 TWA.

NIOSH REL: 0.05 ppm/0.1 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.05 ppm/0.11 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 0.5 ppm.

Protective Action Criteria (PAC)*
TEEL-0: 0.05 ppm
PAC-1: 0.1 ppm
PAC-2: **0.83** ppm
PAC-3: **2.5** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Arab Republic of Egypt: TWA 0.05 ppm (0.1 mg/m^3), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Denmark: TWA 0.05 ppm (0.1 mg/m^3), 1999; Finland: STEL 0.05 ppm (0.1 mg/m^3), 1999; Norway: TWA 0.05 ppm (0.1 mg/m^3), 1999; the Philippines: TWA 0.05 ppm (0.1 mg/m^3), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg [HF]/m^3, 1999; the Netherlands: MAC 0.1 mg/m^3, 2003; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.05 ppm. Several states have set guidelines or standards for oxygen difluoride in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Connecticut and Nevada) to 80,000 μg/m^3 (Virginia).

Determination in Air: No NIOSH Analytical Method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Gas under pressure is corrosive to eyes, skin, and respiratory tract; causes burns. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure at low levels may result in severe, intractable headaches.

Points of Attack: Lungs, eyes.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50)* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Protect cylinder containers against physical damage. Do not use wood pallets. Preferably handle behind body shield, in outdoor, or open protective fences. Wear long rubber gloves, goggles, protective clothing, and self-contained breathing apparatus. See 29 CFR 1910.101 for specific regulations on storage of compressed gas. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Oxygen difluoride requires a shipping label of "POISON GAS, OXIDIZER, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

Oxygen difluoride, oxygen difluoride, compressed

First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 3.3/5.3
Night 7.0+/11.0+

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 7.0+/11.0+
Night 7.0+/11.0+

Fire Extinguishing: This chemical is a nonflammable gas but a strong oxidizer that can increase the intensity of a fire. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray or sift on a thick layer of a (1:1) mixture of dry soda ash and slaked lime behind a shield. After mixing, spray water from an atomizer with great precaution. Transfer slowly into a large amount of water. Neutralize and drain into the sewer with sufficient water.

Ozone O:0230

Molecular Formula: O_3
Synonyms: Oxygen mol (O_3); Ozono (Spanish); Triatomic oxygen
CAS Registry Number: 10028-15-6
RTECS® Number: RS8225000
UN/NA & ERG Number: UN1955/123
EC Number: 233-069-2
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse; no evidence: rat; NTP: Carcinogenesis Studies (inhalation); some evidence: mouse.
US EPA Gene-Tox Program, Negative: *In vivo* cytogenetics—nonhuman bone marrow; Negative: *In vivo* SCE—nonhuman; Inconclusive: *In vivo* cytogenetics—nonhuman lymphocyte; Inconclusive: *In vitro* cytogenetics—human lymphocyte; Inconclusive: *In vivo* cytogenetics—human lymphocyte; Inconclusive: Cytogenetics—male germ cell.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).
SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
SARA Hazard Classes: Sudden Release of pressure hazard; Fire Hazard; Acute Health Hazard; Chronic Health Hazard.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; Category DIA, C. D2B.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Ozone is a colorless to blue gas with a very pungent, characteristic, sulfur-like odor, associated with electrical sparks; condenses to a blue-black liquid or crystalline solid. The odor threshold is 0.045 ppm. Molecular weight = 48.00; Boiling point = −112°C; Freezing/Melting point = −193°C; Vapor pressure = >1 atm at 20°C; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3. Slightly soluble in water; solubility = 0.001% at 0°C.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Ozone is found naturally in the atmosphere as a result of the action of solar radiation and electrical storms. It is also formed around electrical sources, such as X-ray or ultraviolet generators, electric arcs; mercury vapor lamps; linear accelerators; and electrical discharges. Ozone is used as an oxidizing agent in the organic chemical industry (e.g., production of azelaic acid); as a disinfectant for air, mold and bacteria inhibitor for food in cold storage rooms, and for water (e.g., public water supplies; swimming pools; sewage treatment); for bleaching textiles; waxes, flour, mineral oils and their derivatives; paper pulp; starch and sugar; for aging liquor and wood; for processing certain perfumes; vanillin and camphor; in treating industrial wastes; in the rapid drying of varnishes and printing inks; and in the deodorizing of feathers.
Incompatibilities: A powerful oxidizer. A severe explosion hazard when exposed to shock or heat. Spontaneously decomposes to oxygen under ordinary conditions; heating increases oxygen production. Reacts with all reducing agents, combustibles, organic, and inorganic oxidizable materials, and can form products that are highly explosive. Incompatible with alkenes, aniline, benzene, bromine, ether, ethylene, hydrogen bromide, nitric oxide, stibine. Attacks metals except gold and platinum.
Permissible Exposure Limits in Air
OSHA PEL: 0.1 ppm/0.2 mg/m^3 TWA.
NIOSH REL: 0.1 ppm/0.2 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: (*heavy work*) 0.05 ppm/0.1 mg/m^3 TWA; (*moderate work*) 0.08 ppm/0.16 mg/m^3 TWA; (*light work*) 0.01 ppm/0.2 mg/m^3 TWA; (*light, moderate, or heavy workload* $\leq$*2 h*) 0.2 ppm/0.4 mg/m^3 TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 5 ppm.
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.15 ppm
PAC-2: 1 ppm
PAC-3: 5 ppm
DFG MAK: Carcinogen Category 3B.
Arab Republic of Egypt: TWA 0.1 ppm (0.02 mg/m^3), 1993; Australia: TWA 0.1 ppm (0.2 mg/m^3); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.2 mg/m^3), 1999; Belgium: STEL 0.1 ppm (0.2 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.2 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.2 mg/m^3); STEL 0.3 ppm (0.6 mg/m^3), 1999; France: VME 0.1 ppm (0.2 mg/m^3), VLE 0.2 ppm (0.4 mg/m^3), 1999; Hungary: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, 1993; Japan: 0.1 ppm (0.2 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.2 mg/m^3), 1999; the Philippines: TWA 0.1 ppm (0.2 mg/m^3), 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.6 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 0.1 mg/m^3, 1993; Sweden: NGV 0.1 ppm (0.2 mg/m^3), TGV 0.3 ppm (0.6 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.2 mg/m^3), KZG-W 0.2 ppm (0.4 mg/m^3), 1999; Turkey: TWA 0.1 ppm (0.2 mg/m^3), 1993; United Kingdom: STEL 0.2 ppm (0.4 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.
The US EPA has set a national ambient air quality standard of 0.12 ppm (240 μg/m^3) for ozone on a 1-h average basis and a standard of 0.08 ppm (160 μg/m^3) for total photochemical oxidants (expressed as ozone) on a 1-h average basis (to be exceeded not more than once a year). The Czech Republic[35] has set a TWA of 0.1 mg/m^3 in workplace air with a ceiling of 0.2 mg/m^3. Russia set a MAC of 0.16 mg/m^3 for ambient air in residential areas on a once-daily basis and 0.03 mg/m^3 on an average daily basis. State

limits for ozone in ambient air[60] range from 0.005 mg/m^3 in Nevada to 0.235 mg/m^3 in Connecticut.

Determination in Air: Use OSHA Analytical Method ID-214.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Eye exposure may result in conjunctivitis (red, inflamed eyes). Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation of the gas may cause asthma-like reactions. The liquid may cause frostbite. May affect the central nervous system, causing headache and impaired concentration and performance. Signs and symptoms of acute exposure to ozone may be severe and include irritation and burns of the skin, eyes, and mucous membranes. An increased respiratory rate, shallow breathing, cough, dyspnea (shortness of breath), bronchitis, pulmonary edema, and pulmonary hemorrhage may occur. Tachycardia (rapid heart rate) and hypotension (low blood pressure) may be observed. Neurologic effects include fatigue, dizziness, drowsiness, headache, exhilaration, and depression. Nausea, vomiting, and anorexia may occur. A level of 0.2 ppm for 3 h did not produce symptoms. Levels of 0.3 ppm may cause tightness in chest and throat, dry throat; and irritation of throat and lungs within 30 min. Levels of 0.5 ppm and above produce a sulfur-like odor and may cause headache, drowsiness, loss of coordination, and accumulation of fluid in the lungs. Levels near 10 ppm may result in immediate, severe irritation of throat and lungs, excessive sweating, continual coughing, decreased blood pressure, weak and rapid pulse, and severe chemical pneumonia. Death may occur from prolonged exposures at 2 ppm or short exposures at 10 ppm.

Note: There may be a delay in onset of breathing difficulties for up to 6 h.

Ozone is highly toxic via inhalation or by contact of liquid to skin, eyes, or mucous membranes. It is capable of causing acute to chronic lung damage, burns, and death or permanent injury. Ozone can be toxic at a concentration of 100 ppm for 1 min. Ozone is capable of causing death from pulmonary edema. It increases sensitivity of the lungs to bronchoconstrictors and allergens; increases susceptibility to and severity of lung bacterial and viral infections.

Long Term Exposure: Repeated or prolonged exposure may cause lung damage and/or chronic respiratory disease. Ozone may damage the developing fetus.

Points of Attack: Eyes, respiratory system, lungs.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential. Preemployment and periodic physical examinations should be concerned especially with significant respiratory diseases. Eye irritation may also be important.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Administer 100% O_2. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: In areas of excessive concentration, gas masks with proper canister and full face-piece or goggles or the use of supplied-air respirators is recommended. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *Up to 5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-, mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated place. Detached storage preferred, away from combustible material and reducing agents. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Compressed gas, toxic, n.o.s. (Ozone) must be labeled "POISON GAS, OXIDIZER." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor, contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable; however, ozone may react with any combustible substance to cause fire or explosion. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Ozone*, Report PB-276.678. Rockville, MD, pp. 47−50

National Academy of Sciences. (1977). *Medical and Biologic Effects of Environmental Pollutants: Ozone and Other Photochemical Oxidants*. Washington, DC

US Environmental Protection Agency. (1978). *Air Quality Criteria for Ozone and Other Photochemical Oxidants*, Report EPA-600/8-78-004. Research Triangle Park, NC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Ozone*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Ozone*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 52−53

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Ozone*. Trenton, NJ

P

Pancreatin P:0050

Synonyms: Beef viokase; Diastase vera; Donnazyme; Entozyme; Ilozyme; Intrazyme; Pancreatic extract; Pancrex-V; Pankreon; Pankrotanon; Panteric; Stamyl; Viobin; Viokase; Zypanar

CAS Registry Number: 8057-43-0; 9002-16-8; 8049-47-6; 9046-39-3

RTECS® Number: RT9033000

Regulatory Authority and Advisory Bodies

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pancreatin is a yellowish to cream-colored amorphous powder with a strong odor. Slightly soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: It is an enzyme found in the pancreas and is used in medicines and in treating leather and textiles.

Incompatibilities: Alcohols, acids.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Pancreatin can affect you when breathed in. Exposure can cause an asthma-like lung reaction, with rapidly occurring symptoms of wheezing and shortness of breath. A second type of lung reaction, with fatigue, shortness of breath, and possibly fever, can occur hours after exposure. This can lead to scars in the lungs. Once allergy develops, even low exposures can trigger symptoms. Other proteolytic enzymes similar to Pancreatin can cause severe eye irritation and irritate the tongue, mouth, and cause nosebleeds and skin sores.

Long Term Exposure: Repeated breathing exposure may cause changes in lung function, even without symptoms. May cause skin allergy, with rash and itching. May cause asthma-like allergy. Can cause severe allergic lung reaction with chills, fever, chest tightness, cough, and/or shortness of breath. Repeated attacks may lead to permanent lung scarring. Once allergy develops, even low exposures can trigger symptoms.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation for up to 8 h after breathing exposure is recommended, as symptoms may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to pancreatin, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alcohol and acids.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00015-1

If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 1987). *Hazardous Substances Fact Sheet: Pancreatin*. Trenton, NJ

Paraffin wax P:0100

Molecular Formula: C_nH_{2n+2}

Synonyms: Hard paraffin; Paraffin; Paraffin, *n*-; Paraffin fume

CAS Registry Number: 8002-74-2; 71808-29-2 (waxes, petroleum, clay-treated, reaction)

RTECS® Number: RV0350000

UN/NA & ERG Number: Not regulated.

EC Number: 232-315-6

Regulatory Authority and Advisory Bodies

FDA—over-the-counter drug.

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9311.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Paraffin wax is a white, somewhat translucent solid and consists of a mixture of solid aliphatic hydrocarbons. It may be obtained from petroleum and consists of a mixture of high-molecular-weight hydrocarbons (e.g., $C_{36}H_{74}$). Specific gravity (H_2O:1) = 0.88−0.92; Freezing/Melting point = 46−68°C; Flash point = 198.9°C; Autoignition temperature = 245°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Primary Irritant. Paraffin is used in the manufacture of paraffin paper, candles, food package material, varnishes, floor polishes, and cosmetics. It is also used in waterproofing and extracting of essential oils from flowers for perfume.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Paraffin wax fume

OSHA PEL: None.

NIOSH REL: 2 mg/m^3 TWA.

ACGIH TLV®[1]: 2 mg/m^3 TWA.

Protective Action Criteria (PAC)

8002-74-2

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

71808-29-2

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Australia: TWA 2 mg/m^3 (fume), 1993; Belgium: TWA 2 mg/m^3 (fume), 1993; Denmark: TWA 2 mg/m^3 (fume), 1999; Finland: TWA 1 mg/m^3 (fume), 1999; France: VME 2 mg/m^3 (fume), 1999; Norway: TWA 2 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3 (fume), 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3. Several states have set guidelines or standards for paraffin wax fume in ambient air[60] ranging from 20−60 μg/m^3 (North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 48 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2047.

Routes of Entry: Inhalation, eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates eyes and respiratory system. Inhalation can cause nausea. Occasionally sensitivity reactions have been reported. Chronic exposure can produce chronic dermatitis, wax boils, folliculitis, comedones, melanoderma, papules, and hyperkeratoses.

Long Term Exposure: Fume can cause lung damage, and paraffins contain carcinogens. Carcinoma of the scrotum in pressmen exposed to crude petroleum wax has been documented. Other malignant lesions of an exposed area in employees working with finished paraffin are less well documented. Carcinoma of the scrotum, occurring in workmen exposed 10 years or more, began as a hyperkeratotic nevus like a lesion and developed into a squamous cell carcinoma. The lesions can metastasize to regional inguinal and pelvic lymph nodes. Paraffinoma has been reported from use of paraffin for cosmetic purposes. Summarize by calling it an equivocal tumorigenic agent.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Medical examinations should be concerned especially with the skin. Surveillance should be continued indefinitely.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Paraffin wax is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 69−70

Paraformaldehyde P:0120

Molecular Formula: $(CH_2O)_x$; $C_3H_6O_4$

Synonyms: Aldacide; Flo-more; Formagene; Formaldehyde polymer; Granuform; Paraform; Paraform 3; Paraformaldehido (Spanish); Polyformaldehyde; Polymerized formaldehyde; Polyoxymethylene; Polyoxymethylene glycol; Triformol; Trioxymethylene

CAS Registry Number: 30525-89-4; 110-88-3 (1,3,5-trioxane)

RTECS® Number: RV0540000 (paraformaldehyde); YM1400000 (trioxane)

UN/NA & ERG Number: UN2213/133

EC Number: 203-812-5 [*Annex I Index No.:* 605-002-00-0] (1,3,5-trioxane)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*110-88-3*): Hazard Symbol: F, Xn; Risk phrases: R11, R37; R63; Safety phrases: S2; S36/37; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Paraformaldehyde is a white crystalline solid with an irritating odor. The term "trioxane" applies specifically to this trimer $(CH_2O)_3$, but paraformaldehyde is applied both to trioxane and other low polymers or oligomers of formaldehyde. Boiling point = 115°C (trioxane); Freezing/Melting point = 64°C (trioxane); 120−180°C (decomposition/paraformaldehyde); Flash points = 45°C (trioxane); 70°C (paraformaldehyde); Autoignition temperature = 300°C. Explosive limits: LEL = 3.6%; UEL = 28.7% (trioxane); LEL = 7.0%; UEL = 73.0% (paraformaldehyde). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Primary Irritant. Paraformaldehyde is used in polyacetal resin manufacture, as a food additive, and as an odorless fuel.

Incompatibilities: Dust forms an explosive mixture with air. Decomposes on contact with oxidizers, strong acids, acid fumes, and bases; with elevated temperatures, forms formaldehyde. May explode when heated. May explode on impact if peroxide contamination develops. Mixtures with hydrogen peroxide or liquid oxygen are explosives sensitive to heat, shock, or contact with lead.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 4 mg/m^3
PAC-1: 12.5 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 100 mg/m^3
No TEEL available for *trioxane.*

The Netherlands: 2 ppm/3 mg/m^3 ceiling value[57]; Japan: 5 ppm TWA.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can irritate the eyes, nose, throat, and skin. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. See also "Formaldehyde"; this chemical forms formaldehyde when heated.

Long Term Exposure: Repeated or prolonged contact may cause skin and lung sensitization, resulting in allergies. Paraformaldehyde may cause mutations. Handle with extreme caution. May cause kidney damage. Testing has not been completed to determine the carcinogenicity of paraformaldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Paraformaldehyde, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Paraformaldehyde must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), and alkaline materials (such as potassium or sodium hydroxide), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where paraformaldehyde is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Protect containers from physical damage. Store in tightly closed containers in a cool, well-ventilated area away from areas of high humidity.

Shipping: Paraformaldehyde requires a shipping label of “FLAMMABLE SOLID.” It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep paraformaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Dust can form an explosive mixture with air. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including formaldehyde. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 90−92

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Paraformaldehyde*. Trenton, NJ

Paraldehyde P:0130

Molecular Formula: $C_6H_{12}O_3$

Common Formula: $(CH_3CHO)_3$

Synonyms: A13-03115; *p*-Acetaldehyde; Acetaldehyde, trimer; DEANo. 2585; Elaldehyde; NSC9799; Paraacetaldehyde; Paracetaldehyde; Paral; Paraldehido (Spanish); Paraldehyd (German); Paraldehyde draught; Paraldehyde enema; PCHO; Poral; Triacetaldehyde (French); 2,4,6-Trimethyl-1,3,5-trioxacyclohexane; 1,3,5-Trimethyl-2,4,6-trioxane; 2,4,6-Trimethyl-*s*-trioxane; 2,4,6-Trimethyl-1,3,5-trioxane; *s*-Trimethyltrioxymethylene; *S*-Trioxane, 2,4,6-trimethyl

CAS Registry Number: 123-63-7

RTECS$^®$ Number: YK0525000

UN/NA & ERG Number: UN1264/129

EC Number: 204-639-8 [*Annex I Index No.:* 605-004-00-1]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

US EPA Hazardous Waste Number (RCRA No.): U182.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R10; Safety phrases: S2; S29. (See Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Paraldehyde is a colorless liquid with a pleasant odor. Molecular weight = 132.18; Boiling point = 125°C; Freezing/Melting point = 12°C; Flash point = 36°C; Autoignition temperature = 237°C. Explosive Limits: LEL = 1.3%; UEL — unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Human Data; Primary Irritant. Paraldehyde is used primarily in medicine. It is used as a hypnotic agent, in delirium tremens, and in treatment of psychiatric states characterized by excitement when drugs given over a long period of time. It is also administered for intractable pain which does not respond to opiates and for basal and obstetrical anesthesia. It is effective against experimentally induced convulsions and has been used in emergency therapy of tetanus, eclampsia, status epilepticus, and poisoning by convulsant drugs. Since it is used primarily in medicine, the chance of accidental human exposure or environmental contamination is low. However, paraldehyde decomposes to acetaldehyde and acetic acid; these compounds have been found to be toxic. In this case, occupational exposure or environmental contamination is possible. Since paraldehyde is prepared from acetaldehyde by polymerization in the presence of an acid catalyst, there exists a potential for adverse effects, although none have been reported in the available literature. It is also used in the manufacture of organic compounds.

Incompatibilities: Forms explosive mixture with air. Incompatible with strong oxidants, strong acids, alkalis, ammonia, amines, iodides, hydrocyanic acid. Violent reaction with liquid oxygen. Contact with acids form acetaldehyde. Attacks rubber and plastics.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 40 mg/m^3
PAC-2: 300 mg/m^3
PAC-3: 300 mg/m^3
Russia[43] set a MAC of 5.0 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Paraldehyde can affect you when breathed in and by passing through your skin. Contact can cause severe eye irritation or burns with possible permanent damage, and irritates the skin. Overexposure can cause poor coordination and make you sleepy. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: High or repeated exposure can damage the liver and kidneys. Can irritate the lungs; bronchitis may develop. Repeated exposure may cause fatigue, tremors, changes in speech, personality changes, and/or poor memory.

Points of Attack: Liver, kidneys, lungs, brain.

Medical Surveillance: Liver and kidney function tests. Examine for brain effects. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to paraldehyde, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Paraldehyde must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), liquid oxygen, alkalis, and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where paraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of paraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of paraldehyde.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including formaldehyde, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in added solvent. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Paraldehyde, Health and Environmental Effects Profile No. 140*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 87–90 (1985) and 8, No. 6, 74–79 (1988)

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Paraldehyde*. Trenton, NJ

Paraoxon P:0140

Molecular Formula: $C_{10}H_{14}NO_6P$

Synonyms: Chinorta; Diaethyl-*p*-nitrophenylphosphorsaeurеester (German); *O*,*O*′-Diethyl-*p*-nitrophenylphosphat (German); *O*,*O*-Diethyl *O*,*p*-nitrophenyl phosphate; *O*,*O*-Diethyl *p*-nitrophenyl phosphate; Diethyl-*p*-nitrophenyl phosphate; Diethyl paraoxon; *O*,*O*-Diethylphosphoric acid *O*, *p*-nitrophenyl ester; E 600; ENT16,087; Ester 25; Ethyl-*p*-nitrophenyl ethylphosphate; Ethyl paraoxon; Eticol; Fosfakol; HC2072; Mintaco; Mintacol; Miotisal; Miotisal A; *O*,*p*-Nitrofenilfosfato de *O*,*O*-dietilo (Spanish); *p*-Nitrophenyl diethylphosphate; Oxyparathion; Paraoxone; Paroxan; Pestox 101; Phosphacol; Phosphoric acid, diethyl *p*-nitrophenyl ester; Phosphoric acid, diethyl 4-nitrophenyl ester; Soluglacit; TS219

CAS Registry Number: 311-45-5

RTECS® Number: TC2275000

UN/NA & ERG Number: UN3278 (organophosphorus compound, toxic n.o.s.)/151

EC Number: 206-221-0

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P041.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Paraoxon is an odorless, reddish-yellow oil. Molecular weight = 275.22; Boiling point = 170°C at 1 mmHg; Freezing/Melting point = 189°C; Vapor pressure = 9×10^{-5} mmHg at 25°C. Slightly soluble in water; solubility = 3640 mg/L at 20°C.

Potential Exposure: An organophosphate insecticide. It has been used as a medication.

Incompatibilities: Decomposes in alkaline materials.

Permissible Exposure Limits in Air

No standards or TEEL available.

This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.59$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can cause rapid organophosphate poisoning. Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. LD_{50} = (oral-rat) 1.8 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Repeated exposure may cause personality changes, including depression, anxiety, irritability. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Refer to the NIOSH Criteria Documents #78-174 and #76-147 on manufacturing, formulating, and working safely with pesticides.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus compound, toxic n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.6/2.6
Night 2.8/4.5

Fire Extinguishing: This chemical is a combustible liquid, but does not readily ignite. Poisonous gases, including oxides of phosphorus and nitrogen, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Paraoxon*. Trenton, NJ

Paraquat (paraquat dichloride) P:0150

Molecular Formula: $C_{12}H_{14}Cl_2N_2$

Common Formula: $C_{12}H_{14}N_2Cl_2$

Synonyms: AH 501; AI3-61943; 4,4′-Bipyridinium, 1,1′-dimethyl-, dichloride; Bipyridinium, 1,1′-dimethyl-4,4′-, dichloride; Cekuquat; *para*-COL; Crisquat; Dextrone; Dextrone-X; *N*,*N*′-Dimethyl-4,4′-bipyridinium dichloride; 1,1′-Dimethyl-4, 4′-bipyridinium dichloride; *N*,*N*′-Dimethyl-4,4′-bipyridylium dichloride; 1,1′-Dimethyl-4,4′-bipyridynium dichloride; 1,1-Dimethyl-4,4-dipyridilium dichloride; 4,4′-Dimethyldipyridyl dichloride; 1,1′-Dimethyl-4,4′-dipyridylium chloride; *N*,*N*′-Dimethyl-4,4′-dipyridylium dichloride; 1,1′-Dimethyl-4,4′-dipyridylium dichloride; Dimethyl violgen chloride; Dimethyl viologen chloride; Esgram; Gamixel; Goldquat 276; Gramoxone; Gramoxone D; Gramoxone dichloride; Gramoxone S; Gramoxone W; Herboxone; Methyl viologen; Methyl viologen (reduced); Methyl viologen chloride; Methyl viologen dichloride; NSC263500; NSC 88126; OK622; Paraquat chloride; *ortho*-Paraquat Cl; Paraquat Cl; Paraquat dichloride; Paraquat dichloride bipyridylnium herbicide; Pathclear; Pillarquat; Pillarxone; PP 148; Sweep; Terraklene; Toxer total; Viologen, methyl-; Weedol

Note: Paraquat is a cation ($C_{12}H_{14}N_2{}^{++}$; 1,1-Dimethyl-4,4-bipyridinium ion); the commercial product is the dichloride salt of paraquat.[NIOSH]

CAS Registry Number: 4685-14-7 (cation); 1910-42-5 (dichloride); *(alt.)* 3765-78-4; *(alt.)* 57593-74-5; *(alt.)* 65982-50-5; *(alt.)* 136338-65-3; *(alt.)* 205105-68-6; *(alt.)* 247050-57-3; 4032-26-2 (diiodide); 2074-50-2 (dimethylsulfate; methosulfat)

RTECS® Number: DW1960000 (cation); DW2275000 (dichloride); DW2280000 (diiodide); DW2010000 (dimethylsulfate)

UN/NA & ERG Number: UN2781

EC Number: 225-141-7; 217-615-7 [*Annex I Index No.:* 613-090-00-7]; 223-714-6 [*Annex I Index No.:* 613-089-00-1] (diquat dichloride); 218-196-3 [*Annex I Index No.:* 613-090-00-7] (paraquat-dimethylsulfate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (*dichloride*): Possible Human Carcinogen.

US EPA Gene-Tox Program, Positive: *S. cerevisiae* gene conversion.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg) (dichloride).

Reportable Quantity (RQ): 10 lb (4.54 kg) (dichloride).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations (*dichloride*): Hazard Symbol: T, N; Risk phrases: R24/25; R26; R36/37/38; R48/25; R50/53; Safety phrases: S1/2; S22; S28; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Paraquat is a yellow solid with a faint, ammonia-like odor. Molecular weight = 186.28; Specific gravity (H_2O:1) = 1.25; Boiling point = decomposes; Freezing/Melting point = 298°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): (paraquat) Health 4, Flammability 0, Reactivity 0. Soluble in water. Paraquat dichloride is a quaternary ion which is usually used as the dichloride salt. Molecular weight = 257.18. Highly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Those engaged in the manufacture, formulation, and application of this herbicide. Classified for restricted use: limited to use by a certified applicator, or those under applicator's direct supervision.

Incompatibilities: Strong oxidizers, alkylaryl-sulfonate wetting agents; strong bases (hydrolysis). Corrosive to metals. Decomposes in the presence of ultraviolet light. Decomposes in heat (see physical properties, above) and in the presence of UV light, producing nitrogen oxides, hydrogen chloride.

Permissible Exposure Limits in Air

OSHA PEL (*cation, dichloride, methosulfate*): 0.5 mg/m^3 respirable dust TWA [skin].

NIOSH REL (*dichloride*): 0.1 mg/m^3 respirable fraction TWA [skin].

ACGIH TLV®[1] (*cation*): 0.5 mg/m^3/; 0.1 mg/m^3 respirable fraction TWA.

NIOSH IDLH: 1 mg/m^3.

Protective Action Criteria (PAC) *(dichloride)*

TEEL-0: 0.1 mg/m^3

PAC-1: 0.1 mg/m^3

PAC-2: 0.15 mg/m^3

PAC-3: 1 mg/m^3

4685-14-7

TEEL-0: 0.1 mg/m^3

PAC-1: 0.25 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

DFG MAK (*dichloride*): 0.1 mg/m^3 measured as the inhalable fraction TWA; Peak Limitation Category I(1); [skin].

Austria: MAK 0.1 mg/m^3, [skin], 1999; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.2 mg/m^3, [skin], 1999; United Kingdom: TWA 0.08 mg/m^3, respirable dust, 2000; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m^3.

Several states have set guidelines or standards for paraquat in ambient air[60] ranging from 0.33 μg/m^3 (New York) to 0.50 μg/m^3 (South Carolina) to 1.0 μg/m^3 (Florida) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5003, Paraquat.

Permissible Concentration in Water: A lifetime health advisory of 3.0 μg/L has been derived by EPA (See "References" Below). In addition, the state of Maine[61] has set a guideline of 17.0 μg/L for paraquat in drinking water.

Determination in Water: Fish Tox = 2115.13304000 ppb (VERY LOW); Octanol−water coefficient: Log $K_{\mathrm{ow}} = -4.2$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Effects occur in two stages, immediate and delayed. Caution is advised. Exposure to paraquat may be fatal; there is no effective antidote. Signs and symptoms of acute exposure to paraquat may be severe and include nausea, vomiting, diarrhea, and abdominal pain. A burning sensation of the mouth and esophagus with possible ulceration may occur following ingestion. Eye exposure may result in corneal opacification (cloudiness). Dermatitis and nail atrophy may occur following dermal contact. Delayed effects include transient reversible liver injury, acute renal failure, and progressive pulmonary fibrosis with associated dyspnea (shortness of breath) and pulmonary edema. Absorbed through the skin and can lead to symptoms as listed in the following paragraph. In addition, can cause fingernail discoloration and damage (which returns to normal when exposure stops), irritation, redness, swelling, and burning. Exposure through ingestion may cause burning of the mouth and throat, nausea, vomiting, abdominal pain, diarrhea, and damage to the kidneys, heart, and liver. Lung damage, leading to death, may occur. One-half ounce of a 20% solution has caused death. Ingestion can also cause lung hemorrhage and fibrosis. The substance may cause effects on the lungs, kidneys, liver, cardiovascular system, and gastrointestinal tract, resulting in impaired functions, tissue lesions.

Long Term Exposure: Repeated or prolonged contact with skin may cause damage and possible loss of the fingernails, and can lead to dry and cracking skin with blistering. Repeated or prolonged exposure to the aerosol can cause lung irritation, lung damage; bronchitis may develop. Can cause scarring of the lungs leading to breathlessness. Can damage the liver, kidneys, and affect the heart. Human Tox = 3.15000 ppb Health Advisory (HIGH).

Points of Attack: Eyes, skin, respiratory system, heart, liver, kidneys, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; liver function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1s); urine (chemical/metabolite); urinalysis (routine). Consider the points of attack in preplacement and periodic physical examinations. Kidney function tests. EKG. Chemical users should be cautioned about the use of alcohol which can increase liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water, or bentonite clay in water, or activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. Obtain authorization and/or further instructions from the local hospital for performance of other invasive procedures. Rush to a health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 mg/m*^{3}*:* CcrOv95* (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter); or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. This chemical is inactivated by inert clays and anionic surfactants. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, alkylaryl-sulfonate wetting agents, light. Where possible, automatically pump material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Bipyridilium pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Paraquat is in Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Poisonous gases, including nitrogen oxides, are produced in fire. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. If water pollution occurs, notify appropriate authorities. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Procedures for bipyridilium pesticides are as follows. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Paraquat is rapidly inactivated in soil. It is also inactivated by anionic surfactants.

Therefore, an effective and environmentally safe disposal method would be to mix the product with ordinary household detergent and bury the mixture in clay soil. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Pasi, A. (1978). *The Toxicology of Paraquat, Diquat and Morfamquat*. Bern, Switzerland: H. Huber

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US Environmental Protection Agency. (August 1987). *Health Advisory: Paraquat*. Washington, DC: Office of Drinking Water

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Paraquat* (Version 2 and Version 3). Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Paraquat*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Paraquat methosulfate P:0160

Molecular Formula: $C_{14}H_{20}N_2O_8S_2$

Common Formula: $C_{12}H_{14}N_2(CH_3SO_4)_2$

Synonyms: 4,4-Bipyridinium, 1,1′-dimethyl-, bis(methyl sulfate); 1,1′-Dimethyl-4,4′-bipyridyniumdimethylsulfate; 1,1′-Dimethyl-4,4′-dipyridynium di(methyl sulfate); Gramoxone methyl sulfate; Paraqiat I; Paraquat bis(methyl sulfate); Paraquat dimethosulfate; Paraquat dimethyl sulphate; Paraquat dimethyl sulfate; Paraquat methsulfate bipyridylnium herbicide; PP 910

CAS Registry Number: 2074-50-2

RTECS® Number: DW2010000

UN/NA & ERG Number: UN2781/151

EC Number: 218-196-3 [*Annex I Index No.*: 613-090-00-7]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Hungary) (UN).[13]

SUPERFUND/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations (*includes dichloride*): Hazard Symbol: T, N; Risk phrases: R24/25; R26; R36/37/38; R48/25; R50/53; Safety phrases: S1/2; S22; S28; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Paraquat methosulfate is a white to yellow crystalline solid. Molecular weight = 408.48; Freezing/Melting point = 175−180°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Those who might be involved in the manufacture or use of this contact herbicide and desiccant.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 40 mg/m^3

A MAC of 0.01 mg/m^3 has been set in Bulgaria according to the EPA Profile (see "References," below).

Determination in Air: Use NIOSH Analytical Method (IV) #5003, Paraquat.

Permissible Concentration in Water: Paraquat: A lifetime health advisory of 3.0 μg/L has been derived by EPA (see "References," below). In addition, the state of Maine[61] has set a guideline of 17.0 μg/L for paraquat in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact causes irritation. Inhalation causes nosebleeds, headaches, coughing, and a sore throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Swallowing causes burning in mouth, throat, and abdomen; vomiting, bloody vomitus; diarrhea with bloody stools; and headaches. It can cause death by shock and/or pulmonary damage. The fatal dose is estimated to be 6 g of paraquat ion. Exposure may cause renal tubular damage and liver dysfunction. Death may occur in 24 h or less.

Long Term Exposure: Liver and kidney damage.

Points of Attack: Lungs, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests (paraquat dichloride): chest X-ray; liver function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); urine (chemical/metabolite); urinalysis (routine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

The following is for reference: NIOSH (for *paraquat dichloride*): *Up to 1 mg/m^3:* CcrOv95* (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter); or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Bipyridilium pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Paraquat is in Packing Group III.

Spill Handling: Remove all ignition sources. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Paraquat Methosulfate*. Washington, DC: Chemical Emergency Preparedness Program

Parathion P:0170

Molecular Formula: $C_{10}H_{14}NO_5PS$

Synonyms: AAT; AATP; ACC 3422; Alkron; Alleron; American cyanamid 3422; Aphamite; Aralo; B 404; BAY E-605; Bayer E-605; Bladan F; Compound 3422; Corothion; Corthion; Corthione; Danthion; *O*,*O*-Diethyl *O*-(*p*-nitrophenyl) phosphorothioate; *O*,*O*-Diethyl *O*-(4-nitrophenyl) phosphorothioate; *O*,*O*-Diethyl *O*,*p*-nitrophenyl phosphorothioate; Diethyl *p*-nitrophenyl phosphorothionate; Diethyl 4-nitrophenyl phosphorothionate; Diethyl *p*-nitrophenyl thionophosphate; *O*,*O*-Diethyl *O*,*p*-nitrophenyl thiophosphate; Diethyl parathion; DNTP:; DPP; Drexel parathion 8E; E 605; E 605 F; Ecatox; Ekatin WF & WF ULV; Ekatox; ENT15,108; Ethlon; Ethyl parathion; Etilon; Folidol; Folidol E; Folidol E-605; Folidol E&E 605; Folidol oil; Fosfermo; Fosferno; Fosfex; Fosfive; Fosova; Fostern; Fostox; Gearphos; Genithion; Kalphos; Kypthion; Lethalaire G-54; Lirothion; Murfos; Murphos; NCI-C00226; Niran; Niran E-4; Nitrostigmin (German); Nitrostigmine; NIUIF 100; Nourithion; Oleofos 20; Oleoparathene; Oleoparathion; OMS 19; Orthophos; PAC; Pacol; Panthion; Paradust; Paramar; Paramar 50; Paraphos; Parathene; Parathion-ethyl; Parathion thiophos; Parationa (Spanish); Parawet; Penncap E; Pestox plus; Pethion; Phoskil; Phosphorothioic acid, *O*,*O*-diethyl *O*-(*p*-nitrophenyl) ester; Phosphorothioic acid, *O*,*O*-diethyl *O*-(4-nitrophenyl) ester; Phosphostigmine; Pleoparaphene; RB; Rhodiasol; Rhodiatox; Rhodiatrox; Selephos; SNP; Soprathion; Stathion; STCC4921469; Sulphos; Super rodiatox; T-47; Thiomex; Thiophos; Thiophos 3422; Tiofos; TOX 47; Toxol (3); Vapophos; Vitrex

CAS Registry Number: 56-38-2; *(alt.)* 8057-70-3; *(alt.)* 11111-91-4; *(alt.)* 110616-89-2

RTECS® Number: TF4550000

UN/NA & ERG Number: UN2783 (Methyl parathion, solid)/152; UN1967 (Parathion and compressed gas mixture)/123; UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-271-7 [*Annex I Index No.:* 015-034-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse.

US EPA Gene-Tox Program, Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal Banned or Severely Restricted (many countries) (UN).[13]

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P089.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 4.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Safe Drinking Water Act: Priority List (55 FR 1470) as parathion degradation.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [parathion (all formulations—aerosols, dustable powder (DP), emulsifiable concentrate (EC), granules (GR), and wettable powders (WP)—of this substance are included, *except* capsule suspensions (CS))].

European/International Regulations: Hazard Symbol: T +, N; Risk phrases: R24; R26/28; R48/25; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Parathion is a clear liquid when fresh; pale yellow to dark-brown liquid with a garlic-like odor. Commercial formulations use carrier solvents that may change the physical properties shown. Molecular weight = 291.28; Specific gravity (H_2O:1) = 1.27; Boiling point = 375°C; 157−162°C at 6 mmHg (for CW agent); Freezing/Melting point = 6.1°C; also listed at 2.9°C for chemical warfare (CW) agent; Flash point = 195°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 24 mg/L.

Potential Exposure: A severely hazardous pesticide formulation. Those engaged in the manufacture, formulation, and application of this broad-spectrum insecticide. This material has also been used as a chemical warfare agent.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Attacks some plastics, rubbers, and coatings. Rapidly hydrolyzed by alkalis.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg/m^3 TWA [skin].

NIOSH REL: 0.05 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI; 0.05 mg[creatinine]/g in urine, end-of-shift.

NIOSH IDLH: 10 mg/m^3.

Protective Action Criteria (PAC)*

TEEL-0: 0.1 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: **1.5** mg/m^3

PAC-3: **2** mg/m^3

AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.1 mg/m^3 measured as the inhalable fraction TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group D; BAT: 100 μg[*p*-nitrophenol]/L in urine after several shifts (sampling time).

Arab Republic of Egypt: TWA 0.1 mg/m^3, [skin], 1993; Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3, short-term exposure limit 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Japan: 0.1 mg/m^3, [skin], 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Russia: STEL 0.05 mg/m^3, 1993; Thailand: TWA 0.11 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3, short-term exposure limit 0.3 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for parathion in ambient air[60] ranging from 0.238 μg/m^3 (Kansas) to 0.33 μg/m^3 (New York) to 0.5 μg/m^3 (South Carolina) to 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 1.87 μg/m^3 (Pennsylvania) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; OSHA Analytical Method ID-62.

Permissible Concentration in Water: Russia set a MAC[35] of 3.0 μg/L in surface water and Mexico has set maximum permissible concentrations of 1.0 μg/L in coastal waters and 10.0 μg/L in estuaries. Several states have set guidelines for parathion in drinking water[61] ranging from 8.6 μg/L in Maine to 30.0 μg/L in California and Kansas.

Determination in Water: Fish Tox = 0.26514000 ppb MATC (EXTRA HIGH); Octanol−water coefficient: Log K_{ow} = 3.15−3.8.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Parathion irritates the eyes, skin, and respiratory tract. A cholinesterase inhibitor. Acute exposure to parathion may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. This material is extremely toxic; the probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. As little as 1 drop can endanger life if splashed in the eye. Toxicity is highest by inhalation. People at special risk are those with a history of glaucoma, cardiovascular disease, hepatic disease, renal disease, or central nervous system abnormalities. Some additional details on short-term exposure to parathion are as follows: *Inhalation:* Occasional human exposures at concentrations of 0.1−0.8 mg/m^3 did not give rise to any symptoms. Occasional human exposure at 1.5−2.0 mg/m^3 resulted in nausea and vomiting. Higher exposures can give rise to dizziness, blurred vision, wheezing, excessive salivation, and muscle and abdominal cramps. An estimated 10−20 mg (1/1500 oz) may cause death. *Skin:* However, many human poisonings have occurred through extensive skin contact at unspecified levels. This is the greatest hazard for some workers. Symptoms of poisoning include nausea, vomiting, weakness, blurring of vision, and muscle cramps. NIOSH lists the following symptoms of exposure: irritation of the eyes, skin, respiratory system; miosis; rhinorrhea (discharge of thin nasal mucus); headache; chest tightness; wheezing, laryngeal spasm; salivation, cyanosis, anorexia, nausea, vomiting, abdominal cramps; diarrhea; sweating; muscle fasciculation; weakness, paralysis; giddiness, confusion, ataxia; convulsions, coma; low blood pressure; cardiac irregular/irregularities.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 0.23100 ppb Health Advisory (EXTRA HIGH).

Points of Attack: Respiratory system, central nervous system, cardiovascular system, eyes, skin, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: blood serum; cholinesterase: whole blood (chemical/metabolite); cholinesterase: blood plasma; cholinesterase: blood plasma, red blood cells/count; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-workweek. NIOSH recommends that medical surveillance, including preemployment and periodic examinations, shall be made available to workers who may be occupationally exposed to parathion. Biologic monitoring is also recommended as an additional safety measure. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *0.5 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *1.25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store where possible leakage from containers will not endanger the worker. Maintain regular inspection of containers for leakage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and alkaline material. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." Parathion falls in DOT Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is not very combustible. Poisonous gases, including carbon monoxide, sulfur oxides, phosphorous oxides, nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. One manufacturer recommends the use of a detergent in a 5% trisodium phosphate solution for parathion disposal and cleanup problems. For parathion disposal in general, however, the recommended method is incineration (816°C, 0.5 s minimum for primary combustion; 1204°C, 1.0 s for secondary combustion) with adequate scrubbing and ash disposal facilities.[22]

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Parathion*, NIOSH Document No. 76-190

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 92−97

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Parathion*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Parathion* (Version 2 and Version 3). Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Paris green P:0180

Molecular Formula: $C_4H_6As_6Cu_4O_{16}$

Synonyms: Acetoarsenite de cuivre (French); Acetoarsenito de cobre (Spanish); Basle green; C.I. 77410; C.I. Pigment green 21; Copper acetoarsenite; Cupric acetoarsenite; Emerald green; ENT884; French green; Imperial green; King's green; Meadow green; Mineral green; Mitis green; Moss green; Mountain green; Neuwied green; New green; Paris green; Parrot green; Patent green; O-P-G bait; Powder green; Schweinfurtergruen (German); Schweinfurt green; Sowbug & cutworm bait; Swedish green; Vienna green

CAS Registry Number: 12002-03-8

RTECS® Number: GL6475000

UN/NA & ERG Number: UN1585/151

Regulatory Authority and Advisory Bodies

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high-risk pollutants (Section 63.74) as arsenic compounds.

Clean Water Act: Section 311 Hazardous Substances/RQ 1 lb (0.454 kg); Toxic Pollutant (Section 401.15) as copper and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Safe Drinking Water Act 47FR9352 Regulated chemical: MCL, 0.05 mg/L (Section 141.11) applies only to community water systems (arsenic).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) *Note:* All species in the ground water that contain copper are included.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% arsenic, water-soluble compounds.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Paris green (copper acetoarsenite) is an odorless emerald green crystalline powder which decomposes upon heating. Molecular weight = 1013.78. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used primarily as an insecticide; it may be used as a wood preservative and a pigment, particularly for ships and submarines; and also finds use as an anthelmintic.

Incompatibilities: Can react vigorously with oxidizers. Emits highly toxic arsenic fumes on contact with acid or acid fumes; and in elevated temperatures.

Permissible Exposure Limits in Air

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA.

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

Protective Action Criteria (PAC)

Paris green; cupric acetoarsenite

TEEL-0: 1.13 mg/m^3

PAC-1: 3.38 mg/m^3

PAC-2: 22 mg/m^3

PAC-3: 22 mg/m^3

As arsenic, organic compounds

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 350 mg/m^3

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3; TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on a daily average basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301, #7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons but has set a guideline of 50 μg/L[61] for drinking water.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It has also been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry. See OSHA Analytical Method #ID-105 for arsenic.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: It may cause eye and respiratory tract irritation. Industrial exposure may cause dermatitis. This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. Some absorption may occur through the skin and by inhalation, but most poisonings result from ingestion. Symptoms usually appear ½ to 1 h after ingestion, but may be delayed. Causes gastric disturbance, tremors, muscular cramps, and nervous collapse, which may lead to death. Symptoms of exposure also include a sweetish, metallic taste and garlicky odor; difficulty in swallowing; abdominal pain; vomiting and diarrhea; dehydration; rapid heartbeat; dizziness and headache; and eventually coma; sometimes convulsions; and death.

Long Term Exposure: May cause liver damage. Arsenic compounds may cause blood, kidneys, and nervous system damage, and skin abnormalities may develop. See also entries for "Arsenic" and "Copper."

Points of Attack: Liver, kidneys, blood, skin.

Medical Surveillance: Liver and kidney function tests. Blood tests including CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metal poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018*, Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *"Inorganic Arsenic."*
Respirator Selection: *Copper dusts and mists: 5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *10 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Note: Substance reported to cause eye irritation or damage; may require eye protection.
Arsenic: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with copper acetoarsenite you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, away from strong bases, strong acids, and moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: Copper acetoarsenite requires a shipping label of "POISONOUS/TOXIC MATERIALS." Copper acetoarsenite falls in Hazard Class 6.1 and Packing Group II.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Do not touch spilled material. Take up *small spills* with sand or other noncombustible absorbent material and place in sealed containers for later disposal. For *small dry spills*, use a clean shovel to place material in clean, dry

container. For *large spills*, dike far ahead of spill for later disposal. Use water spray to knock down dust. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous fumes are produced in fire, including arsenic oxide and copper. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (January 1999). *Hazardous Substances Fact Sheet: Copper Acetoarsenite*. Trenton, NJ

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Paris Green*. Washington, DC: Chemical Emergency Preparedness Program

Pentaborane P:0190

Molecular Formula: B_5H_9

Synonyms: Dihydropentaborane (9); Pentaborane (9); Pentaborane undecahydride; Pentaborano (Spanish); (9)-Pentaboron nonahydride; Pentaboron nonahydride; Pentaboron undecahydride; Stable pentaborane

CAS Registry Number: 19624-22-7

RTECS® Number: RY8925000

UN/NA & ERG Number: UN1380/135

EC Number: 243-194-4

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Reportable Quantity (RQ): 500 lb (227 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pentaborane is a colorless, volatile liquid with an unpleasant, sweetish odor, like sour milk. The odor threshold is 0.8 ppm. Molecular weight = 63.14; Specific gravity (H_2O:1) = 0.62; Boiling point = 60°C; Freezing/Melting point = −47°C; Vapor pressure = 171 mmHg at 25°C; Flash point = 30°C; Autoignition temperature: about 35°C. Explosive limits: LEL = 0.42%; UEL = 98%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Reacts with water.

Potential Exposure: Pentaborane is used in rocket propellants and in gasoline additives.

Incompatibilities: Reacts on contact with oxidizers, halogens, water, halogenated hydrocarbons. May ignite *spontaneously* in moist air, decomposes at 150°C. Corrosive to natural rubber. Hydrolyzes slowly with heat in water to form boric acid. Contact with solvents, such as ketones, ethers, esters, forms shock-sensitive compounds. Corrosive to natural rubber and some synthetic rubber; some lubricants.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.58 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.005 ppm/0.01 mg/m^3 TWA.

NIOSH REL: 0.005 ppm/0.01 mg/m^3 TWA; 0.015 ppm/0.03 mg/m^3 STEL.

ACGIH TLV®[1]: 0.005 ppm/0.013 mg/m^3 TWA; 0.015 ppm/0.039 mg/m^3 STEL.

NIOSH IDLH: 1 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.005 mg/m^3

PAC-1: 0.015 mg/m^3

PAC-2: **0.14** mg/m^3

PAC-3: **0.70** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.005 ppm/0.013 mg/m^3 TWA; Peak Limitation Category II(2).

Arab Republic of Egypt: TWA 0.1 mg/m^3, [skin], 1993; Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3, short-term exposure limit 0.3 mg/m^3,

[skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Japan: 0.1 mg/m^3, [skin], 1999; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Russia: STEL 0.05 mg/m^3, 1993; Thailand: TWA 0.11 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3, short-term exposure limit 0.3 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for pentaborane in ambient air[60] ranging from 0.16 μg/m^3 (Virginia) to 0.2 μg/m^3 (Connecticut) to 1.0–3.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Nevada).

Determination in Air: No Analytical Method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Causes severe irritation to the respiratory tract. Pentaborane may affect the central nervous system, resulting in visual disturbances, poor judgment, behavioral changes, loss of recent memory, nausea, vomiting, drowsiness, and difficulty in focusing. Inhalation of higher concentrations may cause headache, dizziness, nervous excitation, muscular pain, muscle incoordination, cramps, tremors, convulsions, and coma. Death can occur by central nervous system poisoning.

Points of Attack: Central nervous system, eyes, skin.

Medical Surveillance: Preemployment and periodic physical examinations to determine the status of the workers' general health should be performed. These examinations should be concerned especially with any history of central nervous system disease, personality or behavioral changes, as well as liver, kidney, or pulmonary disease of any significant nature. Chest X-ray, blood, liver, and renal function studies may be helpful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.05 ppm:* Sa (APF = 10) (any supplied-air respirator). *0.125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *0.25 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Make certain respirator has no exposed rubber gaskets.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, halogens, water, halogenated hydrocarbons. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.2 and Packing Group I. A plus sign (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Do not touch spilled material, stop leak if you can do it without risk. For spills, dike for later disposal and do not apply water unless directed to do so. Clean up only under supervision of an expert. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Avoid breathing vapors, and keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 2.9/4.7
Night 5.5/8.9

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including boron, are produced in fire. Ignites spontaneously in air. Reacts violently with halogenated extinguishing agents. Fires tend to reignite. If material is on fire or involved in fire, do not extinguish unless flow can be stopped. *Do not use water*. Extinguish *small fires* with dry chemical or carbon dioxide. For *large fires* withdraw and let burn. Move container from fire area if you can do it without risk. Cool containers that are exposed to flames with water from the side until well after fire is out. *For massive fire* in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Wear positive pressure breathing apparatus and full protective clothing. If fire becomes uncontrollable or container is exposed to direct flame—evacuate for a radius of 1500 feet. If material is leaking (not on fire), downwind evacuation must be considered. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Pentaborane*. Washington, DC: Chemical Emergency Preparedness Program

Pentachlorobenzene P:0200

Molecular Formula: C_6HCl_5

Synonyms: Benzene, pentachloro-; 1,2,3,4,5-Pentachlorobenzene; QCB

CAS Registry Number: 608-93-5

RTECS® Number: DA6640000

UN/NA & ERG Number: UN3077/171

EC Number: 210-172-0 [*Annex I Index No.:* 602-074-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

TSCA: Subject to a proposed or final SNUR; Subject to a Section 4 test rule.

US EPA Hazardous Waste Number (RCRA No.): U183.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 10.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release).

European/International Regulations: Hazard Symbol: Risk phrases: F, Xn, N; R11; R22; R50/53; Safety phrases: S2; S41; S46; S50; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Pentachlorobenzene is a colorless crystalline solid with a pleasant aroma. Molecular weight = 250.32; Boiling point = 277°C; Freezing/Melting point = 86°C. Insoluble in water; solubility 0.65 mg/L.

Potential Exposure: Pentachlorobenzene is used primarily as a precursor in the synthesis of the fungicide pentachloronitrobenzene, and as a flame retardant. Drug/Therapeutic Agent; Fungicide; bactericide; wood preservative; industrial insecticides; organochlorine; Reproductive Effect; Tumor data.

Incompatibilities: Polychlorinated hydrocarbons can react with oxidizers and may react violently with aluminum, liquid oxygen, potassium, sodium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.04 mg/m^3

PAC-1: 0.125 mg/m^3

PAC-2: 0.75 mg/m^3

PAC-3: 400 mg/m^3

Determination in Air: Filter/XAD-2; workup with hexane; GC/ECD; NIOSH Analytical Method (IV) #5517, Polychlorobenzenes.

Determination in Water: A persistent organic pollutant. Log $K_{ow} = 4.75-5.75$.

Permissible Concentration in Water: The US EPA has set a criterion of 0.5 μg/L based on toxicity studies.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May affect the nervous system. LD_{50}= (oral-rat) 1080 mg/kg.

Long Term Exposure: Pentachlorobenzene may affect the liver and kidneys, causing tissue lesions. Limited animal studies have produced developmental effects and decreased body weights in fetuses.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources.[52] Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

US Environmental Protection Agency. (April 30, 1980). *Pentachlorobenzene, Health and Environmental Effects Profile No. 141*. Washington, DC: Office of Solid Waste

US EPA. (1980). Chlorinated Benzenes: Ambient Water Quality Criteria. Washington, DC

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 1, 105−107

Pentachloroethane P:0210

Molecular Formula: C_2HCl_5

Common Formula: CCl_3CHCl_2

Synonyms: Ethane pentachloride; Ethane, pentachloro-; NCI-C53894; Pentachloraethan (German); Pentachlorethane (French); Pentacloroetano (Spanish); Pentalin

CAS Registry Number: 76-01-7

RTECS® Number: KI6300000

UN/NA & ERG Number: UN1669/151

EC Number: 200-925-1 [*Annex I Index No.:* 602-017-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U184.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5); 8270 (10).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R40; R48/23; R51/53; Safety phrases: S1/2; S23; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pentachloroethane is a colorless, heavy, nonflammable liquid with a sweetish chloroform- or camphor-like odor. Molecular weight = 202.28; Boiling point = 162°C; Freezing/Melting point = −29°C; Flash point = 75°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen. Pentachloroethane is used in the manufacture of tetrachloroethylene and as a solvent for cellulose acetate, certain cellulose ethers, resins, and gums. It is also used as a drying agent for timber by immersion at temperatures greater than 100°C.

Incompatibilities: May self-ignite. Violent reaction with alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium) will produce spontaneous explosive chloroacetylenes. Shock- and friction-sensitive material formed by mixture with potassium.

Permissible Exposure Limits in Air

NIOSH REL: Handle with caution; See *NIOSH Pocket Guide*, Appendix C.

Protective Action Criteria (PAC)

TEEL-0: 46 mg/m^3

PAC-1: 126 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 5 ppm/42 mg/m^3 TWA; Peak Limitation Category II(2).

Rumania: TWA 30 mg/m^3; Yugoslavia: MAC 5 ppm/40 mg/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #2517.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 7240 μg/L on an acute toxicity basis and 1100 μg/L on a chronic basis. *To protect saltwater aquatic* *life:* 390 μg/L on an acute toxicity basis and 231 μg/L on a chronic basis. To protect human health—no criteria derived due to insufficient data.[6]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Pentachloroethane is an irritant and a strong central nervous system depressant. Pentachloroethane has a strong narcotic effect. Symptoms include prompt nausea, vomiting, abdominal pain with diarrhea, headaches, dizziness, confusion, drowsiness, and occasionally, convulsions. Visual disturbances may arise followed by coma and possible death from respiratory arrest or circulatory collapse. Death may occur by respiratory arrest or circulatory collapse. Occasionally, sudden death may occur due to ventricular fibrillation. Other effects may include weight gain, edema, loss of appetite, jaundice, and pain (due to enlarged liver). The chemical is very toxic with a probable oral lethal dose of 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb person. In animals: irritation of eyes, skin; weakness, restlessness, irregular/irregularities of respiration, muscle incoordination; liver, kidney, lung changes (NIOSH).

Long Term Exposure: Exposure to this material may result in injury to the liver, lungs, and kidneys.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator away from alkalis, reactive metals, water. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine, are produced in fire. Fires should be extinguished using water, carbon dioxide, or dry chemical. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site.

Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Pentachloroethane*, Report PB-274,073. Cincinnati, OH, pp. 303−305

US Environmental Protection Agency. (1980). *Chlorinated Ethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (January 4, 1983). *Chemical Hazard Information Profile Draft Reports: Pentachloroethane*. Washington, DC

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Pentachloroethane*. Washington, DC: Chemical Emergency Preparedness Program

Pentachloronaphthalene P:0220

Molecular Formula: $C_{10}H_3C_{15}$

Synonyms: Halowax 1013; Naphthalene, pentachloro-; 1,2,3,4,5-Pentachloronaphthalene

CAS Registry Number: 1321-64-8

RTECS® Number: QK0300000

EC Number: 215-320-8 [*Annex I Index No.:* 602-041-00-5]

Regulatory Authority and Advisory Bodies

US EPA GENETOX PROGRAM: Positive: Histidine reversion—Ames test, 1988.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R21/22; R36/38; R50/53; Safety phrases: S2 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Pentachloronaphthalene is a pale yellow or white solid powder with an aromatic odor. Molecular weight = 300.38; Specific gravity (H_2O:1) = 1.67; Boiling point = 335.6°C. Freezing/Freezing/Melting point = 120°C; Vapor pressure = $<$1 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Used in electric wire insulation, in additives to specialized lubricants, and as a fire- and water-proofing agent.

Incompatibilities: Violent reaction with strong oxidizers, aluminum, liquid oxygen, potassium, sodium. Heat may contribute to instability.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin].

No TEEL available.

DFG MAK: 0.5 mg/m^3 TWA [skin].

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, [skin], 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, 1999; Norway: TWA 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 1.5 mg/m^3, 1999; Sweden: NGV 0.2 mg/m^3, KTV 0.3 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.5 mg/m^3, KZG-W 2.5 mg/m^3, [skin], 1999; Turkey: TWA 0.5 mg/m^3, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 mg/m^3 [skin].

When skin contact also occurs, you may be overexposed, even though air levels are less than the limit listed above.

Determination in Air: Use NIOSH II(2), Method #S9.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 8.73−9.13 (ICSC).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin rash may occur if contaminated skin is exposed to sunlight. Can affect the nervous system, causing headache, fatigue, dizziness, vertigo (an illusion of movement), anorexia (loss of appetite).

Long Term Exposure: Repeated or prolonged contact with skin may cause acne-like rash (chloracne), pruritus. May affect the liver, causing jaundice; liver necrosis.

Points of Attack: Skin, liver, central nervous system.

Medical Surveillance: NIOSH lists the following tests: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 mg/m^3:* Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Pentachloronaphthalene*. Trenton, NJ

Pentachloronitrobenzene P:0230

Molecular Formula: $C_6Cl_5NO_2$

Synonyms: Avicol (Pesticide); Bartilex; Batrilex; Benzene, pentachloronitro-; Botrilex; Brassicol; Brassicol 75; Brassicol earthcide; Brassicol super; Chinozan; Fartox; Folosan; Fomac 2; Fungichlor; GC 3944-3-4; Kobu; Kobutol; KP 2; Marisan forte; NCI-C00419; Nitropentachlorobenzene; Olipsan; Olpisan; PCNB; Pentachlornitrobenzol (German); Pentachloronitrobenzene; Pentagen; Phomasan; PKHNB; Quinosan; Quintocene; Quintoceno (Spanish); Quintozene; RTU1010; Saniclor 30; Terrachlor; Terraclor; Terraclor30 G; Terrafun; Tilcarex; Tripcnb; Tritisan

CAS Registry Number: 82-68-8; *(alt.)* 39378-26-2

RTECS® Number: DA6650000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 201-435-0 [*Annex I Index No.:* 609-043-00-5] (quintozene)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (feed); no evidence: mouse; NTP: Carcinogenesis Studies (feed); no evidence: mouse.

US EPA Gene-Tox Program, Negative: Host-mediated assay; *In vitro* UDS—human fibroblast; Negative: TRP reversion; *S. cerevisiae*—homozygosis; Negative/limited: Carcinogenicity—mouse/rat; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

Banned or Severely Restricted (Germany, US) (UN).[13]

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U185.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 4.8.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R43; R50/53; Safety phrases: S2; S13; S24; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pentachloronitrobenzene forms colorless needles. Technical-grade PCNB contains an average of 97.8% PCNB, 1.8% hexachlorobenzene (HCB), 0.4% 2,3,4,5-tetrachloronitrobenzene (TCNB), and less than 0.1% pentachlorobenzene. Molecular weight = 295.32; Boiling point = 328°C; Freezing/Melting point = 146°C; Vapor pressure = 1×10^{-4} mbar at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those engaged in the manufacture, formulation, and application of this soil fungicide and seed treatment chemical.

Incompatibilities: Alkalis.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg/m^3 TWA: not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

Denmark: TWA 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Russia[35,43] set a MAC of 0.5 mg/m^3 in work-place air and MAC values for ambient air in residential areas of 0.01 mg/m^3 on a momentary basis and 0.006 mg/m^3 on a daily average basis. A guideline in ambient air has been set[60] in Pennsylvania at 2.47 μg/m^3.

Determination in Water: Fish Tox = 64.49856000 MATC (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May cause skin and eye irritation; sensitization with erythema, itching, and edema. A rebuttable presumption against registration of PCNB for pesticidal uses was issued on October 13, 1977 by EPA on the basis of oncogenicity.

Long Term Exposure: There is limited evidence that this compound is an animal carcinogen. Human Tox = 2.10000 ppb (HIGH).

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place away from strong bases. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. It has been observed that the product decomposes readily when burned with polyethylene. The compound is highly stable in soil in general, as would be expected on the basis of the polychlorinated aromatic structure.[22]

References

US Environmental Protection Agency. (April 30, 1980). *Pentachloronitrobenzene, Health and Environmental Effects Profile No. 142*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 11−16

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Chloronitrobenzenes (mixed isomers)*. Trenton, NJ

Pentachlorophenol P:0240

Molecular Formula: C_6HCl_5O

Common Formula: C_6Cl_5OH

Synonyms: Chem-tol; Chlon; Chlorophen; Cryptogil ol; Dowcide 7; Dowicide 7; Dowicide EC-7; Dowicide G; Dow pentachlorophenol DP-2 antimicrobial; Dura treet II; Durotox; EP30; Fungifen; Glaze penta; Grundier arbezol; 1-Hydroxypentachlorobenzene; Lauxtol; Lauxtol A; Liroprem; NCI-C54933; NCI-C55378; NCI-C56655; PCP; Penchlorol; Penta; Pentachlorofenol; Pentachlorophenate; 2,3,4,5,6-Pentachlorophenol; Pentachlorophenol, Dowicide EC-7; Pentachlorophenol, DP-2; Pentachlorophenol, technical; Pentachlorphenol (German); Pentaclorofenol (Spanish); Pentacon; Penta-Kil; Pentasol; Penwar; Peratox; Permacide; Permagard; Permasan; Permatox DP-2; Permatox penta; Permite; Phenol, pentachloro-; Pol nu; Preventol P; Priltox; Santobrite; Santophen; Santophen 20; Sinituho; Term-i-trol; Thompson's wood fix; Weedone; Woodtreat A

CAS Registry Number: 87-86-5

RTECS® Number: SM6300000

UN/NA & ERG Number: UN3155/154

EC Number: 201-778-6 [*Annex I Index No.:* 604-002-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2B, 1991; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; (feed); equivocal evidence: rat.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—forward mutation; Negative: Host-mediated assay; Mouse spot test; Negative: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.
Banned or Severely Restricted (several countries) (UN).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): D037.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA Toxicity Characteristic (Section 261.24), Maximum.
Concentration of Contaminants, regulatory level, 100 mg/L.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.089; Nonwastewater (mg/kg), 7.4.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (50).
Safe Drinking Water Act: MCL, 0.001 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as pentachlorophenol and its salts and esters).
California Proposition 65 Chemical: Cancer 1/1/90.
European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R36/37/38; R40; R50/53; Safety phrases: S1/2; S22; S36/37; S45; S52; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Pentachlorophenol is a colorless to white crystalline solid. It has a benzene-like odor; pungent when hot. The odor threshold in water is 1600 μg/L and the taste threshold in water is 30 μg/L. Molecular weight = 266.32; Specific gravity (H_2O:1) = 1.98; Boiling point = 308.9°C (decomposes); Freezing/Melting point = 190°C (anhydrous); Vapor pressure = 0.0001 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility in water = 0.001 at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Pentachlorophenol (PCP) is a commercially produced bactericide, fungicide, and slimicide used primarily for the preservation of wood, wood products, and other materials. As a chlorinated hydrocarbon, its biological properties have also resulted in its use as an herbicide and molluscicide. Two groups can be expected to encounter the largest exposures. One involves the small number of employees involved in the manufacture of PCP. All of these are presently under industrial health surveillance programs. The second and larger group are the formulators and wood theaters. Exposure, hygiene and industrial health practices can be expected to vary from the small theaters to the larger companies. The principal use as a wood preservative results in both point source water contamination at manufacturing and wood preservation sites and, conceivably, nonpoint source water contamination through runoff wherever there are PCP-treated lumber products exposing PCP to soil.

Incompatibilities: Reacts violently with strong oxidizers, acids, alkalis, and water.

Permissible Exposure Limits in Air
OSHA PEL: 0.5 mg/m^3 TWA [skin].
NIOSH REL: 0.5 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin]; BEI: 2 mg[total *PCP*]/g creatinine in urine/prior to last shift of workweek; 5 mg [free PCP]/L in plasma/end-of-shift; confirmed animal carcinogen with unknown relevance to humans.
NIOSH IDLH: 2.5 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.5 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 2.5 mg/m^3
DFG MAK: [skin] Carcinogen Category 2.
Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.005 ppm (0.05 mg/m^3), [skin], 1999; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, [skin], continuous carcinogen, 1999; Hungary: TWA 0.2 mg/m^3; STEL 0.4 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.06 mg/m^3, [skin], 2003; Norway: TWA 0.05 ppm (0.5 mg/m^3), 1999; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, [skin], 1993; Sweden: NGV 0.5 mg/m^3, KTV 1.5 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.5 mg/m^3); STEL 0.1 ppm, [skin], 1999; Turkey: TWA 0.5 mg/m^3, [skin], 1993; United Kingdom: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The notation "skin" is added to indicate the possibility of cutaneous absorption. Russia[43] set a MAC of 0.1 mg/m^3 in work-place air and a MAC in ambient basis. Several states have set guidelines or standards for Pentachlorophenol in ambient air[60] ranging from zero (North Carolina) to 0.034 μg/m^3 (Massachusetts) to 1.67 μg/m^3 (New York) to 5.0 μg/m^3 (North Dakota and South Carolina) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut and South Dakota) to 12.0 μg/m^3 (Nevada and Pennsylvania) to 25.64 μg/m^3 (Kansas).

Determination in Air: Use NIOSH (IV) Analytical Method #5512, Pentachlorophenol; in blood, #8001; in urine, #8303; OSHA Analytical Method 39.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 5.0$.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 55 μg/L on an acute toxicity basis and 3.2 μg/L on a chronic basis. *To protect saltwater aquatic life:* 53 μg/L on an acute basis and 34 μg/L on a chronic basis. To protect human health—1.010 μg/L is the criteria set by EPA based on toxicity data. A value of 30 μg/L is set on an organoleptic basis.[6] More recently, EPA[47] has developed a lifetime health advisory of 220 μg/L. WHO[35] has set a limit of 10 μg/L on pentachlorophenol in drinking water. Russia[43] set a MAC of 300 μg/L in water bodies used for domestic purposes. More recently, EPA has set a guideline of 200 μg/L for drinking water.[62] Several states have set guidelines for Pentachlorophenol in drinking water[61] ranging from 6 μg/L (Maine) to 30 μg/L (California) to 200 μg/L (Arizona) to 220 μg/L (Kansas and Minnesota).

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Fish Tox = 23.89351000 MATC (INTERMEDIATE) ppb.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Pentachlorophenol irritates the eyes, skin, and respiratory tract. May affect the cardiovascular system. *Inhalation:* Levels of 1 mg/m^3 can cause severe irritation of the nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Breathing dust or particulates tainted with pentachlorophenol can give rise to sneezing. *Skin:* A 0.04% solution can cause pain and inflammation at point of contact. Chloracne, a skin disorder, has been observed in workers in pentachlorophenol manufacturing plants and wood preserving operations. Profuse sweating and elevated temperature are symptoms of poisoning due to prolonged contact. Excessive skin exposure has caused human death. *Eyes:* Levels of 1 mg/m^3 may be irritating and excessive contact can lead to loss of sight due to corneal damage. *Ingestion:* The lethal human dose is approximately equal to 1 teaspoon for a 150-lb person. Ingestion of 4–8 oz followed by prompt emergency treatment still produced symptoms of poisoning which included rapid breathing followed by a decrease in breathing rate, abdominal pain, reduced blood pressure, excessive and slurred speech, and weakness.

Long Term Exposure: Irritation of eyes, throat, nose, and upper lungs has been reported by individuals using pentachlorophenol as an insecticide for periods of a few years. Chemical acne has been associated with prolonged exposure to this compound. May affect the central nervous system, kidneys, liver, lungs. May be a carcinogen in humans. May damage the developing fetus. There is limited evidence that pentachlorophenol is a teratogen in animals. Tumors have been detected in experimental animals. Human Tox = 1.00000 ppb MCL (HIGH).

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, liver, kidneys, central nervous system. Cancer site in animals: liver.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; urine (chemical/metabolite); urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior-to-shift; urine (chemical/metabolite), prior-to-last-shift-of-workweek. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for pentachlorophenol. Liver and kidney function tests. Refer to the NIOSH Criteria Documents #78-174 and #76-147, *Manufacturing, formulating, and working safely with pesticides*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, polyvinyl chloride, and Tychem® (from E.I. du Pont de Nemours & Company) are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2.5 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter) or Sa

(APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Pentachlorophenol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pentachlorophenol requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire (the material itself does not burn). Poisonous gases, including hydrogen chloride, dioxines, and chlorinated phenols, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Incineration (600−900°C) coupled with adequate scrubbing and ash disposal facilities.[22] Alternatively pentachlorophenol in wastewaters, for example, may be recovered and recycled.

References

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Pentaerythritol P:0250

Molecular Formula: $C_5H_{12}O_4$
Common Formula: $C(CH_2OH)_4$
Synonyms: 2,2-bis(Hydroxymethyl)-1,3-propanediol; Methane tetramethylol; Monopentaerythritol; PE; Pentaerythrite; Tetrahydroxymethylmethane; Tetramethylolmethane
CAS Registry Number: 115-77-5
RTECS® Number: RZ2490000
EC Number: 204-104-9
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Pentaerythritol is a white crystalline solid. Molecular weight = 136.17; Specific gravity (H_2O:1) = 1.38; Boiling point = (sublimes) 276°C at 30 mmHg; Freezing/Melting point = (sublimes) 261°C; Vapor pressure = 8×10^{-8} mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water; 6% at 15°C.
Potential Exposure: Pentaerythritol is used in coatings and stabilizers; in the formation of alkyd resins and varnishes. It is used as an intermediate in the manufacture of plasticizers, explosives (PETN), and pharmaceuticals.
Incompatibilities: Organic acids, oxidizers. Explosive compound is formed when a mixture of PE and thiophosphoryl chloride is heated.
Permissible Exposure Limits in Air
OSHA PEL: 15 mg/m^3 (total inhalable dust) TWA; 5 mg/m^3 TWA, respirable fraction.
NIOSH REL: 10 mg/m^3 (total inhalable dust) TWA; 5 mg/m^3 TWA, respirable fraction.
ACGIH TLV®[1]: 10 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 15 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 500 mg/m^3
Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, total inhalable dust; TWA 4 mg/m^3, respirable dust, 2000; the Netherlands: MAC-TGG 10 mg/m^3 (total dust), 2003; the Netherlands: MAC-TGG 5 mg/m^3 (respirable dust), 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3. States which have set guidelines or standards for pentaerythritol in ambient air[60] include Virginia at 80 μg/m^3 and Connecticut at 300 μg/m^3.
Determination in Air: Use NIOSH IV Method #0500, total dust; Method #0600 (respirable dust), Particulates NOR.
Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes and respiratory system. Feeding studies using human volunteers showed that 85% of Pentaerythritol fed was eliminated unchanged in the urine within 30 h. There are, in general, no significant effects on health by common routes of exposure even at abnormal use concentrations.
Points of Attack: Eyes, respiratory system.
Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use dust respirator.
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organic acids, oxidizers.
Shipping: Not regulated.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Pentaerythritol tetranitrate P:0255

Molecular Formula: $C_5H_8N_4O_{12}$

Common Formula: $C(CH_2ONO_2)_4$

Synonyms: Angicap; Angitet; Cardiacap; 1,3-Dinitrato-2,2-bis(nitratomethyl)propane; Nitropenta; Pentaerythrite tetranitrate; Pentaerithrityl tetranitrate; Pentaerithrityltetranitrat (German); Pentrita (Spanish); PETN; 1,3-Propanediol,2,2-bis[(nitrooxy) methyl]-, dinitrate (ester); Tetranitrato de pentaeritritilo (Spanish); Tétranitrate de pentaerithrityle (French); Vasitol; Vasodiatol

CAS Registry Number: 78-11-5; *(alt.)* 103842-90-6; *(alt.)* 108736-71-6

RTECS®Number: RZ2620000

UN/NA & ERG Number: UN3344 (Pentaerythrite tetranitrate mixture, desensitized, solid, n.o.s. with >10% but not >20% PETN, by mass)/113; UN0150 (Pentaerythrite tetranitrate, wetted or Pentaerythritol tetranitrate, wetted, or PETN, wetted or Pentaerythrite tetranitrate, or Pentaerythritol tetranitrate or PETN, desensitized)/112

EC Number: 201-084-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Not listed under California Proposition 65.

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 4 (1%).

European/International Regulations: Hazard Symbol: E; Risk phrases: R3; Safety phrases: S2; S35 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pentaerythrite tetranitrate (PETN) is a high explosive, especially when dry. PETN is a sand-like, white crystalline solid. Practically odorless. Molecular weight = 316.17; Boiling point = 205−215°C (explodes); Vapor pressure = negligible; 1.04×10^{-10} mmHg at 25°C; 1.035×10^{-10} mmHg at 25°C. Density 1.75−1.77 g/cm^3. Freezing/Melting point = 138−140°C. Autoignition temperature = (explodes) 210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability, 2; Reactivity, 4. Solubility in water = 4.3 mg/100 g at 25°C. The principal hazard from PETN is blast from sudden and abrupt explosion; not from ruptured or bursting container fragments or rocketing projectiles.

Potential Exposure: Compound Description: Tumorigen, Drug, Mutagen, Human Data. First introduced following WWII, PETN shares the same chemical family as nitroglycerine. It is 70% more powerful than TNT.[NYT] Used in the manufacture of fuses for detonation and explosive specialties, including the plastic explosive, Semtex, and in blasting caps. PETN is also used as a medical vasodilator to lower blood pressure by widening blood vessels to improve blood flow. PRTN has been used in terrorism attempts in 2001 by the so-called "shoe bomber," in 2009 by the "underwear bomber," and most recently in October 2010, hidden in printer cartridges being shipped internationally by passenger jet.

Incompatibilities: Normally stable, PETN does not easily explode when dropped or set on fire (rapid heating can cause detonation when heated to 210°C). Nevertheless, PETN is a dangerous high explosive and a strong oxidizer. PETN normally requires a blasting cap or other kind of detonator but may decompose explosively from concussion, shock, friction, static charges. Contact with reducing agents (e.g., zinc, alkaline metals) may cause explosion. Keep away from combustible materials, other oxidizers (e.g., nitrates, permanganates). Contact with sulfur trioxide may cause detonation. May explode in the presence of strong bases (i.e., sodium or potassium hydroxide). May react with heavy metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.015 mg/m^3

PAC-1: 0.05 mg/m^3

PAC-2: 0.35 mg/m^3

PAC-3: 500 mg/m^3

If material is mixed with TNT, see entry T:0920.

Determination in Air: NIOSH method not established. If material is mixed with TNT, see entry T:0920.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.60.

Routes of Entry: Inhalation of dust, fume, or vapor; ingestion of dust; percutaneous absorption from dust, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive and highly irritating. Target organs are the skin and heart. Contact irritates the eyes, nose, and throat. Can penetrate the skin. Exposure can cause red eyes, dizziness, irritability, headache, convulsions, nausea, vomiting.

PETN is a vasodilator and can affect the cardiovascular system, resulting in widening of blood vessels and the lowering of blood pressure. Medical care is advised.

Long Term Exposure: Lowest published toxic dose (oral, man): 1669 mg/kg/8 year—continuous. [British Journal of Dermatology (87, 498, 1972)].

Medical Surveillance: If material is mixed with TNT, see entry T:0920.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The Webster skin test (colorimetric tests with alcoholic sodium hydroxide) or indicator soap should be used to make sure workers have washed all PETN off their skins.

Respirator Selection: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or any air-purifying full-face-piece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or any supplied-air respirator with a full face-piece that is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: An explosive and a strong oxidizer. Color Code—Red Stripe: Flammability Hazard: Store in a explosion-proof refrigerator and keep away from reducing agents.[52] Store in a cool, dark place in a airtight container, separately from all other flammable materials. Unless specified by manufacturer, store between 15°C and 30°C. Protect from light. Prior to working with this chemical you should be trained on its proper handling and storage. Keep material wet with water and treat as an explosive. Keep away from heat, sources of ignition, metal, nitric acid, and reducing materials. Protect containers from shock. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pentaerythrite tetranitrate mixture, desensitized, solid, n.o.s. with $>10\%$ but not $>20\%$ PETN, by mass. Must be labeled "FLAMMABLE SOLID." This falls into Hazard Class 4.1 and Packing Group II. Pentaerythrite tetranitrate, wetted or Pentaerythritol tetranitrate, wetted, or PETN, wetted or Pentaerythrite tetranitrate, or Pentaerythritol tetranitrate or PETN, desensitized must be labeled "EXPLOSIVE 1.1D." It falls in Hazard Class 1.1D and Packing Group II. Air transport in passenger and cargo planes is FORBIDDEN.

Spill Handling: Seek expert help or contact manufacturer. Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust. Do not wash material to sewer. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Seek expert help or contact manufacturer. This chemical is a dangerously explosive solid and a strong oxidizer. It will increase the activity of an existing fire. The major hazard from PETN is the blast from sudden and abrupt explosion; not necessarily from ruptured or bursting container fragments or rocketing projectiles. When heated to decomposition, this material emits highly toxic nitrogen oxide fumes. If material is on fire and conditions permit, do not extinguish. Evacuate area and let burn. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Pentaerythrite Tetranitrate*. Trenton, NJ

Chang, K. (November 31, 2010). The New York Times news article, *Explosive on Planes Was Used in Past Plots*. New York, NY

Pentane P:0260

Molecular Formula: C_5H_{12}

Synonyms: Amyl hydride; Normalpentane; *n*-Pentane; *normal*-Pentane; *n*-Pentano (Spanish); Skellysolve-A

CAS Registry Number: 109-66-0

RTECS® Number: RZ9450000

UN/NA & ERG Number: UN1265/128

EC Number: 203-692-4 [*Annex I Index No.:* 601-006-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R12; R51/53; R65; R66; R67; Safety phrases: S2; S9; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Pentane is a colorless liquid. Gas above 36°C. Gasoline-like odor. Molecular weight = 72.17; Specific gravity (H_2O:1) = 0.63; Boiling point = 36°C; Freezing/Melting point = −129°C; Vapor pressure = 420 mmHg at 25°C; Flash point = −49.4°C (cc); Autoignition temperature = 260°C; also listed at 284 and 309°C. Explosive limits: LEL = 1.4%; UEL = 7.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Human Data. Pentane is used in the manufacture of ice, low-temperature thermometers, in solvent extraction processes, as a blowing agent in plastics, as a fuel, as a chemical intermediate (e.g., amylchlorides).

Incompatibilities: Reacts with strong oxidizers. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.95 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/2950 mg/m^3 TWA.

NIOSH REL: 120 ppm/350 mg/m^3 TWA; 610 ppm/1800 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 600 ppm/1770 TWA.

NIOSH IDLH: 1500 ppm [LEL].

Protective Action Criteria (PAC)

TEEL-0: 120 ppm

PAC-1: 120 ppm

PAC-2: 610 ppm

PAC-3: 1500 ppm

DFG MAK: 1000 ppm/3000 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Australia: TWA 600 ppm (1800 mg/m^3); STEL 750 ppm, 1993; Austria: MAK 600 ppm (1899 mg/m^3), 1999; Belgium: TWA 600 ppm (1770 mg/m^3); STEL 750 ppm (2210 mg/m^3), 1993; Denmark: TWA 500 ppm (1500 mg/m^3), 1999; Finland: TWA 500 ppm (1500 mg/m^3); STEL 625 ppm (1800 mg/m^3), 1999; France: VME 600 ppm (1800 mg/m^3), 1999; Hungary: TWA 500 mg/m^3; STEL 1500 mg/m^3, 1993; the Netherlands: MAC-TGG 1800 mg/m^3, 2003; the Philippines: TWA 1000 ppm (2950 mg/m^3), 1993; Poland: MAC (TWA) 1800 mg/m^3; MAC (STEL) 2300 mg/m^3, 1999; Russia: TWA 300 ppm; STEL 300 mg/m^3, 1993; Sweden: NGV 600 ppm (1800 mg/m^3), KTV 750 ppm (2000 mg/m^3), 1999; Switzerland: MAK-W 600 ppm (1800 mg/m^3), 1999; Turkey: TWA 1000 ppm (2950 mg/m^3), 1993; United Kingdom: LTEL 600 ppm (1800 mg/m^3); STEL 750 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 600 ppm. Russia[43] set a MAC of 100 mg/m^3 in ambient air in residential areas on a momentary basis and 25 mg/m^3 on a daily average basis. Several states have set guidelines or standards for pentane in ambient air[60] ranging from 7.0 mg/m^3 (Connecticut) to 18.0−22.5 mg/m^3 (North Dakota) to 30.0 mg/m^3 (Virginia) to 42.857 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1500, Hydrocarbons, BP 36-126°C; #2549, Volatile organic compounds.[18]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.4.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Pentane can affect you when breathed in. Exposure can cause lightheadedness and dizziness and may cause you to pass out. It may damage the nervous system, causing numbness, "pins and needles," and weakness in the arms and legs. Skin contact may cause rash and a burning sensation.

Long Term Exposure: Repeated or prolonged contact can cause dry, cracked skin.

Points of Attack: Eyes, skin, respiratory system, and central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Nerve conduction studies should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1200 ppm:* Sa (APF = 10) (any supplied-air respirator). *1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Pentane must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where pentane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of pentane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of pentane.

Shipping: Pentanes require a label of "FLAMMABLE LIQUID." They fall in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location,

use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Document No. 77-151. Washington, DC

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Pentane*. Trenton, NJ

2,4-Pentanedione P:0270

Molecular Formula: $C_5H_8O_2$

Common Formula: $CH_3COCH_2COCH_3$

Synonyms: Acetoacetone; Acetyl acetone; Diacetylmethane; Pentane-2,4-dione; 2-Propanone, acetyl

CAS Registry Number: 123-54-6; 81235-32-7

RTECS® Number: SA1925000

UN/NA & ERG Number: UN2310/131

EC Number: 204-634-0 [*Annex I Index No.:* 606-029-00-0]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*23-54-6*): Hazard Symbol: Xn; Risk phrases: R10; R22; Safety phrases: S2; S21; S23; S24/25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: 2,4-Pentanedione is a colorless to yellowish liquid with a sour, rancid odor. The odor threshold is 0.01 ppm. Molecular weight = 100.13; Boiling point = 139°C; Freezing/Melting point = −23°C; Flash point = 34°C; Autoignition temperature = 340°C. Explosive limits: LEL = 2.4%; UEL = 11.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Acetoacetic acid derivative. Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Primary Irritant. 2,4-Pentanedione is used in gasoline and lubricant additives, fungicides, insecticides, and colors manufacture; as a chemical intermediate and in the manufacture of metal chelates.

Incompatibilities: Oxidizing material, bases, reducing agents, halogens, aliphatic amines, alkanolamines, organic acids, isocyanates. Light may cause polymerization.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: (2010 Notice of intended change) 25 ppm TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 50 ppm

PAC-2: 100 ppm

PAC-3: 100 ppm

DFG MAK: 20 ppm/83 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye irritation may be severe. May affect the nervous system. If inhaled, will cause dizziness, coughing, headaches, convulsions, loss of consciousness, and possible death. In addition, to neuropathy, 2,4-pentanedione causes thymic atrophy; it complexes with and inhibits the activities of oxidizing enzymes; it causes minor to severe eye injury and minor to moderate skin irritation in animals; and it has caused contact urticaria and allergic contact dermatitis in humans.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. High exposure may affect the brain. May affect the lungs, thymus, central nervous system. There is limited evidence of reproductive damage and mutations.

Points of Attack: Skin, brain, lungs, central nervous system, thymus.

Medical Surveillance: Evaluation by a qualified allergist. Evaluation of brain effects. Thymus function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in stainless steel containers away from oxidizers, reducing agents, bases. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Pentane-2,4-dione requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 25−26 (as Acetylacetone)

US Environmental Protection Agency. (August 25, 1988). *Chemical Hazard Information Profile Draft Report: Pentanedione*. Washington, DC: Office of Toxic Substances

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Pentane-2,4-dione*. Trenton, NJ

1-Pentene P:0280

Molecular Formula: C_5H_{10}

Common Formula: $CH_3(CH_2)_2CH{=}CH_2$

Synonyms: Amylene; α-*n*-Amylene; Pentene; Pentylene; Propylethylene

CAS Registry Number: 109-67-1; *(alt.)* 25377-72-4

RTECS®Number: SB2179000

UN/NA & ERG Number: UN1108/128

EC Number: 246-916-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pentene is a colorless liquid. Molecular weight = 70.15; Boiling point = 30°C; Vapor pressure = 60.8 mmHg at 20°C; Flash point = −18°C; Autoignition temperature = 276°C. Explosive limits: LEL = 1.5%; UEL = 8.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1.

Potential Exposure: Workers in petroleum refineries and petrochemical plants.

Incompatibilities: Strong oxidants.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

109-67-1

TEEL-0: 300 ppm
PAC-1: 750 ppm
PAC-2: 6000 ppm
PAC-3: 75,000 ppm

Russia[43] set a MAC for amylene in ambient air of residential areas at 1.5 mg/m^3 both on a momentary and a daily average basis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Simple asphyxiant. Narcotic in high concentrations. May affect central nervous system. Moderately toxic by oral and inhalation routes.

Long Term Exposure: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

Points of Attack: Skin, eyes, respiratory tract, and nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Use protective gloves and safety goggles. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: 1-Pentene requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 69−71 (1982) and 3, No. 2, 56−57 (1983)

New Jersey Department of Health and Senior Services. (March 2007). *Hazardous Substances Fact Sheet: n-Pentene*. Trenton, NJ

Peracetic acid P:0290

Molecular Formula: $C_2H_4O_3$

Common Formula: CH_3COOOH

Synonyms: Acetic peroxide; Acetyl hydroperoxide; Acide peracetique (French); Acido peracetico (Spanish); Desoxon 1; Estosteril; Ethaneperoxoic acid; Hydrogen peroxide and peroxyacetic acid mixture; Hydroperoxide, acetyl; Monoperacetic acid; Osbon AC; Oxymaster; PAA; Peroxyacetic acid; Proxitane; Proxitane 4002

CAS Registry Number: 79-21-0

RTECS® Number: SD8750000

UN/NA & ERG Number: UN3105 [Organic peroxide type D, liquid (stabilized)]/145; UN3109 [Organic Peroxide Type F, Liquid (with ≤17% Peracetic Acid with ≤26% Hydrogen Peroxide)]/145

EC Number: 201-186-8 [*Annex I Index No.*: 607-094-00-8]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Highly Reactive Substance and Explosive (World Bank).[15]

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, C, N; Risk phrases: R7; R10; R20/21/22; R35; R50; Safety phrases: S1/2; S3/7; S14; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Peracetic acid is a colorless liquid. Transported and stored in diluted solution with acetic acid and hydrogen peroxide to prevent explosion. Molecular weight = 76.06; Specific gravity (H_2O:1) = 1.2; Boiling point = 105°C (violent decomposition at 110°C); Freezing/Melting point = 0.1°C; Flash point = 41.3°C (oc); 56°C (32% in dilute acetic acid and <6% hydrogen peroxide); Autoignition temperature = 198°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Primary Irritant. This compound is used as polymerization initiator, curing agent, and cross-linking agent; as bactericide and fungicide, especially in food processing; a reagent in making caprolactam and glycerol; an oxidant for preparing epoxy compounds; a bleaching agent; a sterilizing agent; and a polymerization catalyst for polyester resins.

Incompatibilities: This material is a powerful oxidizer. Thermally unstable, it decomposes violently at 110°C. Concentrated material is shock- and friction-sensitive. May explode if concentration exceeds 56% of carrier, due to evaporation. Isolate from other stored material, particularly accelerators, oxidizers, organic or combustible materials, olefins, hydrogen peroxide, acetic anhydride, reducing substances. Keep away from acids, alkalis, heavy metals, organic materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.15 mg/m^3

PAC-1: **0.52** mg/m^3

PAC-2: **1.6** mg/m^3

PAC-3: **15** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 3B; See section X(a).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause severe irritation and burns; may cause permanent damage. Irritates the respiratory tract. Contact may burn the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Signs and symptoms of acute ingestion of peracetic acid may include corrosion of mucous membranes of mouth, throat, and esophagus with immediate pain and dysphagia (difficulty in swallowing); ingestion may cause gastrointestinal tract irritation. This is a very toxic compound. The probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb person.

Long Term Exposure: There is limited evidence that peracetic acid causes cancer in animals. It may cause cancer of the lungs. High or repeated exposure may affect the liver and kidneys.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber and Viton are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Keep in a cool, well-ventilated area, separated from organic and combustible materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Organic peroxide type D, liquid, requires a shipping label of "ORGANIC PEROXIDE." They fall in DOT Hazard Class 5.2 and Packing Group I. Organic peroxide type F, liquid, requires a shipping label of "Organic Peroxide Type F, Liquid (with $<=$ 17% Peracetic Acid with $<=$ 26% Hydrogen Peroxide)." They fall in DOT Hazard Class 5.2 and Packing Group II. Shipment of solutions with $>$43% peracetic acid is FORBIDDEN under any conditions.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid breathing vapors. Do not touch the spilled material; shut off all ignition sources and stop the leak if this can be done without risk. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Do not use spark-generating metals or organic materials for sweeping up or handling spilled material. Dispose of the absorbed peroxyacetic acid solution, in small quantities at a time, by placing it on the ground in a remote outdoor area and igniting with a long torch. Empty containers should be washed with a 10% sodium hydroxide solution. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid and a powerful oxidizer that can increase the activity of an existing fire. It explodes at 230°F/110°C and is shock sensitive, particularly if organic solvents are used in place of acetic acid as a carrier. Poisonous gases are produced in fire. Fight fires from an explosion-resistant location. In advanced or massive fires, area should be evacuated. For small fires: use dry chemical, carbon dioxide, water spray, or foam. For large fires: flood area with water. If fire occurs in the vicinity of this compound, water should be used to keep containers cool. Cleanup and salvage operations should not be attempted until all of the peroxyacetic acid solution has cooled completely. Keep unnecessary people away; wear self-contained breathing apparatus and full protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Peracetic Acid*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Peracetic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Peroxyacetic Acid*. Trenton, NJ

Perchloromethyl mercaptan P:0300

Molecular Formula: CCl_4S
Common Formula: CCl_3SCl
Synonyms: Clairsit; Mercaptan methylique perchlore (French); Perchloromethanethiol; PMM; Trichloromethane sulfenyl chloride; Trichloromethylsulfenyl chloride; Trichloromethyl sulfur chloride; Trichloromethylsulphenyl chloride PCV
CAS Registry Number: 594-42-3
RTECS® Number: PB0370000
UN/NA & ERG Number: UN1670 (inhalation zone B)/157
EC Number: 209-840-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb (67.5 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Perchloromethyl mercaptan is a pale yellow oily liquid with a foul-smelling, unbearable, acrid odor. Molecular weight = 185.87; Specific gravity (H_2O:1) = 1.69; Boiling point = (decomposes) 147.2°C; Vapor pressure = 3 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. Perchloromethyl mercaptan is used as an intermediate for the synthesis of dyes and fungicides, such as Captan and Folpet. It has been considered as a warfare tear gas because of its highly irritant properties.

Incompatibilities: Water contact forms HCl, sulfur, and carbon dioxide. Reacts with alkalies, amines, hot water, alcohols, oxidizers, reducing agents, iron, and steel. Attacks most metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.60 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 0.1 ppm/0.8 mg/m^3 TWA.
NIOSH REL: 0.1 ppm/0.8 mg/m^3 TWA.
ACGIH TLV®[1]: 0.1 ppm/0.76 mg/m^3 TWA.
NIOSH IDLH: 10 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.013 ppm
PAC-1: **0.013** ppm
PAC-2: **0.3** ppm
PAC-3: **0.9** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.1 ppm (0.8 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.8 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.76 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.8 mg/m^3), 1999; Finland: STEL 0.1 ppm (0.8 mg/m^3), 1999; France: VME 0.1 ppm (0.8 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.8 mg/m^3), 1999; the Netherlands: MAC-TGG 0.8 mg/m^3, 2003; Switzerland: MAK-W 0.1 ppm (0.8 mg/m^3), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.8 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm. Several states have set guidelines or standards for PMM in ambient air[60] ranging from 8.0 μg/m^3 (North Dakota) to 13.0 μg/m^3 (Virginia) to 16.0 μg/m^3 (Connecticut) to 19.0 μg/m^3 (Nevada).

Determination in Air: Sample collection by charcoal tube, analysis by gas liquid chromatography.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Signs and symptoms of acute exposure to perchloromethyl mercaptan may lead to liver, heart, and kidney damage. Respiratory effects include coughing, dyspnea (shortness of breath), painful breathing, and lung congestion. Tachycardia (rapid heart rate) is often observed. Nausea, vomiting, abdominal cramping, and diarrhea may also occur. Contact with Perchloromethyl mercaptan may result in severe dermatitis (red, inflamed skin), conjunctivitis (red, inflamed eyes), and burns with ulceration and severe pain. May cause death or permanent injury after short exposure to small quantities. Brief exposure to lower concentrations may produce central nervous system depression and lung, liver, and heart congestion. Severe exposures may be fatal. May be absorbed through the skin in quantities sufficient to cause general toxic effects. Ingestion may cause damage to mucous membranes and result in pain and burning of the mouth and throat, nausea, vomiting, cramps, and diarrhea. In severe cases, tissue ulceration and CNS depression may occur.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urinalysis (routine); white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa* (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SaT: Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 10 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. Store in a cool, dry place. Protect from moisture, metals, oxidizing and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Perchloromethyl mercaptan requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. It may be necessary to seek emergency assistance.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.9/1.5

Fire Extinguishing: This compound is neither flammable nor a serious fire hazard, although it will support combustion. Fight small fires with dry chemical, carbon dioxide, water spray, or foam, and large fires with water spray, fog, or foam. Move containers containing this compound away from fire area if possible. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Positive pressure breathing apparatus and special protective clothing should be worn. Poisonous gases, including chlorine and sulfur oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration together with a flammable solvent in a furnace equipped with afterburner and scrubber.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Perchloromethyl Mercaptan*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Perchloromethyl Mercaptan*. Trenton, NJ

Perchloryl fluoride P:0310

Molecular Formula: $ClFO_3$
Common Formula: ClO_3F
Synonyms: Chlorine oxyfluoride; Chlorine fluoride oxide; Trioxychlorofluoride
CAS Registry Number: 7616-94-6
RTECS® Number: SD1925000
UN/NA & ERG Number: UN3083/124
EC Number: 231-526-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 ($\geq$25.67% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Perchloryl fluoride is a colorless gas with a characteristic sweet odor. Shipped as a liquefied compressed gas. Molecular weight = 102.45; Boiling point = − 46.7°C; Freezing/Melting point = − 147.8°C; Relative vapor density (air = 1) = 3.64; Vapor pressure = 10.5 atm at 25°C; Relative vapor density (air = 1) = 3.64. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 3 (Oxidizer). Slightly soluble in water; solubility = 0.06% at 20°C.

Potential Exposure: Perchloryl fluoride has been used as a liquid oxidant in rocket propellant combinations, as an insulating gas in high-voltage electrical systems, as a fluorinating agent in organic synthesis.

Incompatibilities: A strong oxidizer. Violent reaction with benzene, calcium hydride, combustibles, olefins, strong bases, sulfur, sulfuric acid, amines, reducing agents, alcohols. Contact with carbonaceous materials (such as charcoal) or finely divided metals (such as powdered magnesium, aluminum, zinc) are a fire and explosion hazard. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.19 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 3 ppm/13.5 mg/m^3 TWA.
NIOSH REL: 3 ppm/14 mg/m^3 TWA; 6 ppm/28 mg/m^3 STEL.
ACGIH TLV®[1]: 3 ppm/13 mg/m^3 TWA; 6 ppm/25 mg/m^3 STEL.
NIOSH IDLH: 100 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 1.5 ppm
PAC-1: **1.5** ppm
PAC-2: **4.0** ppm
PAC-3: **12** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 3 ppm (14 mg/m^3); STEL 6 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: TWA 3 ppm (13 mg/m^3); STEL 6 ppm (25 mg/m^3), 1993; Denmark: TWA 3 ppm (14 mg/m^3), 1999; Finland: TWA 3 ppm (14 mg/m^3); STEL 6 ppm (25 mg/m^3), 1999; France: VME 3 ppm (14 mg/m^3), 1999; Norway: TWA 3 ppm (14 mg/m^3), 1999; the Netherlands: MAC-TGG 14 mg/m^3, 2003; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 3 ppm (13 mg/m^3), 1999; United Kingdom: TWA 3 ppm (13 mg/m^3); STEL 6 ppm (26 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 6 ppm.

Several states have set guidelines or standards for perchloryl fluoride in ambient air[60] ranging from 140−280 μg/m^3 (North Dakota) to 230 μg/m^3 (Virginia) to 270 μg/m^3 (Connecticut) to 333 μg/m^3 (Nevada).

Determination in Air: Sample collection by impinger or fritted bubbler; analysis by ion-specific electrode.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the respiratory tract. May affect the blood, causing the destruction of red blood cells; formation of methemoglobin. Cyanosis and anemia may result. The liquid may cause frostbite.

Long Term Exposure: May cause anemia. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth. Repeated exposure may cause nausea, vomiting, loss of appetite, diarrhea, or constipation.

Points of Attack: Respiratory system, skin, blood.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite), Methemoglobin; Complete blood count; chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Consider the points of attack in preplacement and periodic physical examinations. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 30 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 75 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 100 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, well-ventilated area away from incompatible materials listed above. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Perchloryl fluoride requires a shipping label of "POISON GAS, OXIDIZER." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 2.0/3.2
Night 5.2/8.4

Fire Extinguishing: Nonflammable gas, but will support combustion and add to the intensity of an existing fire. Poisonous gases, including fluorine, fluorine oxides, chlorine, and chlorine oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration together with flammable solvent in furnace equipped with afterburner and scrubber.

Reference

New Jersey Department of Health and Senior Services. (November 2001). *Hazardous Substances Fact Sheet: Perchloryl Fluoride*. Trenton, NJ

Persulfates

See "Potassium Persulfate" as good example of this class of compounds.

Phenanthrene P:0320

Molecular Formula: C_4H_{10}
Synonyms: Coal tar pitch volatiles: Phenanthrene; Phenanthren (German); Phenantrin
CAS Registry Number: 85-01-8
RTECS® Number: VB2600000
UN/NA & ERG Number: Not regulated.
EC Number: 201-581-5
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.
OSHA, 29CFR1910 Specifically Regulated Chemicals (CFR1910.1002) as coal tar pitch volatiles.
Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total Toxic Organics, 40CFR423, Priority Pollutants, as polynuclear aromatic hydrocarbons (PAH).
RCRA 40CFR258, Appendix 2.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4.
RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10).
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration: 1% as phenanthrene; 0.1% as coal tar pitch volatiles; DSL list.
Mexico, Drinking Water, Criteria (Ecological): 0.02 mg/L; wastewater: organic toxic pollutant.
European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R50/53; Safety phrases: S29; S36/37; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Phenanthrene is a white[2] crystalline substance with a weak aromatic odor. Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Molecular weight = 178.22.[2] Molecular weight = 178.24; Boiling point = 340°C at 760 mmHg[2]; Freezing/Melting point = 100°C[2]; Flash point = 171°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.
Potential Exposure: Mutagen. Used for making dyes, other chemicals; explosives, pharmaceuticals; in biological research.
Incompatibilities: Oxidizers.
Permissible Exposure Limits in Air: No specific standards have been established for phenanthrene.
OSHA PEL: 0.2 mg/m^3 TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.
NIOSH REL: 0.1 mg/m^3 (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.
ACGIH TLV®[1]: 0.2 mg/m^3 TWA (as benzene-soluble aerosol); Confirmed Human Carcinogen.
NIOSH IDLH: 80 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: [skin].
Several states have set guidelines or standards for coal tar pitch volatiles in ambient air[60] ranging from zero (North Carolina) to 0.0161 $\mu g/m^3$ (Kansas) to 0.48 $\mu g/m^3$ (Pennsylvania) to 2.0 $\mu g/m^3$ (Connecticut and Virginia) to 5.0 $\mu g/m^3$ (Nevada).
Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Skin contact can cause irritation. A skin photosensitizer, contaminated skin exposed to sunlight can develop rash, skin burns, and blisters. Irritates the eyes and respiratory tract.
Long Term Exposure: May cause skin allergy. If allergy develops, very low future exposure can cause itching and skin rash.
Points of Attack: Skin, respiratory system, bladder, liver, kidneys.
Medical Surveillance: NIOSH lists: complete blood count; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria.[2]
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration over 0.1 mg/m^3:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Not regulated. However, the "Acridine" standard may be used for this chemical. The required label is "POISONOUS/TOXIC MATERIALS." It would fall in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US EPA. (April 1975). *Identification of Organic Compounds in Effluents from Industrial Sources*, EPA-560/3-75-002. Washington, DC

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Phenanthrene*. Trenton, NJ

Phenazopyridine & phenazo-pyridine hydrochloride P:0330

Molecular Formula: $C_{11}H_{12}ClN_5$

Synonyms: AP; 2,6-Diamino-3-phenylazopyridine; Diridone; DPP; Gastracid; Gastrotest; Mallophene; NC150; Phenazodine; Phenylazo; 3-(Phenylazo)-2,6-pyridinediamine; Pirid; Pyrazofen; Pyridacil; Pyridium; Pyripyridium; Sedural; Uridinal; Urodine; W 1655

Hydrochloride: Azodine; Azodium; Azodyne; Azo gantrisin; Azo gastanol; Azo-mandelamine; Azomine; Azo-standard; Azo-stat; Azotrex; Baridium; Bisteril; Cystopyrin; Cystural; 2,6-Diamino-3-phenylazopyridine hydrochloride; 2,6-Diamino-3-(phenylazo)pyridine monohydrochloride; Di-azo; Diridone; Dolonil; Eucistin; Giracid; Mallofeen; Mallophene; NC150; NCI-C01672; Nefrecil; PAP; PDP; Phenazo; Phenazodine; Phenazopyridine hydrochloride; Phenazopyridinium chloride; β-Phenylazo-α,α′-diaminopyridine hydrochloride; 3-Phenylazo-2,6-diaminopyridine hydrochloride; Phenylazodiaminopyridine hydrochloride;

Phenylazo-α,α′-diaminopyridine monohydrochloride; 3-(Phenylazo)-2,6-pyridinediamine, hydrochloride; Phenylazopyridine hydrochloride; Phenyl-idium; Phenylidium 200; Pirid; Piridacil; Pyrazodine; Pyrazofen; Pyredal; Pyridacil; Pyridenal; Pyridene; Pyridiate; Pyridium; Pyridivite; Pyripyridium; Pyrizin; Sedural; Suladyne; Sulodyne; Thiosulfil-A forte; Urazium; Uridinal; Uriplex; Urobiotic-250; Urodine; Urofeen; Uromide; Urophenyl; Uropyridin; Uropyrine; Utostan; Vestin; W 1655

CAS Registry Number: 94-78-0; 136-40-3 (hydrochloride)

RTECS®* *Number: US7875000 (hydrochloride); US7700000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-363-2; 205-243-8 (hydrochloride)

Regulatory Authority and Advisory Bodies

Carcinogenicity: (hydrochloride) IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; (feed); clear evidence: rat; NTP: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical: Cancer 1/1/88; 1/1/88 (hydrochloride).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phenazopyridine is a red crystalline compound. Molecular weight = 213.27; 249.73 (hydrochloride); Freezing/Melting point = (fine base) 139°C; 233−238°C (hydrochloride). Slightly soluble in water.

Potential Exposure: Phenazopyridine hydrochloride has been used for 50 years as an analgesic drug either alone or in combination with other drugs to reduce pain associated with urinary tract infection. Also used as a local anesthetic. Exposure to phenazopyridine hydrochloride occurs during manufacture and formulation.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can affect you if swallowed. Symptoms of exposure include diarrhea, nausea, or vomiting; dehydration, decreased urine volume. May affect the development of red blood cells, causing cyanosis and methemoglobinemia and changes in blood sodium levels.

Long Term Exposure: May affect the kidneys. Phenazopyridine hydrochloride was tested in mice and rats by oral administration. In female mice, it significantly increased the incidence of hepatocellular adenomas and carcinomas. In male and female rats, it induced tumors of the colon and rectum. Symptoms of exposure include deeply stained vomitus and urine, methemoglobinemia, Heinz body anemia, hepatic enlargement, abnormal renal function. May cause mutations.

Points of Attack: Blood, kidneys.

Medical Surveillance: Complete blood count (CBC). Kidney function tests.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Protect from air and light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Phenol P:0340

Molecular Formula: C_6H_6O

Common Formula: C_6H_5OH

Synonyms: Acide carbolique (French); Benzene, hydroxy-; Benzenol; Carbolic acid; Carbolsaure (German); ENT 1814; Fenol (Spanish); Hydroxybenzene; Monohydroxybenzene; Monophenol; NCI-C50124; Oxybenzene; Phenic acid; Phenole (German); Phenyl alcohol; Phenyl hydrate; Phenyl hydroxide; Phenylic acid; Phenylic alcohol

CAS Registry Number: 108-95-2

RTECS® Number: SJ3325000

UN/NA & ERG Number: UN1671 (solid)/153; UN2312/153 (molten); UN2821 (solution)/153

EC Number: 203-632-7 [*Annex I Index No.:* 604-001-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (oral); no evidence: mouse, rat; IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential; Not Classifiable as to human carcinogenicity.

US EPA Gene-Tox Program, Negative: *N. crassa*—reversion.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): U188.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.039; Nonwastewater (mg/kg), 6.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (1); 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; R34; R48/21/22/23; R68; Safety phrases: S1/2; S24/25; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Phenol is a colorless to light pink crystalline solid with a sweet, acrid odor. Phenol liquefies by mixing with about 8% water. The odor threshold in air is 0.04 ppm and in water is 7.9 ppm. Molecular weight = 94.12; Boiling point = 182°C; Freezing/Melting point = 42.8°C; Relative vapor density (air = 1) = 1.00 at 20°C; Vapor pressure = 0.4 mmHg at 25°C; Relative vapor density (air = 1): 3.2; Flash point = 79.4°C (cc); Autoignition temperature = 715°C. Explosive limits: LEL = 1.3%; UEL = 8.6%. Hazard Identification (based on NFPA-704 M Rating System) (*liquid, crystals*): Health 4, Flammability 2, Reactivity 1 (Corrosive). Soluble in water; solubility = 9% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Phenol is used as a pharmaceutical, in the production of fertilizer; coke, illuminating gas; lampblack, paints, paint removers; rubber, asbestos goods; wood preservatives; synthetic resins; textiles, drugs, pharmaceutical preparations; perfumes, bakelite, and other plastics (phenol formaldehyde resins); polymer intermediates (caprolactam, bisphenol-A, and adipic acid). Phenol also finds wide use as a disinfectant and veterinary drug.

Incompatibilities: The aqueous solution is a weak acid. Violent reaction with strong oxidizers, calcium hypochlorite, aluminum chloride, acids. Reacts with metals.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.85 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 5 ppm/19 mg/m^3 TWA [skin].
NIOSH REL: 5 ppm/19 mg/m^3 TWA [skin]; 15.6 ppm/60 mg/m^3/15 min Ceiling Concentration.
ACGIH TLV®[1]: 5 ppm/19 mg/m^3 TWA [skin], not classifiable as a human carcinogen; BEI: 250 mg[total phenol]/g creatinine in urine/end-of-shift.
NIOSH IDLH: 250 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 5 ppm
PAC-1: **15** ppm
PAC-2: **23** ppm
PAC-3: **200** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK; [skin], Carcinogen Category: 3B.
Arab Republic of Egypt: TWA 5 ppm (19 mg/m^3), [skin], 1993; Australia: TWA 5 ppm (19 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (19 mg/m^3), [skin], 1999; Belgium: TWA 5 ppm (19 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (4 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (19 mg/m^3); STEL 10 ppm (38 mg/m^3), [skin], 1999; France: VME 5 ppm (19 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 8 mg/m^3, [skin], 2003; Japan: 5 ppm (19 mg/m^3), [skin], 1999; Norway: TWA 1 ppm (4 mg/m^3), 1999; the Philippines: TWA 5 ppm (10 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3; MAC (STEL) 20 mg/m^3, 1999; Russia: TWA 5 ppm; STEL 0.3 mg/m^3, [skin], 1993; Sweden: NGV 1 ppm (4 mg/m^3), KTV 2 ppm (8 mg/m^3), [skin], 1999; Switzerland: MAK-W 5 ppm (19 mg/m^3), KZG-W 10 ppm (38 mg/m^3), [skin], 1999; Thailand: TWA 5 ppm (19 mg/m^3), 1993; Turkey: TWA 5 ppm (19 mg/m^3), [skin], 1993; United Kingdom: TWA 5 ppm (20 mg/m^3); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[35, 43] has also set a MAC of 0.01 mg/m^3 (10 μg/m^3) for ambient air in residential areas both on a momentary and a daily average basis. Many states have set guidelines or standards for phenol in ambient air[60] ranging, for example, from 10.0 μg/m^3 (New York) to 45.23 μg/m^3 (Kansas) to 52.0 μg/m^3 (Massachusetts) to 95.0 μg/m^3 (Indiana) to 190 μg/m^3 (Florida, North Dakota, South Carolina) to 315.0 μg/m^3 (Virginia) to 380.0 μg/m^3 (Connecticut, North Dakota, South Dakota) to 452.0 μg/m^3 (Nevada) to 456.0 μg/m^3 (Pennsylvania) to 95.0 μg/m^3 (North Carolina).
Determination in Air: Use NIOSH Analytical Method (IV) #2546, Cresols and Phenol, OSHA Analytical Method 32.
Permissible Concentration in Water: *To protect freshwater aquatic life:* 10,200 μg/L, based on acute toxicity data and 2560 μg/L, based on chronic toxicity data. *To protect saltwater aquatic life:* 5800 μg/L, based on acute toxicity data. For the protection of human health from phenol ingested through water and through contaminated aquatic organisms, the concentration in water should not exceed 3500 μg/L. For the prevention of adverse effects due to the organoleptic properties of chlorinated phenols inadvertently formed during water purification processes, the phenol concentration in water should not exceed 300 μg/L.[6] The Czech Republic[35] set a MAC of 0.2 mg/L for surface water and a MAC of 0.05 mg/L for drinking water. The EEC set a MAC of 0.5 μg/L in drinking water. Mexico has set maximum permissible concentrations of 1.0 μg/L in receiving waters used for drinking water supply; 1.0 mg/L in receiving water for recreational use; 0.1 mg/L in estuaries; and 0.01 mg/L in coastal waters. Russia[35, 43] set a MAC of 0.001 mg/L in drinking water. States which have set guidelines for phenol in drinking water[61] include California at 1.0 μg/L and Kansas at 300 μg/L.
Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 1.46.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Phenol and its vapor are corrosive to the eyes, skin, and respiratory tract. Eye contact can cause severe and painful burns and permanent damage. Skin contact may cause severe and painful burns, which promptly become anesthetized (numb) to touch, but deep damage and local gangrene can result. Significant skin contact or inhalation can cause death within minutes. Ulceration may follow. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the central nervous system, heart, liver, and kidneys, causing convulsions, coma, cardiac disorders, respiratory failure, collapse. Signs and symptoms of acute exposure to phenol may be severe, and range from tachycardia (rapid heart rate) and tachypnea (rapid respiratory rate) to hypotension (low blood pressure), weak pulse, cardiac failure, pulmonary edema, and respiratory arrest. Cardiac arrhythmias may be noted. Weakness, headache, dizziness, tinnitus (ringing in the ears), delirium, and shock are common. Seizures may often be followed by coma. Pallor, profuse sweating, dilated pupils, and a profound drop in body temperature may occur. Gastrointestinal effects may include nausea, abdominal pain, bloody vomitus, and bloody diarrhea. Renal insufficiency may lead to hematuria (bloody urine). Toxic hazard rating is very toxic: probable oral lethal dose (human) is 50−500 mg/kg. Ingestion of 1 g has been lethal to humans. Lethal amounts may be absorbed through skin or inhaled. Industrial contact can cause chronic poisoning with kidney and liver damage.
Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may damage the liver and kidneys and have an effect on the pancreas and heart muscle. May affect the central nervous system and

cause nerve and/or brain damage. Phenol causes mutations and may cause reproductive damage in humans; and may be a cancer risk.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), last 2 h of 8-h exposure; urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), pre- and postshift; urinalysis. Urinary phenol (See also NIOSH #8305 *Phenol and p-cresol in urine*). These tests should be repeated if overexposure is suspected. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If concentrated phenol gets on a large area of the skin, immediately rush victim to shower and use at full blast; remove all contaminated clothing; scrub the contaminated area with *soap* for at least 10 min—*water alone may be harmful.* If polyethyleneglycol-300 is available, swab exposed area with cotton soaked in it. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Rinse mouth. Give plenty of water and/or vegetable oil to drink. Do not allow the consumption of alcohol. Induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For phenol <30%, sealed chemical materials with good to excellent resistance: polyethylene. For phenol >70%, sealed chemical materials with good to excellent resistance: butyl rubber; Neoprene™, Teflon™, Viton™, Silvershield™. Also, polyethylene offers limited protection. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; Sa (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 ppm:* CcrFOv100 (APF = 50) [air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phenol must be stored to avoid contact with calcium hypochlorite and other strong oxidizers (such as chlorine and bromine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: *Molten phenol* requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II. *Solid phenol* requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II. *Phenol solutions* require a shipping label of “POISONOUS/TOXIC MATERIALS.” They fall in DOT Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Remove all ignition sources. Spills must be disposed of immediately by properly protected personnel; no others should remain in area. Flush with flooding quantities of water, then use caustic soda solution for neutralization. Remove and isolate contaminated clothing at the site. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand, earth, or similar material and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid or liquid. Flammable vapors are produced when phenol is heated. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or foam; use water spray to cool containers in fire area. Move container from fire area if it can be done without risk; fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

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New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Phenol*. Trenton, NJ

Phenol, 3-(1-methylethyl)-, methylcarbamate P:0350

Molecular Formula: $C_{11}H_{15}NO_2$

Synonyms: Carbamic acid, methyl-, *m*-cumenyl ester; Compound 10854; *m*-Cumenol methylcarbamate; *m*-Cumenyl methylcarbamate; ENT 25,500; ENT25,543; H 5727; H 8757; Hercules AC5727; Hercules 5727; HIP; *m*-Isopropylphenol *N*-methylcarbamate; *m*-Isopropylphenol methylcarbamate; 3-Isopropylphenol *N*-methylcarbamate; 3-Isopropylphenol methylcarbamate; *m*-Isopropylphenyl *N*-methylcarbamate; 3-Isopropylphenyl methylcarbamate; Methylcarbamic acid *m*-cumenyl ester; 3-(1-Methylethyl) phenol methylcarbamate; *N*-Methyl-*m*-isopropylphenyl carbamate; *N*-Methyl-3-isopropylphenyl carbamate; OMS-15; *m*-Psopropylphenyl methylcarbamate; UC 10854; Union Carbide UC10,854

CAS Registry Number: 64-00-6

RTECS® Number: FB7875000

UN/NA & ERG Number: UN2757/151

EC Number: 200-572-3

Regulatory Authority and Advisory Bodies

Reportable Quantity (RQ): 10 lb (4.54 kg).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4 as *m*-cumenyl methylcarbamate. Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Phenol, 3-(1-methylethyl)-, methylcarbamate is a white, crystalline, odorless solid. Molecular weight = 193.27; Freezing/Melting point = 73°C. Soluble in water; 270 mg/L at 25°C.

Potential Exposure: Used as a carbamate insecticide.

Incompatibilities: Strong alkalies.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*
TEEL-0: 3 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 16 mg/m^3
PAC-3: 16 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract causing coughing, wheezing, shortness of breath. Inhalation or skin contact can cause rapid, severe carbamate poisoning with headache, dizziness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs also include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control, death. LD_{50} = (oral-guinea pig) 10 mg/kg.

Long Term Exposure: May affect the nervous system. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Refer to the NIOSH Criteria Documents #78-174 and #76-147 on manufacturing, formulating, and working safely with pesticides.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkaline materials. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Carbamate pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." Phenol, 3-(methylethyl)-, Methylcarbamate falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical

as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding fire. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Phenol, 3-(methylethyl)-, Methylcarbamate*. Trenton, NJ

Phenothiazine P:0360

Molecular Formula: $C_{12}H_9NS$

Common Formula: $S(C_6H_4)_2NH$

Synonyms: AFI-tiazin; Agrazine; Antiverm; Biverm; Contaverm; Dibenzoparathiazine; Dibenzothiazine; Dibenzo-1,4-thiazine; ENT 38; Feeno; Fenoverm; Fentiazin; Helmetina; Lethelmin; Nemazene; Nemazine; Orimon; Padophene; Penthazine; Phenegic; Phenosan; Phenoverm; Phenovis; Phenoxur; Phenthiazine; Reconox; Souframine; Thiodiphenylamin (German); Vermitin; Wurm-thional; XL-50

CAS Registry Number: 92-84-2

RTECS®Number: SN5075000

EC Number: 202-196-5

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phenothiazine is a greenish-yellow to greenish-gray crystalline substance with a slight odor and taste. Molecular weight = 199.28; Boiling point = (decomposes) 371°C; Freezing/Melting point = 185°C (sublimes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Phenothiazine is used as an insecticide; as a base for the manufacture of tranquilizers; as anthelmintic in medicine and veterinary medicine; it is used widely as an intermediate in pharmaceutical manufacture; polymerization inhibitor, antioxidant.

Incompatibilities: Organosulfides are incompatible with strong acids and acid fumes; elevated temperatures; sulfur oxides and nitrogen oxides can be produced. Contact with strong reducing agents, azo and diazo compounds, halocarbons, isocyanates can generate heat and may form explosive hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA [skin].

ACGIH: 5 mg/m^3 TWA [skin].

No TEEL available.

Australia: TWA 5 mg/m^3, [skin], 1993; Belgium: TWA 5 mg/m^3, [skin], 1993; Denmark: TWA 5 mg/m^3, [skin], 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3, [skin], 1999; France: VME 5 mg/m^3, [skin], 1999; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 5 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 5 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: 5 mg/m^3 [skin]. Several states have set guidelines or standards for Phenothiazine is ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.2$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Skin absorption.

Harmful Effects and Symptoms

Short Term Exposure: Phenothiazine can affect you when breathed in and by passing through your skin. Exposure can irritate the skin and eyes. Exposure can cause an inflammation in the eye (keratitis). This can also be made worse by sunlight (photosensitization) and cause a severe skin reaction with rash and color changes. Can cause a severe allergic liver reaction. High levels of exposure may affect the blood cells, causing hemolytic anemia and toxic liver degeneration. Exposure may affect the nervous system, causing muscle twitching and shaking. May affect heart rhythm, causing irregular heartbeat.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis and allergy. Can cause kidney and liver damage. Repeated or prolonged contact may cause skin sensitization as well as skin photophobia (abnormal visual intolerance to light). There is limited evidence that this chemical may damage the developing fetus. Several related phenothiazine compounds have been associated with human teratogenic effects.

Points of Attack: Skin, cardiovascular system, liver, kidneys, heart.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nervous system and eyes. Liver function tests, especially bile salts. Complete blood count. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric) since toxic fumes can result.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phenothiazine may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in combustible solvent and spray into incinerator equipped with afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Phenothiazine*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Phenyl dichloroarsine (Agent PD, WMD) P:0370

Molecular Formula: $C_6H_5AsCl_2$
Synonyms: Arsine, dichlorophenyl-; Arsonous dichloride, phenyl-; Diclorofenilarsina (Spanish); Dichlorophenylarsine; PD (military designation); Phenylarsinedichloride; Phenylarsonous dichloride; Phenyl arsonous dichloride; Phenyldichloroarsine
CAS Registry Number: 696-28-6
RTECS®Number: CH5425000
UN/NA & ERG Number: UN1556/152
EC Number: 211-791-9
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA Hazardous Waste Number (RCRA No.): P036.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
As arsenic compounds
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.
Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA (Section 313): Includes any unique chemical substance that contain arsenic as part of that chemical's infrastructure; Form R *de minimis* concentration reporting level: organics 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Phenyldichloroarsine is a colorless or light yellow liquid or gas. Odorless. Molecular weight = 222.93; Boiling point = 257°C; Freezing/Melting point = −19°C; Flash point = 16°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 2₩. Reaction with water; insoluble.
Potential Exposure: It is used in organic synthesis and as a solvent. PD has been used as a military tear gas, vesicant, and blister agent.
Incompatibilities: Contact with water forms HCl. Heat produces fumes of arsenic and chlorine. Attacks some metals in the presence of moisture.
Permissible Exposure Limits in Air
Arsenic, organic compounds
OSHA PEL: 0.5 mg[As]/m^3 TWA.
NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.
ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
Phenyl dichloroarsine; dichlorophenylarsine
Protective Action Criteria (PAC)*
TEEL-0: 0.061 mg/m^3
PAC-1: 0.061 mg/m^3
PAC-2: **0.061** mg/m^3
PAC-3: **0.18** mg/m^3
AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
As arsenic, organic compounds
TEEL-0: 0.5 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 350 mg/m^3
NIOSH IDLH: 5 mg[As]/m^3.
Determination in Air: Filter; Acid; Hydride generation atomic absorption spectrometry; NIOSH Analytical Method (IV) #7900. See also #7300, Elements (arsenic).
Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons but has set a guideline of 50 μg/L[61] for drinking water.
Determination in Water: When phenyldichloroarsine mixes with water it breaks down into hydrochloric acid and arsenicals. *For arsenic:* The atomic absorption graphite furnace technique is often used for the measurement of total arsenic in water. It has also been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry. See OSHA Analytical Method #ID-105 for arsenic.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Phenyldichloroarsine reacts with many enzymes which damages the body. Phenyldichloroarsine will blind you and blister your skin severely, and with enough it will kill. You will know that you have been exposed when you feel immediate pain and you begin to vomit violently. Contact may cause burns to skin and eyes. Strong irritant to eyes, skin, and tissue. Corrosive if swallowed. Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Vomiting and blistering are among symptoms of exposure. The median lethal dosage is 2600 mg-min/m^3. The mean incapacitating dosage is 16 mg-min/m^3 as a vomiting agent and 1800 mg-min/m^3 as a blistering agent. 633 mg-min/m^3 produces eye injury.
Long Term Exposure: In animals: kidney damage; muscle tremor, seizure; possible gastrointestinal tract; reproductive effects; possible liver damage.

Points of Attack: Skin, respiratory system, kidneys, central nervous system, liver, gastrointestinal tract, reproductive system.

Medical Surveillance: Kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to physician: For severe poisoning BAL [British antilewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metal poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you do not have the equipment and training do not enter the hot or the warm zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Be sure you have decontaminated the victims as much as you can before they leave the area so that they do not spread the phenyldichloroarsine. Use the antidote "Anti-Lewisite." See "First Aid" above. Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Arsenic compounds, liquid, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." Phenyl dichloroarsine falls in DOT Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

PD, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Fire Extinguishing: Phenyl dichloroarsine may burn but does not ignite readily. Burned phenyl dichloroarsine is safer and better than the unburned product. In case of fire, evacuate the area. If there is some reason that you have to put out the fire—for example, there are things you cannot let burn nearby—use unattended equipment. You can fight phenyl dichloroarsine fires with water streams, water fog; ordinary foam; universal foam; and, for confined fires, carbon dioxide. Remember that phenyl dichloroarsine breaks down in water, forming toxic hydrochloric acid and arsenic chemicals. Wear positive pressure breathing apparatus. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including arsenic and chlorine, are produced in fire. Water produces corrosive chlorine fumes. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phenyl Dichloroarsine*. Washington, DC: Chemical Emergency Preparedness Program

Schneider, A. L., (Ed.) (2007). *CHRIS + CD-ROM Version 2.0, United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

m-Phenylenediamine P:0380

Molecular Formula: $C_6H_8N_2$

Synonyms: AI3-52607; 3-Aminoaniline; *m*-Aminoaniline; *meta*-Aminoaniline; Aminoaniline, *meta*-; Apco 2330; *meta*-Benzenediamine; *m*-Benzenediamine; 1,3-Benzenediamine; Benzene, 1,3-diamino-; C.I. 76025; C.I. Developer 11; Developer 11; Developer C; Developer H; Developer M; *meta*-Diaminobenzene; *m*-Diaminobenzene; 1,3-Diaminobenzene; Direct brown BR; Direct brown GG; 1,3-Fenilendiamina (Spanish); *m*-Fenilendiamina (Spanish); Metaphenylenediamine; 3-Phenylenediamine; *m*-Phenylenediamine; Phenylenediamine, *meta*-

CAS Registry Number: 108-45-2

RTECS®Number: SS7700000

UN/NA & ERG Number: UN1673/153

EC Number: 203-584-7 [*Annex I Index No.:* 612-147-00-3] (*m*-)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: SHE—clonal assay; Histidine reversion—Ames test; Inconclusive: Rodent dominant lethal.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R20/21; R25; R36; R40; R43; R50/53; R68; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *m*-Phenylenediamine is a colorless to white crystalline substance that turns red upon exposure to air. Molecular weight = 108.16; Boiling point = 287°C; Freezing/Melting point = 64.4°C; Flash point = 187°C; Autoignition temperature = 555°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Used in making various dyes; as a curing agent for epoxy resin; rubber, textile fibers; urethanes, corrosion inhibitors; adhesives; in photographic and analytical procedures and processes.

Incompatibilities: Reacts violently with strong oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates. Heat and light contribute to instability. Keep away from metals.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin]; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 125 mg/m^3

DFG MAK: [skin]; Carcinogen Category 3B.

Austria [skin], Suspected: carcinogen, 1999; Denmark: TWA 0.1 mg/m^3, 1999; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use OSHA Analytical Method 87.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Irritates the respiratory tract, causing coughing, wheezing, and/or shortness of breath. May affect the blood, causing the formation of methemoglobin and cyanosis with blue coloration of the skin and lips, headache, fatigue, dizziness. High levels can cause troubled breathing, collapse, and death. The *p*-isomer is more toxic and a more severe irritant than the *m*-isomers. LD_{50} = (oral-rat) 720−1600 mg/kg.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood count (CBC). Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical of more than 0.1 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and

storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phenylenediamines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.[22]

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: m-Phenylenediamine*. Trenton, NJ

o-Phenylenediamine P:0390

Molecular Formula: $C_6H_8N_2$

Synonyms: AI3-24343; 2-Aminoaniline; *o*-Benzenediamine; 1,2-Benzenediamine; C.I. 76010; C.I. Oxidation base 16; *o*-Diaminobenzene; 1,2-Diaminobenzene; 1,2-Fenilendiamina (Spanish); *o*-Fenilendiamina (Spanish); OPDA; Orthamine; *o*-Phenylenediamine; Phenylenediamine, ortho-; PODA

CAS Registry Number: 95-54-5

RTECS®Number: SS7875000

UN/NA & ERG Number: UN1673/153

EC Number: 202-430-6 [*Annex I Index No.:* 612-145-00-2] *(o-)*

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Rodent dominant lethal; *N. crassa—aneuploidy.*

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 5.6.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 5/15/98.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R20/21; R25; R36; R40; R43; R50/53; R68; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: *o*-Phenylenediamine is a white to brownish crystalline substance that turns red upon exposure to air. Molecular weight = 108.16; Boiling point = 257°C; Freezing/Melting point = 104°C; Flash point = 156°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an intermediate in the making of dyes; pesticides, pharmaceuticals, and rubber chemicals; in making fungicides and other chemicals; in photographic and analytical procedures and processes.

Incompatibilities: Reacts violently with strong oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates. Heat and light contribute to instability. Keep away from metals.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 3B.

Austria: carcinogen, 1999; Denmark: TWA 0.1 mg/m^3, 1999; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], carcinogen, 1999.

Determination in Air: Use OSHA Analytical Method 87.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Eye contact may cause permanent damage. Irritates the respiratory tract, causing coughing, wheezing, and/or shortness of breath. May affect the blood, causing the formation of methemoglobin and cyanosis with blue coloration of the skin and lips. Can cause stomach ache, headache, fatigue, dizziness, shaking, and convulsions. The *p*-isomer is more toxic and a more severe irritant than the *o*-isomers.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood count (CBC). Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical of more than 0.1 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phenylenediamines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.[22]

Reference

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: o-Phenylenediamine*. Trenton, NJ

p-Phenylenediamine P:0400

Molecular Formula: $C_6H_8N_2$
Common Formula: $H_2NC_6H_4NH_2$
Synonyms: 4-Aminoaniline; *p*-Aminoaniline; BASF Ursol D; *p*-Benzenediamine; 1,4-Benzenediamine; Benzofur D; C.I. 76060; C.I. Developer 13; C.I. Oxidation base 10; Developer PF; *p*-Diaminobenzene; 1,4-Diaminobenzene; 1,4-Diaminobenzol; Durafur black R; 1,4-Fenilendiamina (Spanish); *p*-Fenilendiamina (Spanish); Fouramine D; Fourrine 1; Fourrine D; Fur black 41867; Fur brown 41866; Furro D; Fur yellow; Futramine D; Nako H; Orsin; Pelagol D; Pelagol grey D; Peltol D; 1,4-Phenylenediamine; Phenylene diamine, para-; PPD; Renal PF; Santoflex IC; Tertral D; Ursol D; Vulkanox 4020; Zoba black D
Hydrochloride:
1,4-Aminoaniline dihydrochloride; 1,4-Benzenediamine dihydrochloride; 1,4-Phenylenediame dihydrochloride
CAS Registry Number: 106-50-3; 624-18-0 (dihydrochloride)
RTECS®Number: SS8050000
UN/NA & ERG Number: UN1673/153
EC Number: 203-404-7 [*Annex I Index No.:* 612-028-00-6]; 210-834-9 [*Annex I Index No.:* 612-029-00-1] (*p*-phenylenediamine dihydrochloride)
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1978.
US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Positive: Cell transform.—SA7/SHE; *D. melanogaster* sex-linked lethal; Negative: Carcinogenicity—mouse/rat; Rodent dominant lethal; Negative: *N. crassa—aneuploidy*; Sperm morphology—mouse; Inconclusive: Mammalian micronucleus.
Banned or Severely Restricted (several countries) (UN).[13]
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations (*includes dihydrochloride*): Hazard Symbol: T, N; Risk phrases: R23/24/25; R36; R43; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: *p*-Phenylenediamines are white to slightly red crystalline solids. They have been described as gray “light brown” which may result from exposure to air. Molecular weight = 108.16; Specific gravity (H_2O:1) = 1.1; Boiling point = 267°C (sublimes); Freezing/Melting point = 146°C; Vapor pressure = <1 mmHg at 25°C; Flash point = 156°C; Autoignition temperature = 400°C. Explosive limits: LEL = 1.5%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 4% at 25°C.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. *p*-Phenylenediamine has been used in dyestuff manufacture, in hair dyes, in photographic developers, in synthetic fibers, in polyurethanes, and as a monomer and in the manufacture of improved tire cords. Also used as a gasoline additive and in making antioxidants.
Incompatibilities: A strong reducing agent. Reacts violently with strong oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates, and strong bases. Incompatible with organic anhydrides, isocyanates, aldehydes. Heat and light contribute to instability. Keep away from metals.
Permissible Exposure Limits in Air
OSHA PEL: 0.1 mg/m^3 TWA [skin].
NIOSH REL: 0.1 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 0.1 mg/m^3 TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 25 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3
Dihydrochloride
TEEL-0: 0.6 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 60 mg/m^3
DFG MAK: 0.1 mg/m^3, measured as the inhalable fraction TWA; Peak Limitation Category II(2); [skin], danger of skin sensitization; Carcinogen Category 3; Pregnancy Risk Group C.
Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.3 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.1 mg/m^3, KTV 0.3 mg/m^3, [skin], 1999; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan,

South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for *p*-phenylenediamine in ambient air[60] ranging from 0.33 μg/m^3 (New York) to 1.0 μg/m^3 (Florida, North Dakota, South Carolina) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use OSHA Analytical Method 87.

Permissible Concentration in Water: Russia[35, 43] set a MAC of 0.1 mg/L in surface water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Contact can severely irritate and burn the eyes and skin. May cause permanent eye damage. Irritates the respiratory tract, causing coughing, wheezing, and/or shortness of breath. Inhalation of dust may irritate the pharynx and larynx; bronchial asthmatic reactions. Swelling of mouth and throat may be observed following ingestion. Exposure can cause abdominal pain, nausea, high blood pressure, dizziness, seizures, and even coma. May affect the blood, causing the formation of methemoglobin and cyanosis with blue coloration of the skin and lips, headache, fatigue, dizziness. High levels can cause troubled breathing, collapse, and death. The *p*-isomer is more toxic and a more severe irritant than the *o*- and *m*-isomers.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Repeated high exposure can cause cataracts. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood count (CBC). Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or a slurry of activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 25 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Causes eye irritation and damage; eye protection needed.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, acid chlorides, acid anhydrides, chloroformates, and metals. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Phenylenediamines require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.[22]

References

US Environmental Protection Agency. (June 1, 1978). *Chemical Hazard Information Profile: Phenylenediamines*. Washington, DC

New Jersey Department of Health and Senior Services. (September, 1999). *Hazardous Substances Fact Sheet: p-Phenylenediamine*. Trenton, NJ

Phenyl glycidyl ether P:0410

Molecular Formula: $C_9H_{10}O_2$

Synonyms: 1,2-Epoxy-3-phenoxypropane; 2,3-Epoxypropylphenyl ether; Glycidyl phenyl ether; PGE; Phenol-glycidaether (German); Phenol glycidyl ether; 3-Phenoxy-1,2-epoxypropane; Phenoxypropene oxide; Phenoxypropylene oxide; Phenyl-2,3-epoxypropyl ether

CAS Registry Number: 122-60-1

RTECS®Number: TZ3675000

UN/NA & ERG Number: UN2810/153

EC Number: 204-557-2 [*Annex I Index No.:* 603-067-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: SHE—focus assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 10/1/90; male 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R20; R37/38; R43; R68; R52/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Phenyl glycidyl ether is a colorless liquid with an unpleasant sweet odor. Molecular weight = 150.19; Specific gravity (H_2O:1) = 1.11; Boiling point = 245°C; Freezing/Melting point = 3.3°C; Vapor pressure = 0.01 mmHg at 20°C; Flash point = 120°C. Explosive limits: LEL = 1.1%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.24% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. PGE is used to increase storage time and stability of halogenated compounds; as a reactive diluent in uncured epoxy resins to reduce the viscosity of the uncured system for ease in casting, adhesive, and laminating applications. NIOSH once estimated that 8000 workers are potentially exposed to PGE.

Incompatibilities: Strong oxidizers, amines, strong acids, strong bases, and curing agents. PGE can presumably form explosive peroxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.14 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 10 ppm/60 mg/m^3 TWA.

NIOSH REL: 1 ppm/6 mg/m^3 [15 min] Ceiling Concentration; A potential occupational carcinogen [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.1 ppm TWA [skin] danger of skin sensitization; confirmed animal carcinogen with unknown relevance to humans.

No TEEL available.

DFG MAK: [skin], danger of skin sensitization; Carcinogen Category 2.

NIOSH IDLH: potential occupational carcinogen 100 ppm.

Australia: TWA 1 ppm (6 mg/m^3), 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 1 ppm (6.1 mg/m^3), 1993; Denmark: TWA 1 ppm (5 mg/m^3), 1999; Finland; STEL 10 ppm (60 mg/m^3), [skin], 1999; France: VME 1 ppm (6 mg/m^3), 1999; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Philippines: TWA 10 ppm (62 mg/m^3), 1993; Poland: MAC (TWA) 0.6 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Sweden: NGV 10 ppm (60 mg/m^3), KTV 15 ppm (90 mg/m^3), 1999; Switzerland: MAK-W 1 ppm (6 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 10 ppm (60 mg/m^3), 1993; United

Kingdom: TWA 1 ppm (6.2 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for PGE in ambient air[60] ranging from 60 μg/m^3 (Connecticut and North Dakota) to 100 μg/m^3 (Virginia) to 143 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV), Phenyl glycidyl ether.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.1$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance irritates the eyes, skin, and upper respiratory tract. Eye and skin irritation may be severe. Exposure could cause lowering of consciousness, with headache, loss of concentration, dizziness, and unconsciousness.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Possible hematopoietic, reproductive effects. A potential occupational carcinogen.

Points of Attack: Eyes, skin, central nervous system, hematopoietic system, reproductive system. The liquid destroys the skin's natural oils, causing dermatitis. Cancer site in animals: nasal cavity.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber, natural rubber, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator or in a cool, dry place. Protect from exposure to acids, bases, oxidizers, and curing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic, liquids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." *N*-Nitrosodimethylamine falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60−70% ethanol; then with soap and with 60−70% ethanol; then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific

recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Phenyl Glycidyl Ether*. Washington, DC

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers*, NIOSH Document No. 78-166. Washington, DC

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Glycidyl Ethers*, Report PB-276,678. Rockville, MD, pp. 116−123

Phenylhydrazine P:0420

Molecular Formula: $C_6H_8N_2$

Common Formula: $C_6H_5NHNH_2$

Synonyms: Fenilhidrazina (Spanish); Hydrazine-benzene; Hydrazinobenzene; Monophenylhydrazine

Hydrochloride: Cloruro de fenilhidrazinio (Spanish); Phenylhydrazine monohydrochloride; Phenylhydrazin hydrochlorid (German); Phenylhydrazinium chloride

CAS Registry Number: 100-63-0; 59-88-1 (hydrochloride)

RTECS® Number: MV8925000; MV9000000 (hydrochloride)

UN/NA & ERG Number: UN2572/53

EC Number: 202-873-5 [*Annex I Index No.:* 612-023-00-9]; 200-444-7 (phenylhydrazinium chloride) [*Annex I Index No.:* 612-023-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: (*Phenylhydrazine and its salts*) Cancer 7/1/92.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Hydrochloride:

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg) (hydrochloride).

Reportable Quantity (RQ): 1000 lb (454 kg) (hydrochloride).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol (*includes hydrochloride*): T, N; Risk phrases: R45; R23/24/25; R36/38; R43; R48/23/24/25; R68; R50; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Phenylhydrazine is a colorless to pale yellow liquid or solid with a weak aromatic odor. The hydrochloride is a white to tan solid with a weak odor. Molecular weight = 108.16; Specific gravity (H_2O:1) = 1.10 (base); Boiling point = (decomposes) 243.3°C (base); Freezing/Melting point = 19.4°C (base); 24°C (hemihydrate); 243−246°C (hydrochloride); Vapor pressure = 0.04 mmHg at 25°C; Flash point = 88°C (cc) (base); Autoignition temperature = 174°C (base). Explosive limits: LEL = 1.1%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2; (*hydrochloride*) Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Phenylhydrazine is a widely used reagent in conjunction with sugars, aldehydes, and ketones. In addition, it is used in the synthesis of dyes; pharmaceuticals, such as antipyrin, cryogenin, and pyramidone; and other organic chemicals. The hydrochloride salt is used in the treatment of polycythemia vera.

Incompatibilities: Phenylhydrazine is very reactive with carbonyl compounds, strong oxidizers, strong bases, alkali metals, ammonia, lead dioxide (violent). Attacks copper salts, nickel, and chromates.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.42 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/22 mg/m^3 TWA [skin].

NIOSH REL: 0.14 ppm/0.6 mg/m^3 [120 min] Ceiling Concentration [skin]; A potential occupational carcinogen

[skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.1 ppm/0.44 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 15 ppm (potential occupational carcinogen).

Protective Action Criteria (PAC)

Phenylhydrazine

TEEL-0: 0.1 ppm

PAC-1: 0.3 ppm

PAC-2: 2 ppm

PAC-3: 15 ppm

Phenylhydrazine hydrochloride

TEEL-0: 50 mg/m^3

PAC-1: 150 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 250 mg/m^3

DFG MAK: [skin], danger of skin sensitization; Carcinogen Category 3B.

Arab Republic of Egypt: TWA 5 ppm (20 mg/m^3), [skin], 1993; Australia: TWA 5 ppm (20 mg/m^3); STEL 10 ppm, [skin], carcinogen, 1993; Austria: MAK 5 ppm (22 mg/m^3), [skin], Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (22 mg/m^3); STEL 10 ppm, [skin], carcinogen, 1993; Denmark: TWA 0.1 ppm (0.6 mg/m^3), [skin], 1999; Finland: STEL 5 ppm (22 mg/m^3), [skin], 1999; Norway: TWA 0.6 mg/m^3, 1999; the Philippines: TWA 5 ppm (22 mg/m^3), 1993; Poland: MAC (TWA) 20 mg/m^3, 1999; Switzerland: MAK-W 5 ppm (22 mg/m^3), [skin], 1999; Turkey: TWA 5 ppm (22 mg/m^3), [skin], 1993; United Kingdom: CHAN, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic[35]: MAC 1.0 mg/m^3. Several states have set guidelines or standards for phenylhydrazine in ambient air[60] ranging from zero (North Dakota) to 66.7 μg/m^3 (New York) to 200.0 μg/m^3 (Connecticut, Florida, South Carolina, and Virginia) to 476.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3518.

Permissible Concentration in Water: Russia[35, 43] set a MAC of 0.01 mg/L of phenylhydrazine in water bodies used for domestic purposes.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.25$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: The dust and fumes can irritate and burn the eyes and skin. Inhalation can cause irritation, coughing, and difficult breathing. This material is poisonous if swallowed or if fumes are inhaled. Phenylhydrazine is a chronic poison. High levels can cause cyanosis and methemoglobinemia. Higher levels can cause troubled breathing, collapse, and even death. Exposure can cause headache, nausea, vomiting, lightheadedness, nervousness, shaking, seizures, and coma.

Long Term Exposure: Repeated or prolonged contact may cause skin irritation, dermatitis, sensitization, and allergy. May affect the blood, causing red cell damage, cyanosis, hemolytic anemia, kidney and liver damage, vascular thrombosis. A potential occupational carcinogen; it may cause leukemia.

Points of Attack: Blood, respiratory system, liver, kidneys, skin. Cancer site in animals: lungs, liver, blood vessels, and intestine. May affect the bone marrow and cause leukemia.

Medical Surveillance: NIOSH lists the following tests: blood plasma, hemoglobin; complete blood count; liver function tests; pulmonary function tests; urine (chemical/metabolite), hemoglobin; urinalysis (routine); white blood cell count/differential. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red Stripe (*100-63-0*): Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Blue (*hydrochloride, 59-88-1*): Health Hazard: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from exposure to light, strong bases, ammonia, oxidizers, metal salts. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Phenylhydrazine requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid contact with solid and dust. Restrict access. Disperse and flush. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* collect powdered material in the most convenient and safest manner and deposit in sealed containers; move container from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid, but does not easily ignite. Poisonous gases, including nitrogen oxides and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines*, NIOSH Document No. 78-172. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phenylhydrazine Hydrochloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Phenylhydrazine Hydrochloride.* Trenton, NJ

Phenyl isocyanate P:0430

Molecular Formula: C_7H_5NO

Common Formula: C_6H_5NCO

Synonyms: Carbanil; Fenylisokyanat; Isocyanic acid, Phenyl ester; Karbanil; Mondur P; Phenylcarbimide; Phenyl carbonimide

CAS Registry Number: 103-71-9

RTECS®Number: DA3675000

UN/NA & ERG Number: UN2487/155

EC Number: 203-137-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: T; Risk phrases: R10; R22; R26; R34; R37; R42/43; Safety phrases: S/23; S/26; S28; S36/37/39; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Phenyl isocyanate is a colorless liquid with an irritating odor. Molecular weight = 119.30; Boiling point = 160°C; Freezing/Melting point = −30°C; Flash point = 56°C. Hazard Identification (based on NFPA-704 M

Rating System): Health 1, Flammability 2, Reactivity 0. Decomposes in water.

Potential Exposure: Compound Description: Mutagen. Phenyl isocyanate is used as a laboratory reagent and in organic synthesis.

Incompatibilities: Forms explosive mixture with air. Violent reaction with strong oxidizers. Isocyanates are incompatible with acids, caustics, ammonia, amines, amides, alcohols, glycols, caprolactum solution, water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.006 mg/m^3

PAC-1: **0.020** mg/m^3

PAC-2: **0.15** mg/m^3

PAC-3: **0.24** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Danger of skin and airway sensitization.

Russia[43] set a MAC of 0.5 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Phenyl isocyanate can affect you when breathed in and by passing through your skin. Exposure can strongly irritate the skin, nose, throat, and lungs. Higher levels may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. LD_{50} = (oral-rat) 800 mg/kg.

Long Term Exposure: Phenyl isocyanate can cause an asthma-like lung allergy to develop, with cough, shortness of breath, and wheezing. It can also cause an allergic skin rash.

Points of Attack: Lungs, skin.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to phenyl isocyanate, as a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phenyl isocyanate requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I. A plus sign (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive

concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.5
Night	0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)

Day	1.0/1.5
Night	1.6/2.5

Fire Extinguishing: Phenyl isocyanate may burn, but does not readily ignite. Poisonous gases are produced in fire, including oxides of nitrogen. Containers may explode in fire. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Phenyl Isocyanate*. Trenton, NJ

Phenyl mercaptan P:0440

Molecular Formula: C_6H_6S
Common Formula: C_6H_5SH
Synonyms: Benzenethiol; Mercaptobenzene; Phenol, thio-; Phenylmercaptan; Phenylthiol; Thiophenol
CAS Registry Number: 108-98-5
RTECS® Number: DC0525000
UN/NA & ERG Number: UN2337/131
EC Number: 203-635-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA Hazardous Waste Number (RCRA No.): P014.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Phenyl mercaptan is a water-white liquid with a repulsive, penetrating, garlic-like odor. The odor threshold is 0.0003 ppm. Molecular weight = 110.18; Specific gravity (H_2O:1) = 1.08; Boiling point = 126°C; Freezing/Melting point = −9.4°C; Vapor pressure = 1 mmHg at 18°C; Flash point = 55.6°C. Explosive limits: LEL = 1.2%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Primary Irritant. Phenyl mercaptan is used as a chemical intermediate in pesticide manufacture; as a mosquito larvicide. It is used in solvent formulations for the removal of polysulfide sealants.

Incompatibilities: Strong acids, strong bases, calcium hypochlorite, alkali metals. Oxidizes on exposure to air; supplied under nitrogen. At normal room temperature may vaporize forming explosive mixtures with air.

Permissible Exposure Limits in Air

OSHA PEL: None.
NIOSH REL: 0.1 ppm/0.5 mg/m^3 [15 min] Ceiling Concentration.
ACGIH TLV®[1]: 0.1 ppm/0.45 mg/m^3 TWA [skin].
Protective Action Criteria (PAC)*
TEEL-0: 0.1 ppm
PAC-1: 0.1 ppm
PAC-2: **0.53** ppm
PAC-3: **1.6** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.5 ppm (2 mg/m^3), 1993; Belgium: TWA 0.5 ppm (2.3 mg/m^3), 1993; Denmark: TWA 0.5 ppm (2.3 mg/m^3), 1999; Finland: STEL 0.5 ppm (2.6 mg/m^3), 1993; France: VME 0.5 ppm (2 mg/m^3), 1999; Norway: TWA 0.5 ppm (2 mg/m^3), 1999; Switzerland: MAK-W 0.5 ppm (2.3 mg/m^3), 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm.

Several states have set guidelines or standards for benzenethiol in ambient air[60] ranging from 20 μg/m^3 (North Dakota) to 35 μg/m^3 (Virginia) to 40 μg/m^3 (Connecticut) to 48 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2075.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.52$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Benzenethiol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Benzenethiol can severely burn the eyes, causing permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause weakness, dizziness, cough, wheezing, dyspnea (breathing difficulty). Higher levels can cause restlessness and irritability followed by paralysis and death. High or repeated exposure can cause liver, kidney, or lung damage. Acute exposure to thiophenol may result in cough, troubled breathing, irritation of the lungs, and pneumonitis. Nausea, vomiting, and diarrhea are often seen. May affect the nervous system.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung, kidney, liver, spleen damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys, liver, spleen.

Medical Surveillance: If symptoms develop or overexposure is suspected, tests of the following may be helpful: Kidney and liver function. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. If available, flush eyes with large amounts of 0.5% silver nitrate, followed immediately by very large amounts of water. Continue water for 15 min. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in airtight containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, should be prohibited where benzenethiol is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of benzenethiol.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including sulfur dioxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in flammable solvent and burn in furnace equipped with afterburner and alkaline scrubber.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thiophenol*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (July 2004). *Hazardous Substances Fact Sheet: Benzenethiol*. Trenton, NJ

Phenylmercury acetate P:0450

Molecular Formula: $C_8H_8HgO_2$

Common Formula: $C_6H_5HgOOCCH_3$

Synonyms: Acetate phenylmercurique (French); (Aceato) phenylmercury; Acetato fenilmercurio (Spanish); Acetic acid, phenylmercury derivitive; Agrosan; Agrosand; Agrosan GN 5; Algimycin; Antimucin WDR; Benzene, (acetoxymercuri)-; Benzene, (acetoxymercurio); Bufen; Cekusil; Celmer; Ceresan; Ceresan universal; Ceresol; Contra creme; Dynacide; Femma; FMA; Fungitox OR; Gallotox; HL-331; Hong kien; Hostaquick; Kwiksan; Leytosan; Liquiphene; Mercuriphenyl acetate; Mercury(II) acetate, phenyl; Mercury (acetoxy)phenyl-; Mergamma; Mersolite; Mersolite 8; Metasol 30; Norforms; Nymerate; Pamisan; Phenmad; Phenomercury acetate; Phenylmurcuriacetate; Phenylmercuric acetate; Phenylquecksilberacetat (German); Phix; PMA; PMAC; PM acetate; PMAL; PMAS; Purasan-SC-10; Puraturf 10; Quicksan; Sanitized SPG; SC-110; Scutl; Seedtox; Shimmerex; Sporkil; Tag; Tag 331; Tag HL 331; Tag fungicide; Trigosan; Ziarnik

CAS Registry Number: 62-38-4; *(alt.)* 1337-06-0; *(alt.)* 61840-45-7; *(alt.)* 64684-45-3

RTECS® Number: OV6475000

UN/NA & ERG Number: UN1674/151

EC Number: 200-532-5 [*Annex I Index No.:* 080-011-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993.

US EPA Gene-Tox Program, Positive: *D. melanogaster*—whole sex chrom. loss; Positive: *D. melanogaster*—nondisjunction; *B. subtilis* rec assay.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P092.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Chemical: Reproductive toxin.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R34; R48/24/25; R50/53; Safety phrases: S1/2; S3; S24/25; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Phenylmercury acetate is a white or yellow crystalline solid. Molecular weight = 336.75; Freezing/Melting point = 152°C; Flash point = >38°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Organometallic, Mutagen; Reproductive Effector; Primary Irritant. Phenylmercury acetate is used as an antiseptic, fungicide; for fungal and bacterial control; herbicide and control of crabgrass; mildewcide for paints; slimicide in paper mills. It was also used in contraceptive gels and foams.

Incompatibilities: Strong oxidizers, halogens.

Permissible Exposure Limits in Air

As organo mercury compound

OSHA PEL: 0.01 mg/m^3 TWA; 0.04 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.01 mg/m^3 TWA; 0.03 mg/m^3 STEL [skin].

NIOSH IDLH: 2 mg Hg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.168 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 16.8 mg/m^3

PAC-3: 16.8 mg/m^3

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3.

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 1 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg [Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3; MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3, [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg [Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Hg]/m^3 [skin].

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.00057 μg/L as a 24-h average, never to exceed 0.0017 μg/L. *To protect saltwater aquatic life:* 0.025 μg/L as a 24-h average, never to exceed 3.7 μg/L. *To protect human health:* 0.144 μg/L (US EPA) set in 1979–1980.[6] These are the limits for inorganic mercury compounds in general.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Overexposure affects the kidneys, causing renal function failure. Extremely toxic. The probable oral lethal dose for humans is 5–50 mg/kg, between 7 drops and 1 teaspoonful for a 70-kg (150 lb) person. Symptoms arising from acute exposure may occur at varying intervals up to several weeks following exposure. Ingestion of mercurial fungicide-treated grain resulted in gastrointestinal irritation with nausea, vomiting, abdominal pain, and diarrhea. Alkylmercurials produce severe neurologic toxicity, such as loss of feeling in lips, tongue, and extremities; confusion, hallucinations, irritability, sleep disturbances; staggering walk; memory loss; slurred speech; auditory defects; emotional instability; and inability to concentrate. It is also a strong skin irritant; erythema and blistering may result 6–12 h after exposure. Phenylmercury acetate, at sufficient concentration, is expected to be injurious to the eye externally. Mercury poisoning can cause "shakes," irritability, sore gums; increased saliva; personality change and brain damage. Skin contact can cause burns, skin allergy, and a gray skin color. Heating or contact with acid or acid "fumes" releases toxic mercury vapors.

Long Term Exposure: Mercury accumulates in the body. Repeated or prolonged contact with skin may cause dermatitis. May affect the nervous system, causing nervous disorders. Based on animal tests, phenylmercuric acetate should be handled as a teratogen—with extreme caution. It also may cause mutations.

Points of Attack: Eyes, skin, central nervous system, peripheral nervous system, kidneys.

Medical Surveillance: Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with: examination of the nervous system, including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider lung function tests for persons with frequent exposures. After suspected illness or overexposure, repeat the above tests and get a blood test for mercury. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Antidotes and Special Procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metal poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #73-11024.

Respirator Selection: *Up to 0.1 mg/m³:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 mg/m³:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2 mg/m³:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where phenylmercuric acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Phenylmercuric acetate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, foam, or carbon dioxide on solution. Use water as necessary, but run-off should be limited and controlled to prevent it from entering streams of water supplies. Materials are extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus; rubber gloves; boots and bands around legs, arms, and waist, should be provided. No skin should be exposed. Poisonous gases are produced in fire, including mercury. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. React to produce soluble nitrate form, precipitate as mercuric sulfide. Return to supplier.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phenylmercury Acetate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Phenylmercuric Acetate*. Trenton, NJ

N-Phenyl-β-naphthylamine P:0460

Molecular Formula: $C_{16}H_{13}N$

Common Formula: $C_{10}H_7NHC_6H_5$

Synonyms: 2-Anilinonaphthalene; β-Naphthylphenylamine; PBNA; 2-Phenylaminonaphthalene; Phenyl-β-naphthylamine

CAS Registry Number: 135-88-6

RTECS®Number: QV4550000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-223-9 [*Annex I Index No.:* 612-135-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1978; NCI: Carcinogenesis Studies (feed); equivocal evidence: mouse; no evidence: rat; NIOSH) (*since metabolized to* β*-naphthylamine*): Potential occupational carcinogen.

Banned or Severely Restricted (Sweden) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R36/38; R40; R43; R51/53; Safety phrases: S2; S26; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phenyl-β-naphthylamine is a light gray powder. A combustible solid. Molecular weight = 219.30; Specific gravity (H_2O:1) = 1.24; Boiling point = 396°C; Freezing/Melting point = 107.8°C. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Phenyl-β-naphthylamine is used as a rubber antioxidant, as an inhibitor for butadiene, a stabilizer in lubricants, and an intermediate in chemical synthesis.

Incompatibilities: Incompatible with oxidizers, strong acids, organic anhydrides, isocyanates, aldehydes.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: A potential occupational carcinogen* [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A. [**Note:* Since metabolized to β-naphthylamine].

ACGIH TLV®[1]: not classifiable as a human carcinogen.

No TEEL available.

DFG MAK: Carcinogen Category 3B.

Australia: carcinogen, 1993; Austria: Suspected: carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; Poland: MAC (TWA) 0.03 mg/m^3, 1999; Sweden: carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Several states have set guidelines or standards for this compound in ambient air[60] ranging from zero (North Dakota) to 3.0 μg/m^3 (Virginia) to 45.0 μg/m^3 (Pennsylvania).

Determination in Air: Use OSHA Analytical Method 96.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 4.4.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The main problem with this compound is that phenyl-β-naphthylamine, a known carcinogen, is both a contaminant in, and a metabolic product of PBNA. Phenyl-β-naphthylamine can affect you when breathed in and by passing through your skin. Contact can cause skin irritation and rash. Phenyl-β-naphthylamine should be handled as a carcinogen—with extreme caution. Exposure can affect the ability of the blood to carry oxygen (methemoglobinemia), causing cyanosis, a bluish skin color. Higher levels can cause headache and dizziness. Very high levels can cause death. LD_{50} = (oral-mouse) 1450 kg/mg.

Long Term Exposure: Repeated or prolonged contact may cause skin irritation, sensitization, allergy; hypersensitivity to sunlight. A potential occupational carcinogen. Can cause methemoglobinemia (see above); anemia may result.

Points of Attack: Eyes, skin, bladder. *Cancer site:* bladder; in animals: lung, pancreas.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and oil. A regulated, marked area should be established where *N*-phenyl-β-naphthylamine is handled, used, or stored.

Shipping: Toxic solids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III. As a hazardous substance, solid, n.o.s., this imposes no label requirements or maximum on shipping weights.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (December 17, 1976). *Metabolic Precursors of a Known Human Carcinogen, β-Naphthylamine*, Current Intelligence Bulletin No. 16. Rockville, MD

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: N-Phenyl-beta-Naphthylamine*. Trenton, NJ

o-Phenylphenol P:0470

Molecular Formula: $C_{12}H_{10}O$

Common Formula: $C_6H_5{-}C_6H_4OH$

Synonyms: Anthrapole 73; 2-Biphenylol; *o*-Biphenylol; (1,1′-Biphenyl)-2-ol; *o*-Biphenylol; *o*-Diphenylol; Dowicide 1; Dowcide 1 antimicrobial; *o*-Fenilfenol (Spanish); 2-Hydroxybiphenyl; *o*-Hydroxybiphenyl; 2-Hydroxy-1,1′-biphenyl; *o*-Hydroxydiphenyl; 2-Hydroxydiphenyl; Invalon OP; Kiwiydiphenyl; Nectryl; Orthophenylphenol; Orthoxenol; *o*-Phenylphenol; 2-Phenylphenol; Preventol O extra; Remol TRF; Tetrosin OE; Tetrosin OE-N; Torsite; Tumescal OPE; *o*-Xenol

CAS Registry Number: 90-43-7

RTECS® Number: DV5775000

UN/NA & ERG Number: UN3143 Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s./151

EC Number: 201-993-5 [*Annex I Index No.:* 604-020-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (derm); no evidence: rat; IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 8/4/00.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R36/37/38; R50; Safety phrases: S2; S22; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: *o*-Phenylphenol is a white to buff-colored crystalline solid. Molecular weight = 170.22; Boiling point = 286°C; Freezing/Melting point = 57°C; Flash point = 124°C; Autoignition temperature = 530°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. *o*-Phenylphenol is used in the manufacture of plastics, resins, rubber, as agricultural chemical; in making fungicides; as an intermediate in making dye stuffs and rubber chemicals; a germicide; used in food packaging.

Incompatibilities: Strong bases, strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 60 mg/m^3

PAC-1: 150 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: No numerical value established. Data may be available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures may affect the kidney, liver, and lungs; gastrointestinal tract; cardiovascular system, causing respiratory failure. *Inhalation:* Dusts can cause irritation of the nose, throat, and lungs. *Skin:* Can cause severe irritation and burns. Concentrations of 0.5% or higher of the sodium form can cause irritation. *Eyes:* Can cause severe irritation, burns, and damage to cornea, especially the sodium form. *Ingestion:* Based on studies of phenol, can cause burning sensation and pain in mouth and throat, sores, abdominal pain, nausea, vomiting, diarrhea, and skin rash. Larger doses may also cause muscle weakness, irregular rapid breathing, blue coloration of the skin, shock, unconsciousness, collapse, and death. Based on animal studies, 5 oz would be lethal to a 150-lb healthy adult.

Long Term Exposure: May cause kidney damage. Prolonged skin contact may cause severe irritation, sores, and skin allergy. Very irritating substances may affect the lungs; bronchitis may develop.

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to *o*-phenylphenol, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water. Sources of ignition, such as smoking and open flames, are prohibited where *o*-phenylphenol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dye intermediates, solid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet ortho-Phenylphenol*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: o-Phenylphenol*. Trenton, NJ

Phenylphosphine P:0480

Molecular Formula: C_6H_7P

Common Formula: $C_6H_5PH_2$

Synonyms: Fenylfosfin; PF; Phosphaniline

CAS Registry Number: 638-21-1

RTECS® Number: SZ2100000

EC Number: 211-325-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Developmental/Reproductive toxin 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Polyphosphinate is a clear, colorless liquid with a foul odor. Molecular weight = 110.10; Specific gravity (H_2O:1) = 1.001 at 15°C; Boiling point = 160°C. Insoluble in water; reacts.

Potential Exposure: Polyphosphinate is used as an intermediate or a chemical reagent. Polyphosphinate compounds are used as catalysts and antioxidants disproportionate, when heated to give phosphonic acid derivatives plus PF.

Incompatibilities: A strong reducing agent. Reacts violently with strong oxidizers. Water reactive; spontaneously combustible in high concentrations in moist air. Potential exposure to gaseous phenylphosphine and phosphorus oxides when heated above 200°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.50 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.05 ppm/0.25 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.05 ppm/0.23 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)

TEEL-0: 0.0025 ppm

PAC-1: 0.0075 ppm

PAC-2: 0.05 ppm

PAC-3: 4 ppm

Australia: TWA 0.05 ppm (0.25 mg/m^3), 1993; Belgium: STEL 0.05 ppm (0.23 mg/m^3), 1993; Denmark: TWA 0.05 ppm (0.25 mg/m^3), 1999; Finland: STEL 0.05 ppm (0.25 mg/m^3), 1999; France: VLE 0.05 ppm (0.25 mg/m^3), 1999; Switzerland: MAK-W 0.05 ppm (0.25 mg/m^3), 1999; the Netherlands: MAC 0.25 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.05 ppm. Several states have set guidelines or standards for PF in ambient air[60] ranging from 2.0 μg/m^3 (Virginia) to 2.5 μg/m^3 (North Dakota) to 6.0 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A level of 0.6 ppm is a threshold effect level for laboratory animals; hypersensitivity to sound and touch and mild hyperemia developed above this level. Above 2.2 ppm, chronic effects developed including decreases in red blood cells, dermatitis, and severe testicular degeneration (which was, however, reversible).[53] This material is highly toxic by inhalation and ingestion; mild respiratory irritant; emits toxic fumes of phosphorus oxides when heated to decomposition.

Symptoms of exposure include mild respiratory irritation, dyspnea, nausea, vomiting, diarrhea, thirst, sensation of pressure in the chest, back pains, chills, stupor, and fainting with marked pulmonary edema. Phenylphosphine can affect you when breathed in. Exposure can cause nausea, loss of appetite, shaking (tremor), irritation of the eyes, and flushed skin.

Long Term Exposure: Repeated exposure can cause skin rash. Phenylphosphine can damage the blood cells. In animals: blood changes; anemia, testicular degeneration; loss of appetite; diarrhea, lacrimation (discharge of tears), hind leg tremor; dermatitis.

Points of Attack: Blood, central nervous system, skin, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: complete blood count. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.05* ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Pyrophoric. Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: Phenylphosphine*. Trenton, NJ

Phenylthiourea P:0490

Molecular Formula: $C_7H_8N_2S$

Common Formula: $C_6H_5NCHCSNH_2$

Synonyms: NCI-C02017; Phenylthiocarbamide; *N*-phenylthiourea; α-Phenylthiourea; Phenyl-2-thiourea; 1-Phenylthiourea; PTC; PTU

CAS Registry Number: 103-85-5
RTECS® Number: YU1400000
UN/NA & ERG Number: UN2767/151
EC Number: 203-151-2
Regulatory Authority and Advisory Bodies
US EPA Hazardous Waste Number (RCRA No.): P093.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R36/38; R43; R51/53; Safety phrases: S28; S36/37-45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: *N*-phenylthiourea is a colorless crystalline solid. Molecular weight = 152.23; Freezing/Melting point = 148−154°C. Soluble in water.

Potential Exposure: Used as a repellent for rats, rabbits, and weasels; in the manufacture of rodenticides and in medical genetics.

Incompatibilities: Incompatible with oxidizers, strong bases, and acids. Contact with acids or acid fumes produces toxic fumes of sulfur oxide.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.6 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 3 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures can cause lung irritation, coughing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may result in vomiting, difficult breathing, noisy breathing, cyanosis, and low body temperature. It is classified as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoon for a 70-kg (150 lb) person.

Long Term Exposure: Not tested for long-term health effects. May cause methemoglobinemia, cyanosis, and anemia. Phenylthiourea is reported to be similar to ANTU.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Blood methemogloblin level. Completed blood count (CBC). Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: Phenylurea pesticides, solid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust or use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up

spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phenylthiourea*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Phenylthiourea*. Trenton, NJ

Phenyl trichlorosilane P:0500

Molecular Formula: $C_6H_5Cl_3Si$

Synonyms: Phenylsilicon trichloride; Phenyl trichlorosilane; Silicon phenyl trichloride; Silane, trichlorophenyl-; Trichlorophenylsilane; Tricloro(fenil)silano (Spanish)

CAS Registry Number: 98-13-5

RTECS® Number: VV6650000

UN/NA & ERG Number: UN1804/156

EC Number: 202-640-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phenyl trichlorosilane is a colorless to light yellow liquid. Molecular weight = 211.55; Specific gravity = 1.32 at 25°C; Boiling point = 202°C; Flash point = 80.6°C; 91°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Water reactive.

Potential Exposure: Phenyl trichlorosilane is used to make silicones for water repellants, insulating resins, heat-resistant paints, and as a laboratory reagent.

Incompatibilities: May spontaneously ignite in air above flash point. Contact with water, steam, or moisture forms hydrogen chloride. Trichlorosilanes may react violently with strong oxidants, strong acids, bases, amines, alcohols, acetone, ammonia. Attacks many metals in the presence of water, releasing explosive hydrogen gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.2 ppm

PAC-1: 0.6 ppm

PAC-2: 7.3 ppm

PAC-3: 33 ppm

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact may damage the corneas and cause blindness. Inhalation may cause throat to swell, causing suffocation; and may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Highly toxic; may cause death or permanent injury after short inhalation exposure to small quantity. Chemical burns to all exposed membranes and tissues with severe tissue destruction. *Delayed:* after oral exposure, stomach and intestines may perforate to be obstructed by scar tissue. Ingestion may cause mild to moderately severe oral and esophageal burns, with severe burns occurring in stomach. Perforations and peritonitis may occur. Severe irritation may produce spontaneous vomiting. Viscid white or blood-stained foamy mucus and threads of tissue may appear in mouth.

Long Term Exposure: Many highly irritating substances can cause lung damage; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk; then give demulcents, such as milk, cornstarch, and water. Do not induce vomiting.

Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to phenyl trichlorosilane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water at temperatures below 50°C. Phenyl trichlorosilane can give off corrosive hydrogen chloride gas on contact with water, steam, or moisture. Sources of ignition, such as smoking and open flames, are prohibited where Phenyl trichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Phenyl trichlorosilane requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.5
Night	1.0/1.5

Fire Extinguishing: This chemical is a combustible and corrosive liquid. Poisonous gases, including chlorine and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide. *Do not use water* or hydrous agents. Full protective clothing, including self-contained breathing apparatus; coat, pants, gloves, boots; and bands around legs, arms, and waist, should be provided. No skin surface should be exposed. Move container from fire area if you can do so without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Trichlorophenylsilane*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Phenyl Trichlorosilane*. Trenton, NJ

Phenytoin P:0510

Molecular Formula: $C_{15}H_{12}N_2O_2$

Synonyms: AI3-52498; Aleviatin; Antisacer; Auranile; Causoin; Citrullamon; Citrulliamon; Comital; Comitoina; Convul; Danten; Dantinal; Dantoinal; Dantoinal klinos; Dantoine; Denyl; Didan TDC 250; Difenilhidantoina (Spanish); Difenin; Difhydan; Dihycon; di-Hydan; Dihydantoin; di-Lan; Dilantin acid; Dilantine; Dillantin; Dintion; Diphantoin; Diphedal; Diphenine; Diphentoin; Diphentyn; Diphenylan; 5,5-Diphenylhydantoin; Diphenylhydantoin; 5,5-Diphenylimidazolidin-2,4-dione; 5,5-Diphenyl-2,4-imida zolidinedione; Diphenylhydantoine; di-Phetine; Ditoinate; DPH; EKKO; EKKO Capsules; Enkelfel; Elepsindon; Epamin; Epanutin; Epasmir 5; Epdantoine simple; Epelin; Epilan; Epilantin; Epinat; Epised; Eptal; Eptoin; Fenantoin; Fenidantoin S; Fenitoina; Fenylepsin; Fenytoine; Gerot-epilan-D; Hidan; Hidantilo; Hidantina; Hidantina senosian; Hidantina vitoria; Hidantomin; Hydantoin; Hydantoin, 5,5-diphenyl-; Hydantoinal; Ictalis simple; Idantoin 2,4-imidazolidinedione, 5,5-diphenyl-; Kessodanten; Labopal; Lehydan; Lepitoin; Lepsin; Minetoin; NCI-C55765; Neos-hidantoina; Neosidantoina; Novantoina; OM-hidantoine simple; OM-hydantoine; Oxylan; Phanantin; Phanatine; Phenatine; Phenatoine; Phenitoin; Ritmenal; Saceril; Sanepil; Silantin; Sodanthon; Sodantoin; Solantoin; Sylantoic; Tacosal; Thilophenyl; Toin; Toin unicelles; Zentronal; Zentropil

CAS Registry Number: 57-41-0; 630-93-3 (sodium salt)

RTECS® Number: MU1050000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-328-6; 211-148-2 (phenytoin sodium)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

US EPA Hazardous Waste Number (RCRA No.): U098.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: Cancer 1/1/88; Reproductive toxin 7/1/87; Cancer 1/1/88 (sodium salt).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phenytoin is a crystalline compound. Molecular weight = 252.29; Freezing/Melting point = 295−298°C; Ignition temperature = 585°C. May react with water.

Potential Exposure: Phenytoin is a pharmaceutical used in the treatment of grand mal epilepsy, Parkinson's syndrome; and in veterinary medicine. Human exposure to phenytoin occurs principally during its use as a drug. Figures on the number of patients using phenytoin are not available, but phenytoin is given to a major segment of those individuals with epilepsy. The oral dose rate is initially 100 mg given 3 times per day and can gradually increase by 100 mg every 2−4 weeks until the desired therapeutic response is obtained. The intravenous dose is 200−350 mg/day.

Incompatibilities: Strong acids, strong oxidizers, water.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include blurred vision, hyperactivity, confusion, drowsiness, nausea, vomiting, epigastric pain, swelling of gums, fever, liver and kidney damage.

Long Term Exposure: Phenytoin is carcinogenic in mice after oral administration or by intraperitoneal injection, producing lymphomas and leukemias.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place or in a refrigerator. Protection from air, light, and moisture is recommended for long term storage.[52] A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." This compound falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources[52]: Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases, including nitrogen oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Phenytoin.* Trenton, NJ

Phorate P:0520

Molecular Formula: $C_7H_{17}O_2PS_3$

Synonyms: Aastar; AC3911; American cyanamid 3,911; *O*, *O*-Diaethyl-*S*-(aethylthio-methyl)-dithiophosphat (German); *O*,*O*-Diethyl *S*-ethylmercaptomethyl dithiophosphonate; *O*, *O*-Diethyl *S*-ethylthiomethyl dithiophosphonate; *O*,*O*-Diethyl *S*-(ethylthio)methyl phosphorodithioate; *O*,*O*-Diethyl *S*-[(ethylthio)methyl] phosphorodithioate; *O*, *O*-Diethylethylthiomethyl phosphorodithioate; *O*,*O*-Diethyl *S*-ethylthiomethyl thiothionophosphate; Dithiophosphatede *O*,*O*-diethyle et d'ethylthiomethyle (French); EL3911; ENT 24,042; Experimental insecticide 3911; Forato (Spanish); Geomet; Gramtox; Granutox; L11/6; Methanethiol, ethylthio-*S*-ester with *O*,*O*-diethyl phosphorodithioate; Phorat (German); Phorate-10G; Rampart; Terrathion granules; the met®; Thimet®; Vegfru; Vergfru Foratox

CAS Registry Number: 298-02-2

RTECS® Number: TD9450000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 206-052-2 [*Annex I Index No.:* 015-033-00-6]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (Malaysia) (UN).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P094.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 4.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8140 (2); 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53 Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phorate is a clear mobile liquid with a skunk-like odor. Molecular weight = 260.39; Specific gravity (H_2O:1) = 1.16 at 25°C; Boiling point = 118−120°C at 0.8 mm; Freezing/Melting point = −42.8°C; Vapor pressure = 0.0008 at 20°C; Flash point = 160°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.005%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Primary Irritant. Those engaged in the manufacture, formulation, and application of this systemic and contact insecticide and acaricide. It is also used as a soil insecticide.

Incompatibilities: Water, alkalis. Hydrolyzed in the presence of moisture and by alkalis; may produce toxic oxides of phosphorus and sulfur. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.05 mg/m^3 TWA; 0.2 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA, inhalable fraction and vapor; [skin] not classifiable as a human carcinogen; BEI$_A$ issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC)*

TEEL-0: 0.04 mg/m^3

PAC-1: 0.04 mg/m^3

PAC-2: **0.040** mg/m^3

PAC-3: **0.12** mg/m^3

AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.05 mg/m^3; STEL 0.2 mg/m^3, [skin], 1993; Belgium: TWA 0.05 mg/m^3, [skin], 1993; Denmark: TWA 0.05 mg/m^3, [skin], 1999; France: VME 0.05 mg/m^3, [skin], 1999; Norway: TWA 0.05 mg/m^3, 1999; Switzerland: MAK-W 0.05 mg/m^3, [skin], 1999; United Kingdom: TWA 0.05 mg/m^3; STEL 0.2 mg/m^3, [skin], 2000; the Netherlands: MAC-TGG 0.05 mg/m^3, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.2 mg/m^3 [skin]. Several states have set guidelines or standards for Phorate in ambient air[60] ranging from 0.5−2.0 μg/m^3 (North Dakota) to 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides.

Permissible Concentration in Water: Maine[61] has set a guideline for phorate in drinking water of 0.2 μg/L.

Determination in Water: Fish Tox = 0.13505000 ppb (EXTRA HIGH). Octanol−water coefficient: Log K_{ow} = 3.88.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Acute exposure to phorate may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Dyspnea (shortness of breath) may be followed by respiratory collapse. Giddiness is common. This material is one of the most toxic organophosphorus insecticides. It is a cholinesterase inhibitor that acts on the nervous system; and produces toxicity similar to parathion. The probable oral lethal dose for humans is less than 5 mg/kg, i.e., a taste (less than 7 drops) for a 70-kg (150 lb) person. LD_{50} = (oral-rat) 37 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure; resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 3.50000 ppm (HIGH).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Not available according to NIOSH. *The following is included for reference:* NIOSH: *(parathion) 0.5 mg/m*^{3}*:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *1.25 mg/m*^{3}: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 mg/m*^{3}*:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m*^{3}*:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and alkalis. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, liquid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, phosphorous oxides, sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Wear positive pressure self-contained breathing apparatus. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Phorate: Health and Environmental Effects Profile No. 145.* Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phorate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Phorate*. Trenton, NJ

Phosacetim P:0530

Molecular Formula: $C_{14}H_{13}Cl_2N_2O_2PS$

Synonyms: Acetimidoylphosphoramidothioic acid *O*,*O*-bis (*p*-chlorophenyl) ester; BAY 33819; Bayer 33819; *O*,*O*-Bis (*p*-chlorophenyl) acetimidoyl phosphoramidothioate; *O*,*O*-Bis (4-chlorophenyl) *N*-acetimidoyl phosphoramidothioate; *O*,*O*-Bis(4-chlorophenyl) 1-iminoethyl phosphoramidothioate; *O*, *O*-Bis(4-chlorophenyl)-1-iminoethylphosphoramidothioic acid; DRC-714; Gophacide; (1-Iminoethyl)phosphoramidothioic acid, *O*,*O*-bis(4-chlorophenyl) ester; Phosazetim; Phosphonodithio-imidocarbonic acid, acetimidoyl-, *O*,*O*-bis (*p*-chlorophenyl) ester; Phosphonodithioimidocarbonic acid, (1-iminoethyl)-, *O*,*O*-bis(*p*-chlorophenyl) ester

CAS Registry Number: 4104-14-7

RTECS® Number: TB4725000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 223-874-7 [*Annex I Index No.:* 015-092-00-8]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (East Germany, Philippines) (UN).[13]

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phosacetim is a crystalline solid. Molecular weight = 375.22. Hazard Identification (based on NFPA-704 M Rating System): Health 4 Flammability 1, Reactivity 0.

Potential Exposure: Used as a rodenticide.

Incompatibilities: Strong oxidizers, nitrates. May hydrolyze on contact with moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.7 mg/m^3

PAC-3: 3.7 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Highly toxic. LD_{50} oral rat is 3.7 mg/kg.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous

system with repeated exposure, resulting in convulsions and respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Organophosphorus pesticides, solid, toxic, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including oxides of phosphorus, sulfur, nitrogen, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosacetim.* Washington, DC: Chemical Emergency Preparedness Program

Phosfolan P:0540

Molecular Formula: $C_7H_{14}NO_3PS_2$

Synonyms: AC 47031; American cyanamid 47031; C.I. 47031; Cyclic ethylene(diethoxyphosphinothioyl)-dithioimidocarbonate; Cyclic ethylene *p,p*-diethylphosphono dithioimidocarbonate; Cylan; Cyolane; Cyolane insecticide; (Diethoxyphosphinyl)dithioimidocarbonic acid cyclic ethylene ester; 2-(Diethoxyphosphinylimino)-1,3-dithiolan; 2-(Diethoxyphosphinylimino)-1,3-dithiolane; *p,p*-Diethyl cyclic ethylene ester of phosphonodithioimidocarbonate; *p*, *p*-Diethyl cyclic ethylene ester of phosphonodithioimidocarbonic acid; Diethyl 1,3-dithiolan-2-ylidenephosphoramidate; EI 47031; ENT 25,830; 1,2-Ethanedithiol, cyclic ester with *p,p*-diethyl phosphonodithioimidocarbonate; 1,2-Ethanedithiol, cyclic ester with phosphonodithioimidocarbonic acid *p,p*-diethyl ester; Imidocarbonic acid, phosphonodithio-, cyclic ethylene *p,p*-diethyl ester; Phosphoroamidic acid, 1,3-dithiolan-2-ylidene-, diethyl ester

CAS Registry Number: 947-02-4

RTECS® Number: NJ6475000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-423-2 [*Annex I Index No.*: 015-111-00-X]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; Safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phosfolan is a colorless to yellow solid. Molecular weight = 255.31; Boiling point = 115−118°C at 0.001 mm; Freezing/Melting point = 37−45°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Incompatible with nitrates and water. May hydrolyze upon contact with water, steam, and moisture, and produce toxic oxides of phosphorus, nitrogen, sulfur, and chlorine.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 9 mg/m^3

PAC-3: 9 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Similar to parathion in health hazards. Death may result due to respiratory arrest as a result of paralysis of respiratory muscles and intense bronchoconstriction. Also considered a cholinesterase inhibitor. Symptoms similar to parathion include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, dizziness, tightness in the chest, blurring or dimness of vision, tearing, loss of muscle coordination, slurring of speech, twitching of muscles, drowsiness, difficulty in breathing, respiratory rales, and random jerky movements.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing

material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, nitrates, and other incompatible materials listed above. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Organophosphorus pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Extinguish with dry chemical, carbon dioxide, water spray, foam, or fog. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosfolan*. Washington, DC: Chemical Emergency Preparedness Program

Phosgene (Agents CG & DP, WMD) P:0550

Molecular Formula: CCl_2O

Common Formula: $COCl_2$

Synonyms: Carbone (oxychlorure de) (French); Carbon dichloride oxide; Carbon oxychloride; Carbonic dichloride; Carbon oxychloride; Carbonylchlorid (German); Carbonyl chloride; Carbonyl dichloride; CG (military designation); Chloroformyl chloride; Combat gas; Diphosgene; DP (military designation for diphosgene); Fosgeno (Spanish); NCI-C60219; Phosgen (German); Trichloroacetyl chloride (diphosgene)

CAS Registry Number: 75-44-5; 503-38-8 (diphosgene)

RTECS® Number: SY5600000

UN/NA & ERG Number: UN1076/125

EC Number: 200-870-3 [*Annex I Index No.:* 006-002-00-8]; 207-965-9 (diphosgene or trichloromethyl chloroformate)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 500 (1.00% concentration); *Theft hazard* 15 (≥0.17% concentration).

Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high-risk pollutants (Section 63.74); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 500 lb (227 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P095.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol *(75-44-5)*: T + ; Risk phrases: R26; R34; Safety phrases: S1/2; S9; S26; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Phosgene (CG) is a colorless, noncombustible gas. It is shipped as a liquefied compressed gas in steel cylinders. At low concentrations CG has a sweet (not pleasant) odor like newly mown hay, green corn, or moldy hay. In higher concentrations, it is poisonous with an odor that is suffocating, irritating, and pungent. The odor is only detectable for a short amount of time when CG is initially released and odor should not be regarded as a reliable indicator of overexposure. A fuming liquid below 8.3°C/47°F. Shipped as a liquefied compressed gas. The odor threshold is between 1.5 and 6 mg/m^3. A choking agent, phosgene (CG), rapidly decomposes in relative humidity over 70%. Molecular weight = 98.92; Boiling point = 8.2°C; Freezing/Melting point = −118°C; Relative vapor density (air = 1) = 3.48; Vapor pressure = 1.61 atm at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 1. Reacts with water (slightly soluble).

Potential Exposure: Compound Description: Human Data. Phosgene can be deadly at a concentration as low as 2 ppm. Phosgene is used as an intermediate in the manufacture of many industrial chemicals, including dyes and plastics; in the making of dyestuffs based on triphenylmethane, coal tar, and urea. It is also used in the organic synthesis of isocyanates and their derivatives, carbonic acid esters (polycarbonates), and acid chlorides. Other applications include its utilization in metallurgy; and in the manufacture of some insecticides and pharmaceuticals. Exposure to phosgene may occur during arc welding and in fires involving vinyl chloride; released from household paint removers and degreasers when they are used in the presence of heat. Phosgene (CG) has been used as a military choking, pulmonary agent since WW I, and has become a staple of chemical arsenals in many countries. ***Persistence of Chemical Agent:*** Phosgene (CG & DO): Summer: 1−10 min; Winter: 10 min to 1 h.

Incompatibilities: Moisture, alkalis, ammonia, alcohols, copper. Reacts slowly in water to form hydrochloric acid and carbon dioxide. Violent reaction with strong oxidizers, amines, aluminum. Attacks many metals in the presence of water. Attacks plastic, rubber, and coatings.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.05 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 0.1 ppm/0.4 mg/m^3 TWA.
NIOSH REL: 0.1 ppm/0.4 mg/m^3 TWA; 0.2 ppm/0.8 mg/m^3 [15 min] Ceiling Concentration.
ACGIH TLV®[1]: 0.1 ppm/0.4 mg/m^3 TWA.
Protective Action Criteria (PAC) **CG***
TEEL-0: 0.1 ppm
PAC-1: 0.1 ppm
PAC-2: **0.3** ppm
PAC-3: **0.75** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
NIOSH IDLH: 2 ppm.
NIOSH IDLH: 2 ppm.
Emergency Response Planning Guidelines (AIHA)
ERPG-1: Inappropriate
ERPG-2: 0.2 ppm
ERPG-3: 1 ppm
DFG MAK: 0.02 ppm; 0.082 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.
Austria: MAK 0.1 ppm (0.4 mg/m^3), 1999; Denmark: TWA 0.05 ppm (0.2 mg/m^3), 1999; Finland: STEL 0.05 ppm (0.2 mg/m^3), [skin], 1999; France: VLE 0.1 ppm (0.4 mg/m^3), 1999; Japan: 0.1 ppm (0.4 mg/m^3), 1999; the Netherlands: MAC-TGG 0.08 mg/m^3, 2003; the Philippines: TWA 0.1 ppm (0.1 mg/m^3), 1993; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Sweden: TGV 0.05 ppm (0.2 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.4 mg/m^3), KZG-W 0.2 ppm (0.8 mg/m^3), 1999; Thailand: TWA 0.1 ppm (0.4 mg/m^3), 1993; Turkey: TWA 0.1 ppm (0.4 mg/m^3), 1993; United Kingdom: TWA 0.02 ppm (0.08 mg/m^3); STEL 0.06 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm. The Czech Republic has set a TWA of 0.5 mg/m^3 and a ceiling value of 1.0 mg/m^3 in work-place air, and MAC in ambient air of 0.01 mg/m^3 and 0.003 mg/m^3 on a daily average basis. Several states have set guidelines or standards for phosgene in ambient air[60] ranging from zero (North Carolina) to 1.33 μg/m^3 (New York) to 4.0 μg/m^3 (Florida, North Dakota, South Carolina) to 7.0 μg/m^3 (Virginia) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method 61.

Determination in Water: Octanol−water coefficient: Log $K_{\mathrm{ow}} = -0.71$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Acute exposure to phosgene may result in severe irritation and burns of the skin, eyes, mucous membranes, and respiratory passages. Cough, dyspnea (shortness of breath), pain in the chest, and severe pulmonary edema may also occur. Cyanosis and anxiety may be observed.

Note: The detection of the odor of phosgene at any time indicates the need for immediate, corrective action or withdrawal. *Inhalation:* Both immediate and delayed symptoms may be felt. Immediate symptoms of irritation to mouth, throat, and eyes, tearing, coughing, and difficult breathing are felt at levels of 5 ppm and above. Delayed effects are the accumulation of fluid in the lungs and death; if proper, rapid treatment is not obtained. The length of delay depends on the dose but may be between 2 and 15 h. Death may result from short exposures to high levels (30 ppm, 17 min) or long exposures to low levels (3 ppm, 3 h). Phosgene is particularly dangerous at low levels because lethal doses may be inhaled without warning symptoms. *Skin:* Contact with skin may lead to severe chemical burns. Liquid may cause frostbite. *Eyes:* Eye irritation begins at 3–5 ppm. Severe and permanent damage may result. Liquid phosgene is more hazardous than vapor. Liquid may cause frostbite. *Ingestion:* Expected symptoms may include severe irritation and chemical burns of the mouth, throat, lungs, and digestive tract.

Long Term Exposure: Even low levels can cause permanent lung damage, emphysema, bronchitis, pulmonary fibrosis.

Points of Attack: Respiratory system, lungs, skin, eyes.

Medical Surveillance: Preemployment medical examinations should include chest X-rays and baseline pulmonary function tests. Consider chest X-ray following acute overexposure. The eyes and skin should be examined. Smoking history should be known. Periodic pulmonary function studies should be done. Workers who are known to have inhaled phosgene should remain under medical observation for at least 24 h to insure that delayed symptoms do not occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you do not have the equipment and training, do not enter the hot zone to rescue and/or decontaminate victims. If the victim cannot move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 min. Wash–strip–wash–evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but do not let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 min. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods: Where liquid phosgene is encountered, protective clothing should be supplied which is impervious to phosgene. Where gas is encountered above safe limits, full-face gas masks with phosgene canisters or supplied-air respirators should be used. Because of the potentially serious consequences of acute overexposure and the poor warning properties of the gas to the human senses, automatic continuous monitors with alarm systems are strongly recommended. Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: *1 ppm:* Sa (APF = 10) (any supplied-air respirator). *2 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Phosgene must be stored to avoid contact with water, moisture, or steam, since violent reactions occur. Store in tightly closed, steel containers in an isolated area away from the work area and separated from all other materials, as well as sunlight. Although phosgene in anhydrous equipment is not corrosive to ordinary metals; in the presence of moisture, use monel, tantalum, or glass-lined storage containers. Phosgene should be stored away from heating and cooling ducts. Containers should be frequently inspected for leaks. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Phosgene requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Phosgene may be neutralized by covering it with sodium bicarbonate or an equal mixture of soda ash and slaked lime. After mixing, spray very carefully with water. Transfer slowly to a larger container of water. *Do not use water* directly on spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

CG, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 2.5/4.1

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 4.7/7.5
Night 7.0+ /11.0+

DP, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.6/2.5

Phosgene

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.6/2.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 2.0/3.2
Night 6.1/9.7

Diphosgene

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: Phosgene may burn, but does not easily ignite. For small fires, use dry chemical or carbon dioxide. Use water spray, fog, or foam for larger fires. Move container from fire area if you can do so without risk. Stay away from the ends of tanks and cool exposed containers with water until well after the fire is out. Isolate the area until gas has dispersed. Poisonous gases are produced in fire, including hydrogen chloride, carbon monoxide, and chlorine fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Diphosgene (DP) will not burn. However, it is possible that a DP tank may be adjacent to a fire. In a fire, a storage tank will heat and the tank may overpressurize and explode, so evacuate the area. When heated, DP breaks down to toxic phosgene, which breaks down into chlorine and hydrogen chloride gases. The danger from a heated DP tank is too great to risk a manned firefighting effort; if possible, an unattended fire monitor aimed at the upper part of the diphosgene tank will cool the tank and may prevent tank failure. In general, it is best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning fuel around.

Disposal Method Suggested: Phosgene may be neutralized by covering it with sodium bicarbonate or an equal mixture of soda ash and slaked lime. After mixing, spray carefully with water. Transfer slowly to a larger container of water. *Do not use water* directly on spill. Pass controlled discharges of phosgene through 10% NaOH solution in a scrubbing tower.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

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Phosgene oxime (Agent CX, WMD) P:0555

Molecular Formula: $CHCl_2NO$

Synonyms: Carbonyl chloride oxime; CX; Dichlorformaldehyde-oxime; Dichloroformaldoxime; 1,2-Dichloroformoxime; Dichloroformoxime; Dichlormethylenhydroxylamine; Dichloroximinomethane; Kohlensauredichloridoxime (German)

CAS Registry Number: 1794-86-1

RTECS® Number: Not established

UN/NA & ERG Number: 2811/154

Regulatory Authority and Advisory Bodies

Report any release of WMD to National Response Center 1-800-424-8802.

While not a mandated "Federally listed" waste, CX is more toxic than most RCRA listed chemicals. However, GF is a "listed" hazardous waste in some states where it may have been stockpiled by the military.

WGK (German Aquatic Class): No value assigned.

Description: Phosgene oxime (military designation CX) is a noncombustible urticant (nettle agent, blister agent) with a short (seconds to minutes) latency period. CX is a colorless, low-melting point (crystalline, white powder) solid or as a liquid (liquid above 39°C; solid below 35°C). On hot days (or at body temperature) it can appear as a yellowish-brown liquid. It has a high vapor pressure (the vapor pressure of the solid is high enough to produce symptoms), slowly decomposes at normal temperatures. It has an intense, disagreeable, penetrating, and violently irritating, peppery odor. Odor detectable at less than 0.3 ppm. Molecular weight = 113.93 Da; Freezing/Melting point = 35−40°C; boiling point = 129°C (with decomposition); Vapor density = 3.9; Vapor pressure = 11.2 mmHg at 20°C (solid); 13 mmHg at 40°C (liquid); Volatility = 1800 mg/m^3 at

20°C; 76,000 mg/m^3 at 40°C; Latent heat of vaporization = 101 cal/g at 40°C; Decomposition temperature = <128°C. Solubility in water = dissolves slowly and completely. High solubility in organic solvents.

History of the chemical: CX was invented in Germany in 1929; it is among the least well-studied chemical warfare agents; therefore, detailed information is limited. Although it is believed that CX was never used on the battlefield, it was after WW II that the military tested concentrated phosgene oxime. These tests revealed that CX was a highly effective and painful chemical warfare agent. Phosgene oxime is of military interest because it easily penetrates garments and rubber much more quickly than do other chemical agents. It is possible that Iraq used CX in the Iran−Iraq war, and North Korea may have produced and stocked quantities of this chemical agent. Phosgene oxime (CX) gives off dangerous gas. It does take very little of this gas to damage a victim's lungs. Terrorists might put CX in an exploding bomb in order to break up the solid into an aerosol that can penetrate the skin and lungs. Once exposed, the victim feels immediate pain and the need to escape. Phosgene oxime (CX) easily penetrates fabrics and rubbers and cause great pain and skin damage (without blisters) in less than a minute. Soon after contact the skin dies. Recovery may take up to 6 months. Eye contact can cause blindness. Inhalation attacks the lungs, resulting in damage that can be permanent.

Potential Exposure: There is no industrial use for Phosgene oxime (CX) and because of its extreme instability, the pure material is not likely to be used in military operations.[FM 3-9] CX is especially dangerous when mixed with other chemicals such as nerve agents. It burns away the skin making it more permeable to any other "added" agents. No other chemical agent is capable of producing immediate extreme pain followed by rapid local tissue death (necrosis). Post World War II studies indicate that concentrations below 8% cause no or inconsistent effects.[ATSDR]

Persistence of Chemical Agent: *Soil:* about 2 h. *Material surfaces and water:* relatively nonpersistent.

Incompatibilities: Phosgene oxime (CX) is among the most important halogenated oximes. CX reacts with water, sweat, and heat, forming hydrochloric acid. CX may be an oxidizer, and it may ignite combustibles (e.g., wood, paper, oil, or clothing). CX is incompatible with strong acids and bases; hydrides and other strong reducing agents; strong oxidizing acids, peroxides, and hydroperoxides. Not hydrolyzed by dilute acids; reacts violently in basic solutions forming carbon dioxide, hydrogen chloride, and hydroxylamine. Hydrolysis products include HCl and methylarsenic oxide. CX quickly penetrates rubber and clothing. CX decomposes when in contact with many metals; it is corrosive to most metals, and contact with metals may cause the release flammable hydrogen gas. Traces of many metals cause it to decompose; however, it corrodes most metals.

Permissible Exposure Limits in Air: Conversion factor = 1 ppm = 4.66 mg/m^3 at 77°C.

The immediately dangerous to life and health (IDLH) concentration of CX has not been defined.

Protective Action Criteria (PAC) **CG***
TEEL-0: 0.0075 mg/m^3
PAC-1: **0.028** mg/m^3
PAC-2: **0.083** mg/m^3
PAC-3: **13** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air:

According to the USAMRICD, do NOT depend on the following for the detection of Agent CX: M272 water testing kit, MINICAMS, ICAD, M21 remote sensing alarm, CAM, ACAMS, DAAMS, and M8A1 automatic chemical-agent detector alarm are incapable of detecting CX. Likewise, M8 and M9 paper should not be depended upon to detect Agent CX.

The M256A1 detector ticket reacts to the presence of CX, but the detection threshold is not known with certainty. Liquid detection: The portable M256A1 has a response time of up to 15 min. The following detectors are listed for Agent CX detection in the *Guide for the Selection of Chemical Detection Equipment for Emergency First Responders, 3rd Edition*, published by the US Department of Homeland Security: Chemical Agent Detector C2 Kit (021330) for vapor, liquids, aerosols: Start-up time (based on experience) 1−5 min; response time (regardless of experience) 20−25 min (Anachemia Canada, Inc.); and M256A1 (T503) (063230COM) Chemical Agent Detector Simulator Training Kits for vapor only: Start-up time (based on experience) 1−5 min; response time (regardless of experience) 20−25 min (Anachemia Canada, Inc.)

The following detectors have the capacity to detect CX at the threshold limits given[USAMRICD]:
Liquid: M18A2 0.5 mg/min^3
Air: M90 (M90-D1-C) 0.15 mg/min^3
M93A1 Fox 10−100 μg/L

Permissible Concentration in Water: Do NOT use the M272 water testing kit.[USAMRICD]

Determination in Water: Contact pollution control authorities and advise shutting water intakes. CX dissolves in water and breaks down into toxic products that are much less dangerous than phosgene oxime, but still poisonous. Do not allow people to drink water containing even the breakdown products.

Routes of Entry: Skin, eye contact, inhalation.

Harmful Effects and Symptoms

Phosgene oxime (CX) is a rapid-acting casualty agent. The effects of phosgene oxime vapor and liquid on the skin, eyes, and lungs are almost instantaneous, causing immediate pain upon contact with the liquid and when the vapors are inhaled. Little is known about how CX works but it eats its way through protective clothing, the skin, and eventually reaches the blood. Phosgene oxime (CX) will cause blindness, kill skin horribly, and with enough of it on the skin a victim could die. *Eyes:* The eyes will immediately burn, the eyelids will swell, and the victim's cornea will scar, causing permanent damage to the eyes with possible blindness. *Lungs*: The effects are immediate: The victim will sneeze and cough, with runny nose. The lungs will fill with fluid causing pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Immediate stinging pain will be felt. The skin reddens and will eventually blister (up to 12 h after exposure). *Ingestion:* It is difficult to understand how one might swallow Phosgene oxime (CX), but it possibly may happen. Animal studies show that the victim's stomach and intestines would swell and bleed.

Short Term Exposure: Pain and local tissue destruction occur immediately on contact with skin, eyes, and mucous membranes. Phosgene oxime is rapidly absorbed from the skin and eyes and may result in systemic toxicity. Phosgene oxime causes redness, wheals (hives), and urticaria on the skin, but does not produce a fluid-filled blister (vesication). Despite the lack of initial blister formation, phosgene oxime produces more tissue damage than the blister agents. Known as a "nettle gas," CX produces immediate pain varying from a mild prickling to almost intolerable pain similar to a severe bee sting. Phosgene oxime has no antidote. Treatment is similar to that of the mustard agents. It causes violent irritation to the mucous membranes of the nose and eyes. Even at low temperature it has sufficient vapor pressure to produce tearing. When CX comes in contact to the skin, the area turns pale in 30 s and develops a red ring around the area. A wheal forms in about 30 min; the blanched area turns brown in 24 h and a scab forms in about a week. The scab usually falls off in about 3 weeks. Itching may be present throughout healing, which in some cases may be delayed beyond 2 months.[Army FM 3-9 and CDC] The LD_{50} for skin exposure is estimated as 25 mg/kg. LCt_{50} = no accurate data available; the estimated LCt_{50} by inhalation is 1500−2000 mg-min/m^3; ICt_{50} (respiratory) 25 mg-min/m^3. Inhaled phosgene oxime is extremely irritating to the upper airways and causes pulmonary edema. Irritation occurs with exposures to 0.2 mg-min/m^3 and becomes unbearable at 3 mg-min/m^3. The estimated LCt_{50} (the product of concentration times time that is lethal to 50% of the exposed population by inhalation) is 1500 to 2000 mg-min/m^3.[ATSDR]

Long Term Exposure: May cause permanent injury, including lung damage and blindness. Information is unavailable about the carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to phosgene oxime.

Points of Attack: Skin, mucous membranes of the nose and eyes.

Medical Surveillance: There are no specific tests to confirm exposure. Extreme pain may persist for days. Patients/victims should be observed for signs of whole-body (systemic) toxicity, including accumulation of fluid in the lungs (pulmonary edema). Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway.[NIOSH]

First Aid: A note to first responders: You cannot help the victim if you kill yourself. *Do not enter an area contaminated with either CX vapor or liquid unprotected.* The only option to your own survival is by wearing "Level A" protection. You must act quickly.

Remove the victim to fresh air without exposing yourself—do not touch the victim! Only when the victim is outside the hot and warm zones and decontaminated you can help. If breathing is difficult, give oxygen. Do not make the victim vomit if the victim has swallowed Phosgene oxime. If the victim is conscious, give the victim milk. Get the victim to a doctor or medical facility as soon as possible, even if symptoms do not appear serious; symptoms are often delayed.

Decontamination: *Note to first responders:* Depending on the dose and the equipment available to you: Evacuate the area and shut down heating, ventilation, and air conditioning systems to prevent further spread of Phosgene oxime (CX). Call for medical and hazmat assistance immediately. If you get CX on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. Because of the rapid reaction of CX with the skin, decontamination may not be entirely effective once pain occurs. Nevertheless, decontaminate as rapidly as possible by flushing the area with large amounts of water to remove any agent that has not reacted with the skin. Wash the victim with warm water and soap. *Bleach does not work with CX.* Be certain you have decontaminated the victims as much as you can before they leave the area so that they do not spread the Phosgene oxime (CX).

Personal Protective Methods: Use Level A protection. CX quickly penetrates rubber and clothing. Corrosive to most metals.

Respirator Selection: CX quickly penetrates rubber and clothing. Corrosive to most metals.

Storage: Stable in steel containers.

Shipping: Shipping Name: Toxic solids, organic, n.o.s. Hazardous Class or Division: 6.1. Subsidiary Hazardous Class or Division: Label Poison (Toxic). Packing Group III.

Spill Handling: Immediately evacuate everyone, including yourself. Immediately call for medical and hazmat assistance. Notify police, federal authorities, medical, hazmat, and emergency authorities. Immediately decontaminate victim. Do not touch the victim or allow Phosgene oxime (CX) to touch your skin or eyes. If possible, ventilate the area. If response personnel must walk through the spilled agent, wear the appropriate Level A protection. Keep combustibles (e.g., wood, paper, and oil) away from the spilled agent. Use water spray to reduce aerosols or divert aerosol cloud drift. Avoid allowing water runoff to contact the spilled agent. Do not direct water at the spill or the source of the leak. Stop the leak if it is possible to do so without risk to personnel. Prevent entry into waterways, sewers, basements, or confined areas. Isolate the area until aerosol has dispersed.[NIOSH]

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mile (800 m) in all directions; also, consider initial evacuation for 0.5 mile (800 m) in all directions.

CX, when used as a weapon

Small spills [involving the release of approximately 52.83 gallons (200 L) or less]

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills [involving quantities greater than 52.83 gallons (200 L)]

First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.6/1.0
Night 1.9/3.1

Fire Extinguishing: Phosgene oxime (CX) is noncombustible; it burns weakly, if at all. CX may decompose upon heating producing corrosive and/or toxic gases. Containers may explode when heated. In case of fire, evacuate the area, including yourself. CX may be an oxidizer, and it may ignite combustible materials (e.g., wood, paper, oil, or clothing). If there is some reason that you have to put out the fire—for example, there are things nearby that cannot be allowed to burn—use unattended equipment, then evacuate everyone immediately, including yourself. If you *must* extinguish a Phosgene oxime (CX) fire, use water streams, water fog, alcohol foam, universal foam, and, for confined fires, carbon dioxide. (For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray.) Vapors are heavier than air and will collect in low areas. Keep out of these areas; stay upwind. Hazardous concentrations may spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas (e.g., sewers, basements, and tanks). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Move containers from the fire area if it is possible to do so without risk to personnel. Dike fire control water for later disposal; do not scatter the material. For fire involving tanks or car/trailer loads, fight the fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tanks. Always stay away from tanks engulfed in fire. Run-off from fire control or dilution water may be corrosive and/or toxic, and it may cause pollution. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested: Seek expert advice from armed services (see Reference section), Center for Disease Control headquarters in Atlanta, GA.

References

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Sidell, R. (1997). *Medical Aspects of Chemical and Biological Warfare*, Borden Institute, Walter Reed Army Medical Center, Washington, DC; Office of The Surgeon General, United States Army, Falls Church, Virginia; United States Army Medical Department Center and School, Fort Sam Houston, Texas; United States Army Medical Research and Materiel Command, Fort Detrick, Frederick, Maryland, Uniformed Services University of the Health Sciences, Bethesda, MD[MACBW]

CDC/NIOSH, *The Emergency Response Safety and Health Database*, <http://www.cdc.gov/NIOSH/ershdb/EmergencyResponseCard_29750015.html>

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Phosmet P:0560

Molecular Formula: $C_{11}H_{12}NO_4PS_2$

Synonyms: APPA; Decemthion; Decemthion P-6; *O*, *O*-Dimethyl phthalimidiomethyl dithiophosphate; *O*,*O*-Dimethyl *S*-(*N*-phthalimidomethyl) dithiophosphate; *O*, *O*-Dimethyl *S*-phthalimidomethyl phosphorodithioate; ENT25,705; Fosmet (Spanish); Ftalophos; Imidan; Kemolate; *N*-(Mercaptomethyl)phthalimide *S*-(*O*,*O*-dimethyl phosphorodithioate); Percolate; Phosphorodithioic acid, *S*-[(1,3-dihydro-1,3-dioxo-isoindol-2-yl)methyl] *O*,*O*-dimethyl ester; Phosphorodithioic acid, *O*,*O*-dimethyl ester, *S*-ester with *N*-(mercaptomethyl) phthalimide; Phthalimide, *N*-(mercaptomethyl)-, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; Phthalimido-*O*,*O*-dimethyl phosphorodithioate; Phthalimidomethyl *O*,*O*-dimethyl phosphorodithioate; Phthalophos; PMP; Prolate; R 1504; Smidan; Stauffer R 1504

CAS Registry Number: 732-11-6
RTECS® Number: TE2275000
UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152
EC Number: 211-987-4 [*Annex I Index No.:* 015-101-00-5]
Regulatory Authority and Advisory Bodies
US EPA, FIFRA, 1998 Status of Pesticides: Supported.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
US DOT MARINE POLLUTANT (49CFR, Subchapter 172.101, Appendix B).
US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.
European/International Regulations (not listed in Annex I, but the following may apply): Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.

Description: Phosmet is a white crystalline solid. Molecular weight = 317.33; Boiling point = (decomposes below BP) >100°C; Freezing/Melting point = 72°C. Hazard; Vapor pressure = 4.9×10^{-7} mbar at 20°C. Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Used as an organophosphorus insecticide and acaricide.

Incompatibilities: Not compatible with other pesticides under alkaline conditions. Contact with water, steam, or moisture forms phthalic acids. Slightly corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.025 mg/m^3
PAC-1: 0.075 mg/m^3
PAC-2: 0.54 mg/m^3
PAC-3: 40 mg/m^3
Russia has set a ceiling value of 0.3 mg/m^3 in work-place air. Russia has also set a MAC of 0.009 mg/m^3 in ambient air in residential area on a once-daily basis and 0.004 mg/m^3 on a daily average basis.

Determination in Air: NIOSH Analytical Method (IV) Method #5600, Organophosphorus pesticides.

Permissible Concentration in Water: Russia[36] set a MAC of 0.2 mg/L in surface water.

Determination in Water: Fish Tox: 4.41815000 ppb MATC (HIGH). Octanol–water coefficient: Log K_{ow} = 2.8.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin on contact. This material is a highly toxic organophosphate; the probable oral lethal dose for humans is 50–500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb person. It is a cholinesterase inhibitor and has central nervous system effects. Oral lethal doses in humans have been reported at 50 mg/kg. Acute exposure to phosmet may produce the following signs and symptoms: pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Dyspnea (shortness of breath) may be followed by respiratory collapse. Giddiness is common.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 7.00000 ppm Health Advisory (HIGH).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Liver function tests. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and/or slurry of activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from other pesticide, alkaline conditions, water, and other forms of moisture. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. As for other organophosphorus pesticides stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. Take up small, dry spills with clean shovel and place in clean, dry container. Dike far ahead of *large spills* for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire, including nitrogen oxides, phosphorous oxides, and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Small amounts may be decomposed with hypochlorite. For large amounts, incineration with effective gas scrubbing is recommended.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosmet*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 1999). *Hazardous Substances Fact Sheet: Decemthion*. Trenton, NJ

Phosphamidon P:0570

Molecular Formula: $C_{10}H_{19}ClNO_5P$

Common Formula: $(CH_3O)_2POOC(CH_3){=}C(Cl)CON(CH_2CH_3)_2$

Synonyms: Apamidon; C 570; C-570; (2-Chlor-3-diaethylamino-methyl-3-oxo-prop-1-en-yl)-dimethylphosphat (German); 2-Chloro-3-(diethylamino)-1-methyl-3-oxo-1-propenyl-dimethyl phosphate; 2-Chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate; 1-Chloro-diethylcarbamoyl-1-propen-2-yl dimethyl phosphate; Ciba 570; Crophosphate; Dimecron; Dimecron 100; *O*,*O*-Dimethyl *O*-[2-chloro-2-(*N*,*N*-diethylcarbamoyl)-1-methylvinyl] phosphate; Dimethyl 2-chloro-2-diethylcarbamoyl-1-methylvinylphosphate; Dimethyl diethylamido-1-chlorocrotonyl(2) phosphate; *O*,*O*-Dimethyl-*O*-(1-methyl-2-chlor-2-*N*,*N*-diethyl-carbamoyl)-vinyl-phosphat (German); [*O*,*O*-Dimethyl *O*-[1-methyl-(2-chloro-2-diethylcarbamoyl)vinyl] phosphate; Dimethyl phosphate of 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide; Dimethyl phosphate ester with 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide; Dimonex; Dixon; ENT25,515; Fosfamidon (Spanish); Fosfamidone; Foszfamidon; ML 97; Merkon phosphamidone; NCI-C00588; OMS 1325; OR1191; Phosphamidon; Phosphate de dimethyle et de(2-chloro-2-diethylcarbamoyl-1-methylvinyle) (French); Phosphoric acid, 2-chloro-3-(diethylamino)-1-methyl-3-oxo-1-propenyl dimethyl ester; Phosphoric acid, dimethyl ester, with 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide

CAS Registry Number: 13171-21-6; 23783-98-4 [(Z) isomer)]; 297-99-4 [(E) isomer]

RTECS® Number: TC2800000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 236-116-5 [*Annex I Index No.:* 015-022-00-6] (phosphamidon)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; no evidence: mouse.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Very Toxic Substance (World Bank).[15]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (soluble liquid formulations of the substance that exceeds 1000 g active ingredient).

European/International Regulations: Hazard Symbol: T + , N; Risk phrases: R24; R28; R50/53; R68; Safety phrases: S1/2; S23; S36/37; S45-S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (CAS: 13171-21-6).

Description: Phosphamidon is a pale yellow oily liquid. Molecular weight = 299.72; Specific gravity (H_2O:1) = 1.22; Boiling point = 162°C at 1.5 mmHg; Freezing/Melting point = −45°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. This material is used as an insecticide on citrus, cotton, and deciduous fruit and nuts. It is also an acaricide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Attacks metals, such as aluminum, iron, tin.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.06 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.3 mg/m^3

PAC-3: 60 mg/m^3

Determination in Water: Fish Tox = 1445.67277000 ppb (EXTRA LOW); FISH STV (Sediment Toxicity Value): LOW; Octanol−water coefficient: Log K_{ow} = <0.9.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. May affect the nervous system, causing convulsions, respiratory failure, and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150-lb person. It is a cholinesterase inhibitor. Acute exposure to phosphamidon may produce pinpoint pupils, blurred vision, headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory effects include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 0.14000 ppm (EXTRA HIGH).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a healthcare facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires: use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including phosphorous oxides, hydrogen chloride, and nitrogen oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be treated with alkali followed by landfill disposal. Large quantities should be incinerated with effluent gas scrubbing.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphamidon*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Phosphamidon*. Trenton, NJ

Phosphine P:0580

Molecular Formula: H_3P

Common Formula: PH_3

Synonyms: Celphos; Delicia; Detia gas-EX-B; Fosfamia (Spanish); Hydrogen phosphide; Phosphorous trihydride; Phosphorous hydride; Phosphorated hydrogen; Phosphorwasserstoff (German); Phostoxin

CAS Registry Number: 7803-51-2

RTECS® Number: SY7525000

UN/NA & ERG Number: UN2199/119

EC Number: 232-260-8 [*Annex I Index No.*: 015-181-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). (1% concentration; *Theft hazard* 15 (≥0.67% concentration).

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Banned or Severely Restricted (several countries) (UN).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

US EPA Hazardous Waste Number (RCRA No.): P096.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: F, T, N; Risk phrases: R12; R17; R26; R34; R50; Safety phrases: S1/2; S28; S36/37; S45; S61; S63 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Phosphine is a colorless gas that is shipped as liquefied compressed gas. Odorless when pure, it has the odor of garlic or the foul odor of decaying fish. The level at which humans detect the odor of phosphine (odor threshold) does not provide sufficient warning of dangerous concentrations. Phosphine presents an additional hazard in that it ignites at very low temperatures. Shipped as a liquefied compressed gas. The pure compound is odorless. The odor threshold is 0.14 ppm. Molecular weight = 34.00; Specific gravity (H_2O:1) = 0.8; Boiling point = −88°C; Freezing/Melting point = −133°C; Relative vapor density (air = 1): 1.18; Vapor pressure = 41.3 atm; >760 mmHg at 20°C; Flash point = (flammable gas) 104°C; Autoignition temperature (depends on concentration and diluent) = 38−100°C. Explosive limits: LEL = 1.8%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Slightly soluble in water; solubility = 25 mL/100 mL at 17°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Human Data. Phosphine is used as a fumigant; in the semiconductor industry, as a doping agent for electronic components (to introduce phosphorus into silicon crystals); in chemical synthesis; used as a polymerization initiator; as an intermediate for some flame retardants. Also, exposures may occur when acid or water comes in contact with metallic phosphides (aluminum phosphide, calcium phosphide). These two phosphides are used as insecticides or rodenticides for grain, and phosphine is generated during grain fumigation. When phosphine toxicity is suspected, but phosphine exposure is not obvious, one should suspect transdermal contamination and/or ingestion of phosphides. Phosphine may also evolve during the generation of acetylene from impure calcium carbide, as well as during metal shaving; sulfuric acid tank cleaning; rustproofing, ferrosilicon, phosphoric acid; and yellow phosphorus explosive handling.

Incompatibilities: Phosphine reacts with acids, air, copper, moisture, oxidizers, oxygen, chlorine, nitrogen oxides, metal nitrates, halogens, halogenated hydrocarbons, copper, and many other substances, causing fire and explosion hazard. Extremely explosive; may ignite spontaneously on contact with air at or about 100°C. Attacks many metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.39 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.3 ppm/0.4 mg/m^3 TWA.

NIOSH REL: 0.3 ppm/0.4 mg/m^3 TWA; 1 ppm/1 mg/m^3 STEL.

ACGIH TLV®[1]: 0.3 ppm/0.42 mg/m^3 TWA; 1 ppm/1.4 mg/m^3 STEL.

NIOSH IDLH: 50 ppm.

Protective Action Criteria (PAC) Phosphine*

TEEL-0: 0.3 ppm

PAC-1: 1 ppm

PAC-2: **2.0** ppm

PAC-3: **3.6** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Emergency Response Planning Guidelines (AIHA)
ERPG-1: Inappropriate
ERPG-2: 0.5 ppm
ERPG-3: 3.5 ppm

DFG MAK: 0.1 ppm/0.14 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.3 ppm (0.4 mg/m^3), 1993; Australia: TWA 0.3 ppm (0.4 mg/m^3); STEL 1 ppm (1 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.15 mg/m^3), 1999; Belgium: TWA 0.3 ppm (0.42 mg/m^3); STEL 1 ppm (1.4 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.15 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.15 mg/m^3); STEL 0.3 ppm (0.4 mg/m^3), 1999; France: VME 0.1 ppm (0.13 mg/m^3), VLE 0.3 ppm (0.4 mg/m^3), 1999; the Netherlands: MAC-TGG 0.4 mg/m^3, 2003; Norway: TWA 0.1 ppm (0.15 mg/m^3), 1999; the Philippines: TWA 0.3 ppm (0.4 mg/m^3), 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.8 mg/m^3, 1999; Russia: STEL 0.1 mg/m^3, 1993; Sweden: NGV 0.3 ppm (0.4 mg/m^3), KTV 1 ppm (1.4 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.15 mg/m^3), KZG-W 0.2 ppm (0.3 mg/m^3), 1999; Thailand: TWA 0.3 ppm (0.4 mg/m^3), 1993; Turkey: TWA 0.3 ppm (0.4 mg/m^3), 1993; United Kingdom: STEL 0.3 ppm (intermittent 0.42 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1 ppm. Several states have set guidelines or standards for phosphine in ambient air[60] ranging from 1.33 μg/m^3 (New York) to 4.0 μg/m^3 (Florida and North Dakota) to 6.7 μg/m^3 (Virginia) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada and North Dakota) to 130 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1003, Phosphine, OSHA Analytical Method ID-180. See also NIOSH Analytical Method #6002.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5.5 μg/L based on health effects.

Determination in Water: Phosphine cannot be used to contaminate water supplies; it breaks down in water. Octanol−water coefficient: Log K_{ow} = (estimated) −0.27.

Routes of Entry: Phosphine can be absorbed into the body by inhalation. Direct contact with phosphine liquid may cause frostbite.

Harmful Effects and Symptoms

Short Term Exposure: Severe irritation to the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact with the liquid may cause frostbite. May affect the central nervous system, cardiovascular system, heart, gastrointestinal tract, liver, and kidneys. Phosphine is a super-toxic gas with a probable oral lethal dose of 5 mg/kg or 7 drops for a 150-lb person. An air concentration of 3 ppm is safe for long-term exposure, 500 ppm is lethal in 30 min, and concentration of 1000 ppm is lethal after a few breaths. Acute exposure to phosphine usually results in headache, cough, tightness and pain in the chest, shortness of breath, dizziness, lethargy, and stupor. Fatigue, muscle pain, chills, tremors, loss of coordination, seizures, and coma may be seen. Pulmonary edema and cardiac arrhythmias are common. Gastrointestinal symptoms include nausea, vomiting, abdominal pain, and diarrhea. Renal (kidney) damage, hepatic (liver) damage; and jaundice may also occur.

Long Term Exposure: Chronic poisoning may cause toothache, swelling of the jaw, spontaneous fractures of bones. May cause anemia. May damage the liver and kidneys. The effects are cumulative. Can irritate the lungs; bronchitis may develop.

Points of Attack: Respiratory system, liver.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, if phosphides have been ingested, **do not induce emesis**. Phosphides will release phosphine in the stomach; therefore, watch for signs similar to those produced by phosphine inhalation. Administer a slurry of activated charcoal at 1 g/kg (usual adult dose: 60−90 g; child dose: 25−50 g). A soda can and a straw may be of assistance when offering charcoal to a child. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Metallic phosphides on clothes, skin, or hair can off-gas phosphine after contact with water or moisture, so a risk of secondary contamination may be present. Have the victim remove clothing; and seal contaminated clothes and personal belongings in a sealed double bag. For skin exposure to the metallic phosphides, scrape or brush all visible particles from the skin and hair. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Persons exposed only to phosphine gas do not pose substantial risks of secondary contamination. Vomitus containing phosphides can also off-gas phosphine. Rinse the eyes, mucous membranes, or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 3 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 7.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 15 ppm:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 50 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phosphine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides; permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), oxygen, and halogenated hydrocarbons, since violent reactions occur. Store in tightly closed containers from physical damage. Use only nonsparking tools and equipment, especially when opening and closing containers of phosphine. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Phosphine requires a shipping label of “POISON GAS, FLAMMABLE GAS.” It falls in Hazard Class 2.3 and Packing Group I. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.5/2.4

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 2.7/4.4
Night 5.6/8.9

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases and mists including oxides of phosphorus and phosphonic acid are produced in fire. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. If material is on fire or involved in a fire, do not extinguish unless flow can be stopped; use water in flooding quantities as fog; cool all affected containers with flooding quantities of water; apply water from as far a distance as possible; solid streams of water may be ineffective; use "alcohol" foam, carbon dioxide or dry chemical. Wear full protective clothing including self-contained breathing apparatus; rubber gloves; boots and bands around legs, arms, and waist. No skin surface should be exposed. For massive fires in cargo areas, use unmanned hose holders or monitor nozzles. Move containers from fire area. The gas is heavier than air and may travel along the ground to an ignition source. Container may explode in heat of fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Controlled discharges of Phosphine may be passed through 10% NAOH solution in a scrubbing tower. The product may be discharged to a sewer.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphine*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1986). Dangerous Properties of Industrial Materials Report, 6, No. 2, 103−107

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substance Fact Sheet: Phosphine*. Trenton, NJ

Phosphoric acid, ortho- P:0590

Molecular Formula: H_3O_4P
Common Formula: H_3PO_4
Synonyms: Acide phosphorique (French); Acido fosforico Spanish); Decon 4512; Evits; Orthophosphoric acid; *o*-Phosphoric acid; Phosphorsaeureloesungen (German); Sonac; WC-Reiniger; White phosphoric acid
CAS Registry Number: 7664-38-2
RTECS® Number: TB6300000
UN/NA & ERG Number: UN1805/154
EC Number: 231-633-2 [*Annex I Index No.:* 015-011-00-6]
Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter and proprietary drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations *(orthophosphoric acid)*: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phosphoric acid is a colorless, odorless, crystalline solid, or thick syrupy liquid. Physical state is strength and temperature dependent. Molecular weight = 98.00; Specific gravity (H_2O:1) = 1.87 (pure); 1.33 (50% solution) at 25°C; Boiling point = Decomposes below BP at 212.8°C; Freezing/Melting point = 42.2°C; Vapor pressure = 0.03 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2 (Corrosive). Highly soluble in water.

Potential Exposure: Compound Description: Mutagen, Human Data; Primary Irritant. Phosphoric acid is used in the manufacture of fertilizers, phosphate salts; polyphosphates, detergents, activated carbon; animal feed; ceramics, dental cement; pharmaceuticals, soft drinks; gelatin, rust inhibitors; wax, and rubber latex. Exposure may also occur during electropolishing, engraving, photoengraving, lithographing, metal cleaning; sugar refining; and water-treating.

Incompatibilities: The substance is a medium strong acid. Incompatible with strong caustics; most metals. Readily attacks and reacts with metals forming flammable hydrogen gas. *Do not mix with solutions containing bleach or ammonia.* Violently polymerizes on contact with azo compounds; epoxides, and other polymerizable compounds. Decomposes on contact with metals, alcohols, aldehydes, cyanides, ketones, phenols, esters, sulfides, halogenated organics; producing toxic fumes.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg/m^3 TWA; 3 mg/m^3 STEL.

ACGIH TLV®[1]: 1 mg/m^3 TWA; 3 mg/m^3 STEL.

NIOSH IDLH: 1000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 2 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy risk Group C.

Arab Republic of Egypt: TWA 1 mg/m^3, 1993; Australia: TWA 1 mg/m^3; STEL 3 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3; STEL 3 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3 [skin]1999; France: VME 1 mg/m^3, VLE 3 mg/m^3, 1999; Japan 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Sweden: NGV 1 mg/m^3, KTV 3 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, 1999; Thailand: TWA 1 mg/m^3, 1993; United Kingdom: STEL 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 mg/m^3. Several states have set guidelines or standards for phosphoric acid in ambient air[60] ranging from 1.4 μg/m^3 (Massachusetts) to 10−30 μg/m^3 (North Dakota) to 10−33 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada) to 25.0 μg/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #7903, Inorganic Acids; OSHA Analytical Method ID-165-SG.

Determination in Water: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact may cause permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Solid is especially irritating to skin in the presence of moisture. Corrosive if swallowed. May cause pain in the throat and stomach, nausea, vomiting, and intense thirst. Severe exposures may result in shock with clammy skin, weak and rapid pulse; shallow breathing; reduced urine output; and death. 1−5 mg/m^3 may cause irritation of nose and throat. 4−11 mg/m^3 may cause coughing. Inhalation of acid mist can cause lung irritation. 1−5 mg/m^3 may cause irritation of nose and throat. 4−11 mg/m^3 may cause coughing.

Long Term Exposure: Repeated or prolonged skin exposure may cause irritation, drying, cracking, and dermatitis. Can cause bronchitis to develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene™, nitrile + pvc, nitrile, Saranex™, and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter) or

SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 mg/m*^{3}*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Phosphoric acid must be stored to avoid contact with metals, aldehydes, cyanides, mercaptans, and sulfides, because violent reactions occur.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phosphoric acid is a noncombustible solid or liquid. Contact with common metals may form flammable hydrogen gas. Use extinguishing agent suitable for surrounding fire. Use water only to keep fire-exposed containers cool and to flush away spills. Poisonous gases are produced in fire, including oxides of phosphorus. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

References

Sax, N. I. (Ed.). (1983). Dangerous Properties of Industrial Materials Report, 3, No. 4, 84−87

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Phosphoric Acid* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Phosphoric Acid*. Trenton, NJ

Phosphorous acid P:0600

Molecular Formula: H_3O_3P

Common Formula: H_3PO_3

Synonyms: Orthophosphorus acid; Phosphonic acid; Phosphorous acid; Phosphorus trihydroxide; Trihydroxy

CAS Registry Number: 13598-36-2; 10294-56-1

RTECS® Number: SZ6475500

UN/NA & ERG Number: UN2834/154

EC Number: 237-066-7 [*Annex I Index No.:* 015-157-00-0]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol *(13598-36-2; 10294-56-1)*: C; Risk phrases: R22; R35; Safety phrases: S26; S36/3739; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phosphonic acid is a white to yellow crystalline solid. Molecular weight = 82.00; Boiling point = about 200°C (decomposes); Freezing/Melting point = 74°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Used in chemicals manufacture; a laboratory chemical.

Incompatibilities: Incompatible with aliphatic amines, alkanolamines, alkylene oxides; aromatic amines; amides, ammonia, ammonium hydroxide; bases, calcium oxide; epichlorohydrin, isocyanates. Unless it is stored in airtight containers it readily absorbs oxygen forming orthophosphoric acid. Attacks some metals.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.006 mg/m^3
PAC-1: 0.015 mg/m^3
PAC-2: 0.125 mg/m^3
PAC-3: 500 mg/m^3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Orthophosphorous acid can affect you when breathed in. Contact can cause severe eye burns leading to permanent eye damage. Inhalation can irritate the eyes, skin, and respiratory tract.

Long Term Exposure: Highly irritating substances can cause lung effects; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to solid ortho phosphorous acid, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposures of liquid ortho phosphorous acid, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in the pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. *o*-phosphorous acid must be stored in airtight containers away from incompatible materials listed above. Avoid contact with metals.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid or liquid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Phosphorous Acid, ortho*. Trenton, NJ

Phosphorus P:0610

Molecular Formula: P; P_4

Synonyms: Bonide blue death rat killer; Common sense cockroach and rat preparations; Exolite 405; Exolit

LPKN275; Exolit VPK-N 361; Fosforo blanco (Spanish); Gelber phosphor (German); Phosphore blanc (French); Phosphorous yellow; Phosphorus-31; Phosphorus elemental, white; Rat-NIP; Red phosphorus; RP (military designation); ST CC4916140; Tetraphosphor (German); Weiss phosphor (German); White phosphorus; Yellow phosphorus

CAS Registry Number: 7723-14-0 (white, red); 12185-10-3 (yellow)

RTECS® Number: TH3500000

UN/NA & ERG Number: UN1381 (Phosphorus, white, dry; under water, in solution; Phosphorus, yellow, dry; yellow, under water; in solution)/136; UN2447 (Phosphorus, white, molten)/136

EC Number: 231-768-7 [*Annex I Index No.:* 015-001-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 (yellow or white) Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant, white, yellow dry, molten or in solution.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*7723-14-0*): Hazard Symbol: F,T,C,N; Risk phrases: R17; R26/28; R35; R50; Safety phrases: S1/2; S5; S26; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phosphorus is a white to yellow, soft, waxy solid with acrid fumes in air. *White/yellow* phosphorus is either a yellow or colorless, volatile, crystalline solid which darkens when exposed to light and ignites in air to form white fumes and greenish light. It has a garlic-like odor. Usually shipped or stored in water. Molecular weight = 123.88; Boiling point = 280°C; Freezing/Melting point = (decomposes) 44°C; Vapor pressure = 0.026 mmHg at 20°C; 0.181 mmHg at 44.1°C; Autoignition temperature = 30°C. Hazard Identification (based on NFPA-704 M Rating System): (*white, red powder*) Health 4, Flammability 4, Reactivity 2. Insoluble in water.

Red phosphorus is a brick red, reddish-brown, or violet amorphous powder, frequently contaminated with a small amount of the yellow. Molecular weight = 30.97; Boiling point = 280°C (with ignition at 200°C); Freezing/Melting point = 416°C (sublimes); Flash point = 260°C; Autoignition temperature = 260°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description (white): Agricultural Chemical; Reproductive Effector; Human Data. White or yellow phosphorus is handled away from air so that exposure is usually limited. Phosphorus was at one time used for the production of matches or "lucifers" but has long since been replaced due to its chronic toxicity. It is used in the manufacture of munitions including tracer bullets, pyrotechnics, explosives, smoke bombs; and other incendiary agents; (because it spontaneously catches fire in air) and as a smoke agent (because it produces clouds of irritating white smoke). Phosphorus is used artificial fertilizers; rodenticides, phosphor bronze alloys; semiconductors, Electro-luminescent coating; and chemicals, such as phosphoric and metallic phosphides. RP is used as a choking/pulmonary agent.

Incompatibilities: Phosphorus spontaneously ignites on contact with air, producing toxic phosphorus oxide fumes.

Reacts with strong bases, releasing toxic phosphine gas. Phosphorus reacts violently with oxidizers, halogens, some metals, nitrites, sulfur, and many other compounds, causing a fire and explosion hazard. *White/yellow* reacts with air, halogens, halides, sulfur, oxidizers, alkali hydroxides (forming gas), and metals (forming reactive phosphides). *Red* is a combustible solid. Friction or contact with oxidizers can cause ignition. Incompatible with many other substances. Forms gas and phosphoric acid on contact with moisture. Opened packages of red phosphorus should be stored under inert gas blanket.

Permissible Exposure Limits in Air

OSHA PEL (*yellow*): 0.1 mg/m^3 TWA.

NIOSH REL (*yellow*): 0.1 mg/m^3 TWA.

ACGIH TLV®[1] (*yellow*): 0.02 ppm/0.1 mg/m^3 TWA.

NIOSH IDLH: 5 mg/m^3.

Protective Action Criteria (PAC) RP

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 3 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK (*White/yellow/red*): 0.05 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2); Pregnancy Risk Group C; *red:* No numerical value established.

Arab Republic of Egypt: TWA 0.1 mg/m^3, 1993; Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: STEL 0.1 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, VLE 0.3 mg/m^3, 1999; Hungary: TWA 0.3 mg/m^3; STEL 0.06 mg/m^3, 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; the Philippines: TWA 0.1 mg/m^3, 1993; Poland: MAC (TWA) 0.3 mg/m^3, 1993; Russia: STEL 0.03 mg/m^3, 1993; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.2 mg/m^3, 1999; Thailand: TWA 0.1 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, 1993; United Kingdom: LTEL 0.1 mg/m^3; STEL 0.3 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3. The Czech Republic[35]: TWA 0.03 mg/m^3; 0.06 mg/m^3 STEL. Several states have set guidelines or standards for yellow phosphorus in ambient air[60] ranging from 0.33 μg/m^3 (New York) to 1.0 μg/m^3 (Florida) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada) to 10.0−30.0 μg/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #7905.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[35, 43] set a MAC of 0.1 μg/L in water bodies used for domestic purposes and zero in surface water used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = (estimated) −0.27.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Yellow phosphorus can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Phosphorus is corrosive to the eyes, skin, and respiratory tract. Eye contact may lead to a total destruction of the eyes. Victims may experience spontaneous hemorrhaging of phosphorus-contaminated skin and mucous membranes. Sudden death, possibly due to irregular heartbeat, may occur after relatively minor (10−15%) burns. *Yellow:* Fumes are irritating to the respiratory tract and cause severe ocular irritation. On contact with the skin it may ignite and produce severe skin burns with blistering. Very high exposure may cause severe or fatal poisoning. *Red:* Irritates eyes. Corrosive if ingested. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the kidneys, liver. Exposure may result in death. Phosphorus is classified as super toxic. The probable lethal dose is less than 5 mg/kg (a taste or less than 7 drops) for a 70-kg (150 lb) person. Signs and symptoms of acute exposure to phosphorus may be severe and occur in three stages. The first stage will involve burns, pain, shock, intense thirst; nausea, vomiting, diarrhea, severe abdominal pain; and "smoking stools." The breath and feces may have garlicky odor. The second stage will be a symptom-free period of several days in which the patient appears to be recovering. The third stage may be severe and include nausea, bloody vomitus; diarrhea (may be bloody), jaundice, liver enlargement with tenderness; renal damage; hematuria (bloody urine), and either oliguria (little urine formation) or anuria (no urine formation). Headache, convulsions, delirium, coma, cardiac arrhythmias; and cardiovascular collapse may also occur. If phosphorus contacts the eyes, then severe irritation and burns, blepharospasm (spasmodic winking), lacrimation (tearing), and photophobia (heightened sensitivity to light) may occur.

Long Term Exposure: Phosphorus may affect the bones, causing bone degeneration (especially the jaw bone, known as "phossy" jaw), dental pain; salivation, jaw pain and swelling. This process can extend into one or both eye sockets. Repeated low exposure can cause low blood count (anemia), weight loss; and bronchitis. May cause jaundice; liver and kidney damage; cachexia. May cause nervous system damage.

Points of Attack: Respiratory system, liver, kidneys, jaw, teeth, blood, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: Complete Blood Count, anemia; Dental X-ray/Examination; liver function tests. Also consider EKG. Special consideration should be given to the skin, eyes, jaws, teeth, respiratory tract; and liver. Preplacement medical and dental examination with X-rays of teeth is highly recommended in the case of yellow phosphorus exposure. Poor dental hygiene may increase the risk in yellow phosphorus exposures, and any required dental work should be completed before workers are assigned to areas of possible exposure. Workers experiencing any jaw injury, tooth extraction; or any abnormal dental conditions should be removed from areas of exposure and observed. X-ray examinations may show necrosis; however, in order to prevent full development of sequestra, the disease should be diagnosed in earlier stages. Liver function should be evaluated periodically.

First Aid: There is no antidote for white phosphorus toxicity. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and brush all traces of dry chemical from skin. Submerge burning phosphorus (yellow) in water or 1% copper sulfate solution if embedded in skin, or wash exposed area with large amounts of water. Seek medical attention immediately. Skin burns from yellow phosphorus should be observed for 1−3 days for possible delayed effects. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m³:* Sa (APF = 10) (any supplied-air respirator). *2.5 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 mg/m³:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red Stripe (*7723-14-0*): Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Phosphorus must be stored in a cool, well-ventilated area away from heat, direct sunlight; air, organic materials; oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Always store away from alkaline materials because of the extreme fire hazard and because poisonous gas is produced. Always store yellow phosphorus under water and protect it from physical damage. Opened packages of red phosphorus should be stored under inert gas blanket. Sources of ignition, such as smoking and open flames, are prohibited where phosphorus is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Phosphorus white, molten, requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.2 and Packing Group III. Subsidiary Hazardous Class or Division 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep spilled material wet and cover with wet sand or dirt. Collect solidified material in the most convenient and safe manner and cover with water in sealed containers. Ventilate area after cleanup is complete. Keep phosphorus out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phosphorus (white/yellow) is a flammable solid which ignites spontaneously in moist air. Combustion in a confined space will deplete oxygen causing asphyxiation. Poisonous gases are produced in fire, including oxides of phosphorus; and phosphoric acid if water is present. Fire may restart after it has been extinguished. *Small fires:* dry chemical, sand, water spray; or foam. *Large fires:* water spray, fog, or foam. Cool containers that are exposed to flames with water from the side until well after fire is out. *White/Yellow:* Deluge with water, taking care not to scatter, until fire is extinguished and phosphorus has solidified, then cover with wet sand or dirt. *Red:* Flood with water and when fire is extinguished, cover with wet sand or dirt. Extreme caution should be used during cleanup of the more hazardous white phosphorus. *White/Yellow:* Ignites at approximately 30°C in air; ignition temperature is higher when air is dry. *Black:* Does not catch fire spontaneously. *Red:* Catches fire when heated in air to approximately 260°C and burns with formation of the pentoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration followed by alkaline scrubbing and particulate removal equipment.

References

Sax, N. I. (Ed.). (1983). Dangerous Properties of Industrial Materials Report, 3, No. 4, 90−93

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphorus*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (October 2002). *Hazardous Substances Fact Sheet: Phosphorus*. Trenton, NJ

Phosphorus oxychloride P:0620

Molecular Formula: Cl_3OP
Common Formula: $POCl_3$
Synonyms: Fosforoxychlorid; Oxicloruro de fosforo (Spanish); Oxychlorid fosforecny; Phosphoric chloride; Phosphorus chloride oxide; Phosphorus oxytrichloride; Phosphoryl chloride; Phosphoryl trichloride
CAS Registry Number: 10025-87-3
RTECS® Number: TH4897000
UN/NA & ERG Number: UN1810/137
EC Number: 233-046-7 [*Annex I Index No.:* 015-009-00-5]
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration). (1% concentration); *Theft hazard* 220 (≥80.00% concentration).
Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 1000 lb (454 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: T + , C; Risk phrases: R14; R22; R26; R35; R48/23; Safety phrases: S1/2; S7/8; S26; S36/37/39; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Phosphorus oxychloride is a clear, colorless to yellow, fuming, oily liquid with a pungent and musty odor. Molecular weight = 153.32; Specific gravity (H_2O:1) = 1.65 at 25°C; Boiling point = 105.6°C; Freezing/Melting point = 1.25°C; Vapor pressure = 40 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3₩ (Corrosive). Reacts with water; decomposes with heat.
Potential Exposure: Phosphorus oxychloride is used in the manufacture of pesticides, pharmaceuticals, plasticizers, gasoline additives; and hydraulic fluids.
Incompatibilities: A powerful oxidizer. Violently decomposes in water, forming heat and hydrochloric and phosphoric acids. Violent reaction with alcohols, phenols, amines, reducing agents; combustible materials; carbon disulfide; dimethylformamide, and many other materials. Rapid corrosion of metals, except nickel and lead.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 6.27 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 0.1 ppm/0.6 mg/m^3 TWA; 0.5 ppm/3 mg/m^3 STEL.
ACGIH TLV®[1]: 0.1 ppm/0.63 mg/m^3 TWA.
Protective Action Criteria (PAC)*
TEEL-0: 0.1 ppm
PAC-1: 0.479 ppm
PAC-2: 0.479 ppm
PAC-3: **0.85** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 0.2 ppm/1.3 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.
Australia: TWA 0.1 ppm (0.6 mg/m^3); STEL 0.5 ppm, 1993; Austria: MAK 0.2 ppm (1 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.63 mg/m^3); STEL 0.5 ppm, 1993; Denmark: TWA 0.1 ppm (0.6 mg/m^3), 1999; Finland: STEL 0.5 ppm (3 mg/m^3), [skin], 1999; France: VME 0.1 ppm (0.6 mg/m^3), 1999; the Netherlands: MAC-TGG 0.6 mg/m^3, 2003; Russia: STEL 0.05 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.1 ppm (0.6 mg/m^3), KZG-W 0.2 ppm (1.2 mg/m^3), 1999; Turkey: TWA 0.5 ppm (3 mg/m^3), 1993; United Kingdom: TWA 0.2 ppm (1.3 mg/m^3); STEL 0.6 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm. Several states have set guidelines or standards for $POCl_2$ in ambient air[60] ranging from 6.0−30.0 $\mu g/m^3$ (North Dakota) to 12.0 $\mu g/m^3$ (Connecticut) to 14.0 $\mu g/m^3$ (Nevada).
Determination in Air: No method available.
Permissible Concentration in Water: No criteria set. ($POCl_2$ decomposes in water).
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact can cause permanent damage. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This material is toxic by inhalation and ingestion and is strongly irritating to skin and tissues. It causes burns of the mucous membranes of the mouth and digestive tract; and may be fatal. Symptoms include burns and extensive reddening of eyes, pains in throat; coughing, labored breathing with a shortness of breath; dizziness, headache, weakness, nausea, vomiting, chest pain; bronchitis, bronchopneumonia, kidney, and liver damage.
Long Term Exposure: May cause nephritis; kidney damage. May cause liver damage.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys, liver.

Medical Surveillance: Lung function tests. Test for liver and kidney functions. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. (2) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “CORROSIVE, POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Keep material out of water sources and sewers; build dikes to contain flow as necessary; use water spray to knock down vapors; *Do not use water* on material itself; and neutralize spilled material with crushed limestone, soda ash; or lime. *For a land spill*, dig a pit, pond, lagoon, or holding area to contain liquid or solid material; dike surface flow using soil, sand bags; foamed polyurethane; or foamed concrete; absorb bulk liquid with fly ash or cement powder; neutralize with agricultural lime (slaked lime), crushed limestone; or sodium bicarbonate. *For a water spill*, neutralize with agricultural lime (slaked lime), crushed limestone; or sodium bicarbonate; use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates; adjust pH to neutral (pH 7). *For air spills* apply water spray or mist to knock down vapors; vapor knock down water is corrosive or toxic and should be diked for containment. Stop leak if you can do so without risk. Do not touch spilled material. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Clean up only under supervision of an expert. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.3/2.0

when spilled in water
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.4/2.3

Fire Extinguishing: This chemical reacts violently with moisture producing hydrochloric and phosphoric acids. Poisonous gases, including chlorides and phosphorus oxides, are produced in fire. *Do not use water* unless used in flooding quantities to control a large fire by wetting down combustibles burning in vicinity of this material. Use dry chemical, carbon dioxide, or dry sand; *Do not use water* on material itself. Use water spray to absorb vapors and cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Avoid breathing vapors; keep upwind. Wear self-contained breathing apparatus. Avoid bodily contact with the material. Wear boots, protective gloves, and goggles. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. If contact with the material is anticipated, wear full protective clothing. Keep unnecessary people away; isolate hazard area and deny entry. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour onto sodium bicarbonate. Spray with aqueous ammonia and add crushed ice. Neutralize and pour into drain with running water. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). Dangerous Properties of Industrial Materials Report, 3, No. 4, 87−88

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphorus Oxychloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Phosphorus Oxychloride*. Trenton, NJ

Phosphorus pentachloride P:0630

Molecular Formula: Cl_5P
Common Formula: PCl_5
Synonyms: Pentacloruro de fosforo (Spanish); Phosphore (pentachlorure de) (French); Phosphoric chloride; Phosphorpentachlorid (German); Phosphorus perchloride
CAS Registry Number: 10026-13-8
RTECS® Number: TB6125000
UN/NA & ERG Number: UN1806/137
EC Number: 233-060-3 [*Annex I Index No.:* 015-008-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R22; R26; R34; R48/20; Safety phrases: S1/2; S7/8; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Phosphorus pentachloride is a pale yellow, fuming solid with an odor like hydrochloric acid. Molecular weight = 208.22; Specific gravity (H_2O:1) = 3.60 at 25°C; Boiling point = (sublimes) 160°C; Freezing/Melting point = (sublimes) 162°C; Vapor pressure = 1 mmHg at 55.6°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Reacts violently with water.

Potential Exposure: Phosphorus pentachloride is used as a chlorinating and dehydrating agent and as a catalyst. It is used in the manufacture of agricultural chemicals;

chlorinated compounds; gasoline additives, plasticizers, and surfactants; and in pharmaceutical manufacture.

Incompatibilities: A powerful oxidizer. Reacts with water (violent), magnesium oxide, chemically active metals, such as sodium and potassium, alkalis, amines. Hydrolyzes in water (even in humid air) to form hydrochloric acid and phosphoric acid. Corrosive to many metals, forming flammable and explosive hydrogen gas. Attacks plastic and rubber.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.
NIOSH REL: 1 mg/m^3 TWA.
ACGIH TLV®[1]: 0.1 ppm/1 mg/m^3 TWA.
NIOSH IDLH: 70 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 70 mg/m^3

DFG MAK: 1 mg/m^3, measured as the inhalable fraction TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

Australia: TWA 0.1 ppm (1 mg/m^3), 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 0.1 ppm (0.85 mg/m^3), 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: STEL 1 mg/m^3, [skin], 1999; France: VME 0.1 ppm (1 mg/m^3), 1999; Japan 0.1 ppm (0.85 mg/m^3), 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Norway: TWA 0.1 mg/m^3, 1999; the Philippines: TWA 1 mg/m^3, 1993; Poland: MAC (TWA) 0.3 mg/m^3; MAC (STEL) 0.9 mg/m^3, 1999; Russia: TWA 0.1 ppm; STEL 0.2 mg/m^3, [skin], 1993; Switzerland: MAK-W 1 mg/m^3, KZG-W 2 mg/m^3, 1999; Thailand: TWA 1 mg/m^3, 1993; Turkey: TWA 1 mg/m^3, 1993; United Kingdom: TWA 0.1 ppm (0.87 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm Several states have set guidelines or standards for PCl_5 in ambient air[60] ranging from 10.0 μg/m^3 (North Dakota) to 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II(5), Method #S-257.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Corrosive if swallowed. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. Can cause death by pulmonary edema or circulation shock. Fumes cause irritation of eyes and respiratory passages. Upon ingestion, immediate pain in the mouth and throat, abdominal pain; nausea, vomiting of mucoid and "coffee-ground" material, intense thirst; clammy skin, weak and rapid pulse; shallow respiration, and circulatory shock occur.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung irritation; bronchitis may develop. May cause liver and kidney damage.

Points of Attack: Respiratory system, lungs, eyes, skin, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* Sa* (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 50 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 70 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color Code—Yellow Stripe (strong oxidizer): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all other combustible and oxidizable materials, and moisture. Where possible, automatically transfer material storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Keep material out of water sources and sewers. Use water spray to knock down vapors. *Do not use water* on material itself; neutralize spilled material with crushed limestone, soda ash, or lime. Avoid breathing vapors; keep upwind. Avoid bodily contact with the materials. Do not handle broken packages without protective equipment. Wash away any materials which may have contacted the body with copious amounts of water or soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.0/1.5

Fire Extinguishing: A noncombustible solid. If material is involved in fire then use dry chemical, carbon dioxide, or dry sand. *Do not use water* on material itself. If large quantities of combustibles are involved, use water in flooding quantities (i.e., spray or fog), and use water spray to absorb vapors. Avoid breathing vapors; keep upwind. Wear self-contained breathing apparatus. Avoid bodily contact with the material; wear boots, protective gloves, and goggles. Poisonous gases are produced in fire, including hydrogen chloride and phosphorus oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. Neutralize acids and dilute if necessary for discharge into the sewer system.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphorus Pentachloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Phosphorus Pentachloride*. Trenton, NJ

Phosphorus pentasulfide P:0640

Molecular Formula: P_2S_5; P_4S_{10}

Common Formula: P_4S_{10}

Synonyms: Pentasulfure de phosphore (French); Phosphoric sulfide; Phosphorus pentasulfide; Phosphorus persulfide;

Phosphorus sulfide; Sulphur phosphide; Thiophosphoric anhydride

CAS Registry Number: 1314-80-3

RTECS® Number: TH4375000

UN/NA & ERG Number: UN1340 (free from yellow or white phosphorus)/139

EC Number: 215-242-4 [*Annex I Index No.:* 015-104-00-1]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U189.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn, N; Risk phrases: R11; R20/22; R29; Safety phrases: S2; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Phosphorus pentasulfide is a greenish-gray to yellow, crystalline solid with an odor of rotten eggs. The odor threshold is 0.005 ppm. Molecular weight = 222.24 (P_2S_5); 444.6 (P_4S_{10}); Specific gravity (H_2O:1) = 2.09; Boiling point = 513.8°C; Freezing/Melting point = 286°C; Vapor pressure = 1 mmHg at 300°C; Autoignition temperature (dry air) = 142°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity₩. Reacts with water.

Potential Exposure: Compound Description: Primary Irritant. Phosphorus pentasulfide is used as an intermediate in the manufacture of lubricant additives, insecticides, flotation agents, lubricating oil, ignition compounds, and matches. It is also used to introduce sulfur into rubber, and organic chemicals, such as pharmaceuticals.

Incompatibilities: Flammable solid; water reactive. Violent reaction with water, alcohols, strong oxidizers, acids, alkalis. Reaction with water to produce heat, hydrogen sulfide, sulfur dioxide, and phosphoric acid. May self-ignite in moist air.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg/m^3 TWA; 3 mg/m^3 STEL.

ACGIH TLV®[1]: 1 mg/m^3 TWA; 3 mg/m^3 STEL.

NIOSH IDLH: 250 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Australia: TWA 1 mg/m^3; STEL 3 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3; STEL 3 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: STEL 1 mg/m^3, 1999; France: VME 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; the Philippines: TWA 1 mg/m^3, 1993; Poland: TWA 1 mg/m^3; STEL 3 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, KZG-W 2 mg/m^3, 1999; Thailand: TWA 1 mg/m^3, 1993; Turkey: TWA 1 mg/m^3, 1993; United Kingdom: TWA 1 mg/m^3; STEL 3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 mg/m^3. Several states have set guidelines or standards for P_2S_5 in ambient air[60] ranging from 10 μg/m^3 (North Dakota) to 16 μg/m^3 (Virginia) to 20 μg/m^3 (Connecticut) to 24 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Inhalation of fumes produced by phosphorus compounds may cause irritation of pulmonary tissues with resultant acute pulmonary edema. The hazards of phosphorus pentasulfide are the same as for hydrogen sulfide to which it rapidly hydrolyzes in the presence of moisture. Symptoms include apnea, coma, convulsions, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), kerato-conjunctivitis, corneal vesiculation, respiratory system irritation, dizziness, headaches, fatigue, irritability, insomnia, gastrointestinal disturbances.

Long Term Exposure: Chronic exposure may lead to lung irritation, cough, bronchitis, and pneumonia.

Points of Attack: Respiratory system, lungs, central nervous system, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin

contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3* Sa (APF = 10) (any supplied-air respirator).* *Up to 25 mg/m^3*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 50 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 250 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* GmFS100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, water, alcohols, strong oxidizers, acids, alkalis. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "DANGEROUS WHEN WET, FLAMMABLE SOLID." It falls in Hazard Class 4.3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, sand. Consider the use of sodium chloride-base extinguisher suitable for metal fires. *Do not use water*. Poisonous gases are produced in fire, including phosphorus oxides and fluorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Decompose with water, forming phosphoric acid, sulfuric acid, and hydrogen sulfide. Provisions must be made for scrubbing hydrogen sulfide emissions. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

Reference

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 89−90

Phosphorus pentoxide P:0650

Molecular Formula: O_5P_2

Common Formula: P_2O_5

Synonyms: Diphosphorus pentoxide; Pentoxido de fosforo (Spanish); Phosphoric anhydride; Phosphorus(V) oxide; Phosphorus(5+) oxide; Phosphorus pentaoxide; Phosphorus oxide; POX

CAS Registry Number: 1314-56-3

RTECS®Number: TH3945000

UN/NA & ERG Number: UN1807/137

EC Number: 215-236-1 [*Annex I Index No.:* 015-010-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Active registration.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R35; Safety phrases: S1/2; S22; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phosphorus pentoxide is a white crystalline solid. Molecular weight = 141.94; Freezing/Melting point = 340°C; it begins to sublime at 360°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩ (Corrosive). Reacts with water.

Potential Exposure: This material is used as an intermediate in organic synthesis; as a catalyst, condensing agent, dehydrating agent; in the preparation of acrylate esters, surfactants, sugar refining; in medicine, fire extinguishing, and special glasses.

Incompatibilities: Reacts violently with water, forming highly corrosive phosphoric acid. Phosphorus pentoxide reacts violently with the following: perchloric acid, ammonia, hydrofluoric acid, oxidizers, hydrogen fluoride, formic acid, oxygen difluoride, potassium, sodium, propargyl alcohol, calcium oxide, inorganic bases, sodium hydroxide, and chlorine trifluoride. Attacks many metals in the presence of water.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 1 mg/m^3

PAC-1: **1** mg/m^3

PAC-2: **10** mg/m^3

PAC-3: **50** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 mg/m^3, measured as inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Austria: MAK 1 mg/m^3, 1999; Denmark: ceiling 1 mg/m^3, 1999; France: VME 1 mg/m^3, 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; Norway: TWA 1 mg/m^3, 1999; Poland: MAC (TWA) 1 mg/m^3; STEL 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Turkey: TWA 1 mg/m^3, 1993; United Kingdom: STEL 2 mg/m^3, 2000.

Permissible Concentration in Water: No criteria set (reacts with water).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Highly corrosive to the eyes, skin, and respiratory tract. Eye contact may lead to a total destruction of the eyes. Particles in contact with eyes react vigorously and even a small amount may cause permanent burns. Contact with the skin will cause severe burns. Corrosive if ingested; will damage the gastrointestinal tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Signs and symptoms of acute exposure to phosphorus pentoxide may include severe burns, pain, shock, intense thirst, nausea, vomiting, diarrhea, severe abdominal pain; and "smoking stools." The breath and feces may have a garlicky odor. A symptom-free period of several days may follow. Exposure to phosphorus pentoxide may also result in bloody vomitus and diarrhea, jaundice, liver enlargement with tenderness, renal damage, hematuria (bloody urine), and either oliguria (scanty urination) or anuria (suppression of urine formation). Headache, convulsions, delirium, coma, cardiac arrhythmias, and cardiovascular collapse may occur. If phosphorus pentoxide contacts the eyes, severe irritation and burns, blepharospasm (spasmodic winking), lacrimation (tearing), and photophobia (heightened sensitivity to light) may occur. Victims may experience spontaneous hemorrhaging of phosphorus pentoxide-contaminated skin and mucous membranes.

Long Term Exposure: Highly corrosive materials can cause lung damage; bronchitis may develop.

Points of Attack: Lungs, skin, eyes,

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to a health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Never pour water into this substance*; always add POX slowly to water when diluting or dissolving.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a

NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Keep unnecessary people away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering them. Stop leak if possible without risk. Do not touch spilled material. Use water spray to reduce vapors, but do not put water on leak or spill. Keep combustibles away from spilled material. Dike spilled area and keep water away from spill. Clean up requires supervision by an expert. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not support combustion. For small fires, use dry chemical, carbon dioxide, or sand. *Do not use water* or hydrous extinguishers. Wear positive pressure breathing apparatus and special protective clothing. Keep combustibles away from spilled material. Poisonous gases, including phosphorus oxides, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. *For large fires*, flood fire area with water from a distance. Do not get solid stream of water on spilled material or in open containers. From a secure, explosion-proof location, use water spray to cool exposed containers long after flames have been extinguished. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring then flush to sewer with large volumes of water.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphorus Pentoxide*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Phosphorus trichloride P:0660

Molecular Formula: Cl_3P

Common Formula: PCl_3

Synonyms: Chloride of phosphorus; Phosphore (trichlorure de) (French); Phosphorous chloride; Phosphortrichlorid (German); Phosphorus chloride; Trichloro; Tricloruro de fosforo (Spanish)

CAS Registry Number: 7719-12-2

RTECS® Number: TH3675000

UN/NA & ERG Number: UN1809/137

EC Number: 231-749-3 [*Annex I Index No.:* 015-007-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (1% concentration); *Theft hazard* 45 ($\geq$3.48% concentration); Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, C; Risk phrases: R14; R26/28; R48/20; Safety phrases: S1/2; S7/8; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Phosphorus trichloride is a colorless to yellow, fuming liquid with an odor like hydrochloric acid. Molecular weight = 137.32; Specific gravity (H_2O:1) = 1.58; Boiling point = 76.1°C; Freezing/Melting point = −112.2°C; Vapor pressure = 100 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Reacts with water.

Potential Exposure: Phosphorus trichloride is used as an intermediate and as a chlorinating agent and catalyst; in the manufacture of agricultural chemicals, pharmaceuticals, chlorinated compounds, dyes, gasoline additives, acetyl cellulose, phosphorus oxychloride, plasticizers, saccharin, and surfactants.

Incompatibilities: Violent reaction with alcohols, phenols and bases, water, when in contact with combustible organics, chemically active metals: sodium, potassium, aluminum, strong nitric acid. Violent reaction with water, producing heat and hydrochloric and phosphorous acids. Attacks most metals. Attacks plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.5 ppm/3 mg/m^3 TWA.

NIOSH REL: 0.2 ppm/1.5 mg/m^3 TWA; 0.5 ppm/3 mg/m^3 STEL.

ACGIH TLV®[1]: 0.2 ppm/1.1 mg/m^3 TWA; 0.5 ppm/2.8 mg/m^3 STEL.

NIOSH IDLH: 25 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.34 ppm

PAC-1: **0.34** ppm

PAC-2: **2** ppm

PAC-3: **5.6** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.5 ppm/2.8 mg/m^3 TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.5 ppm (3 mg/m^3), 1993; Australia: TWA 0.2 ppm (1.5 mg/m^3); STEL 0.5 ppm (3 mg/m^3), 1993; Austria: MAK 0.25 ppm (1.5 mg/m^3), 1999; Belgium: TWA 0.2 ppm (1.1 mg/m^3); STEL 0.5 ppm (2.8 mg/m^3), 1993; Denmark: TWA 0.2 ppm (1.2 mg/m^3), 1999; Finland: STEL 0.5 ppm (3 mg/m^3), [skin], 1999; France: VME 0.2 ppm (1.5 mg/m^3), 1999; the Netherlands: MAC-TGG 1.5 mg/m^3, 2003; Japan 0.2 ppm (1.1 mg/m^3), 1999; Norway: TWA 0.2 ppm (1.5 mg/m^3), 1999; the Philippines: TWA 0.5 ppm (3 mg/m^3), 1993; Poland: MAC (TWA) 3 mg/m^3, 1999; Russia: TWA 0.2 ppm; STEL 0.2 mg/m^3, [skin], 1993; Turkey: TWA 0.5 ppm (3 mg/m^3), 1993; United Kingdom: TWA 0.2 ppm (1.1 mg/m^3); STEL 0.5 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.5 ppm. Several states have set guidelines or standards for PCl_3 in ambient air[60] ranging from 15−30 μg/m^3 (North Dakota) to 30 μg/m^3 (Connecticut) to 36 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 6402.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive if swallowed. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. Very high levels of exposure to vapors can cause death. This material is highly toxic; it may cause death or permanent injury. Exposure may cause dizziness, headache, anorexia, respiratory difficulties, nausea, and vomiting. It can also cause liver and lung disturbances. Occupational exposure has caused coughs, bronchitis, pneumonia, and conjunctivitis.

Long Term Exposure: Highly corrosive materials can cause lung damage; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *25 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Phosphorus trichloride must be stored to avoid contact with acetic acid, aluminum, chromyl chloride, fluorine, alcohol, nitric acid, sodium, potassium, water, hydroxylamine, and lead dioxide since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Phosphorus trichloride corrodes most metals and will attack some forms of plastics, rubber, and coatings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in Hazard Class 6.1 and Packing Group I. A plus sign (+) indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.9/1.5
Night 1.9/3.1

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.7/2.7

Fire Extinguishing: This material may burn but does not easily ignite. Use carbon dioxide or dry chemical on fires involving phosphorus trichloride. *Do not use water.* Poisonous gases are produced in fire, including hydrogen chloride and phosphoric acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Spray cooling water on containers that are exposed to flames until well after fire is out. Do not get water inside containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 93−94

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Phosphorus*

Trichloride. Washington, DC: Chemical Emergency Preparedness Program
New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Phosphorous Trichloride*. Trenton, NJ

Phthalic anhydride P:0670

Molecular Formula: $C_8H_4O_3$
Synonyms: Anhidrido ftalico (Spanish); Anhydride phthalique (French); Araldite HT 901; 1,2-Benzenedicarboxylic anhydride; 1,2-Benzenedicarboxylic acid anhydride; 1,2-Dioxophthalan phthalandione; 1,3-Dioxophthalan; Esen; HT 901; 1,3-Isobenzofurandione; NCI-C03601; PAN; Phthalandione; 1,3-Phthalandione; Phthalanhydride; Phthalic acid anhydride; Phthalsaeureanhydrid (German); Retarder AK; Retarder esen; Retarder PD; TGL 6525; Vulkalent B/C
CAS Registry Number: 85-44-9
RTECS® Number: TI3150000
UN/NA & ERG Number: UN2214/156
EC Number: 201-607-5 [*Annex I Index No.:* 607-009-00-4]
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.
US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
US EPA Hazardous Waste Number (RCRA No.): U190.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 28.
Reportable Quantity (RQ): 5000 lb (2270 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: Xi; Risk phrases: R22; R37/38; R41; R42/43; Safety phrases: S2; S23; S24/25; S26; S37/39; S46 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Phthalic Anhydride is moderately flammable, white solid (flake) or a clear, colorless, mobile liquid (molten) with a characteristic, acrid, choking odor. The odor threshold is 0.05 ppm. Molecular weight = 148.12 (flake); 1.20 (molten); Boiling point = (sublimes) 295°C; Freezing/Melting point = 130.6°C; Vapor pressure = 0.0015 mmHg at 20°C; Flash point = 151.7°C (cc); Autoignition temperature = 570°C. Explosive limits: LEL = 1.7%; UEL = 10.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; slow reaction.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Phthalic anhydride is used in plasticizers, in the manufacture of phthaleins, benzoic acid, alkyd and polyester resins, synthetic indigo, and phthalic acid; which is used as a plasticizer for vinyl resins. To a lesser extent, it is used in the production of alizarin, dye, anthranilic acid, anthraquinone, diethyl phthalate, dimethyl phthalate, erythrosine, isophthalic acid, methylaniline, phenolphthalein, phthalamide, sulfathalidine, and terephthalic acid. It has also found uses as a pesticide intermediate.
Incompatibilities: Dust forms an explosive mixture with air. Strong acids, caustics, ammonia, amines, strong oxidizers, water. Converted to phthalic acid in hot water. Reacts violently with copper oxide or sodium nitrite + heat.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 6.06 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 2 ppm/12 mg/m^3 TWA.
NIOSH REL: 1 ppm/6 mg/m^3 TWA.
ACGIH TLV®[1]: 1 ppm/6.1 mg/m^3 TWA; danger of sensitization; not classifiable as a human carcinogen.
NIOSH IDLH: 60 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 12 mg/m^3
PAC-1: 12 mg/m^3
PAC-2: 12 mg/m^3
PAC-3: 60 mg/m^3
DFG MAK: Danger of skin sensitization; No numerical value established. Data may be available.
Australia: TWA 1 ppm (6 mg/m^3), 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 ppm (6.1 mg/m^3), 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 0.2 mg/m^3, 1999; France: VLE 6 mg/m^3, 1999; Hungary: TWA 1 mg/m^3; STEL 2 mg/m^3, 1993; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Norway: TWA 2 mg/m^3, 1999; the Philippines: TWA 2 ppm (12 mg/m^3), 1993; Poland: MAC (TWA) 1 mg/m^3; STEL 2 mg/m^3 (vapors and aerosols), 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Sweden: NGV 2 mg/m^3, TGV 3 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, KZG-W 2 mg/m^3, 1999; United Kingdom: TWA 4 mg/m^3; STEL 12 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] set a MAC of 0.1 mg/m^3 for ambient air in residential areas (100 μg/m^3). Several states have set guidelines or standards for phthalic anhydride in ambient air[60] ranging from 0.82 μg/m^3 (Massachusetts) to 60−240 μg/m^3 (North Dakota) to 100 μg/m^3 (Virginia) to 120 μg/m^3 (Connecticut) to 143 μg/m^3 (Nevada).
Determination in Air: Use NIOSH II(3), Method #S179; OSHA Analytical Method 90.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.58.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* May cause irritation of nose, throat, and mouth with coughing, sneezing, shortness of breath, and excessive discharge and bleeding from nose. Studies suggest that this will occur at about 4 ppm. *Skin:* Rapid chemical burns may occur on contact with wet skin. Molten material may cause severe burns unless removed immediately. *Eyes:* May cause severe irritation and chemical burns on contact or at dust levels above 5 ppm. *Ingestion:* May cause severe irritation to mouth and throat. Animal studies suggest that death may occur from ingestion of 4−8 oz.

Long Term Exposure: May cause irritation of nose, mouth, throat, and lungs. Repeated or prolonged contact may cause conjunctivitis, nasal ulcer bleeding. Allergy may develop in sensitive individuals which can lead to bronchial asthma. Repeated or prolonged skin contact may cause dermatitis, skin sensitization, and allergy. In animals: liver, kidney damage.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); urine (chemical/metabolite). Lung function tests may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, or wear dust-proof goggles when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *30 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *60 mg/m^3:* 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or 95F (APF = 10) (any air-purifying full-face-piece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100) or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter) or SA* (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White Stripe (*flake*): Contact Hazard; not compatible with materials in solid white category. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phthalic anhydride must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) since violent reactions occur. Sources of ignition (such as smoking and open flames) are prohibited where phthalic anhydride is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *Phthalic Anhydride, Health and Environmental Effects Profile No. 147*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Phthalic Anhydride*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Phthalic Anhydride*. Trenton, NJ

m-Phthalodinitrile P:0680

Molecular Formula: $C_8H_4N_2$

Common Formula: $C_6H_4(CN)_2$

Synonyms: 1,3-Benzenedicarbonitrile; *m*-Benzenedicarbonitrile; *m*-Dicyanobenzene; 1,3-Dicyanobenzene; Isophthalodinitrile; *m*-PDN; Phthalonitrile, *m*-Dicyanobenzene

CAS Registry Number: 626-17-5

RTECS® Number: CZ1900000

UN/NA & ERG Number: UN3276 (Nitriles, toxic, liquid, n.o.s.)/151

EC Number: 210-933-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: *m*-Phthalodinitrile is a needle-like, colorless to white, flaky solid with an almond-like odor. Molecular weight = 128.14; Specific gravity (H_2O:1) = 4.42; Boiling point = sublimes; Freezing/Melting point = 162°C (sublimes); Vapor pressure = 0.01 mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Primary Irritant. This material is used as an intermediate in the manufacture of polyurethane paints and varnishes; in pharmaceuticals, for synthetic fibers, agricultural chemicals, rubber chemicals; an intermediate for phthalocyanine pigments and dyes, and for high-temperature lubricants and coatings; it may be used to produce phthalate esters.

Incompatibilities: Combustible solid. The dust is a severe explosion hazard. Strong oxidizers (e.g., chlorine, bromine, fluorine).

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3, measured as inhalable fraction and vapor, TWA.

No TEEL available.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 20 mg/m^3, [skin], 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3. Several states have set guidelines or standards for *m*-phthalodinitrile in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: *m*-Phthalodinitrile can affect you when breathed in and by passing through your skin. High exposure may cause headache, nausea, weakness, confusion and may cause you to pass out. In animals: irritation of the eyes, skin.

Long Term Exposure: May cause headaches and nausea. No permanent effects are known at this time.

Points of Attack: Eyes, skin, central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a MSHA/NIIOSH approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. *m*-Phthalodinitrile is incompatible with strong oxidizers, such as chlorine, bromine, and fluorine. Store in tightly closed containers in a cool, well-ventilated area away from open flames and high temperatures. Sources of ignition, such as smoking and open flames, are prohibited where *m*-phthalodinitrile is used, handled, or stored in a manner that could create potential fire of explosion hazard. *m*-Phthalodinitrile dust is a severe explosion hazard. Use explosion proof equipment when handling *m*-phthalodinitrile.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.1
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.9

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including ammonia, hydrogen cyanide, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with alcoholic NaOH; after 1 h, evaporate alcohol and add calcium hypochlorite; after 24 h flush into sewer with large volumes of water.

Reference

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: m-Phthalodinitrile*. Trenton, NJ

Phylloquinone P:0690

Molecular Formula: $C_{31}H_{46}O_2$
Synonyms: Antihemorrhagic vitamin; Aqua mephyton; Combinal K_1; Kativ N; Kephton; Kinadion; Konakion; Mephyton; 2-Methyl-3-phythyl-1,4-naphthochinon (German); 2-Methyl-3-(3,7,11,15-tetramethyl-2-hexadecenyl)-1,4-naphthalenedione; Monodion; Phyllochinon (German); α-Phylloquinone; *trans*-Phylloquinone; Phytomenadione; Phytonadione; Vitamin K_1
CAS Registry Number: 84-80-0
RTECS® Number: QJ5800000
EC Number: 201-564-2
Regulatory Authority and Advisory Bodies
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: Dropped From Listing in 1988).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Phylloquinone is an odorless yellow viscous oil or crystals. Molecular weight = 450.77; Boiling point = 140−145°C at 0.001 mm; Freezing/Melting point = −4°C; −20° C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.
Potential Exposure: Phylloquinone is a dietary component essential for normal biosynthesis of several factors required for clotting of blood, as a therapeutic drug used to correct bleeding tendency, and as a food supplement.
Incompatibilities: Phylloquinone decomposes in sunlight and is destroyed by alkali hydroxides and reducing agents.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: High oral toxicity. Intravenous injection can cause toxic responses and occasionally death. Rapid intravenous administration of phylloquinone has produced flushing, irregular breathing, and chest pains. In newborns, it can cause hemolytic anemia and hemoglobinuria. In patients who have severe liver disease, administration of large doses of menadione or phylloquinone may further depress function of liver. Individuals resistant to coumarin may have unusual sensitivity to the antidotal effects of vitamin K.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkali hydroxides and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Spill Handling: Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Shut off ignition sources; no flares, smoking, or flames in hazard area. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch spilled material. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless

the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Irritating fumes are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Phylloquinone*. Washington, DC: Chemical Emergency Preparedness Program

Physostigmine P:0700

Molecular Formula: $C_{15}H_{21}N_3O_2$

Synonyms: Calabarine; Erserine; Eserine; Eserolein; Fisostigmina (Spanish); Methylcarbamate (ester); Methylcarbamic acid, ester with eseroline; Physostol

CAS Registry Number: 57-47-6

RTECS® Number: TJ2100000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151 see "Potential Exposure"

EC Number: 200-332-8 [*Annex I Index No.:* 614-020-00-8]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P204.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/28; R1/2; Safety phrases: S25; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Physostigmine is an odorless white crystalline solid. Molecular weight = 275.39; Freezing/Melting point = 86−87°C (unstable form); 105−106°C (stable form). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water.

Potential Exposure: Material is used as a cholinergic (anticholinesterase) agent and as a veterinary medication. Listed as a carbamate pesticide; however, physostigmine is not registered in the United States as such.

Incompatibilities: Light and heat.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 4.5 mg/m^3

PAC-3: 4.5 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Super toxic. Probable oral lethal dose is less than 5 mg/kg for a 70-kg (150 lb) person. Material is a cholinesterase inhibitor. Effects of exposure may involve the respiratory, gastrointestinal, cardiovascular, and central nervous systems. Death occurs due to respiratory paralysis or impaired cardiac function. Time to death may vary from 5 min to 24 h, in severely poisoned patients, depending on factors, such as the dose and route. General symptoms include: increased secretions, fatigability and generalized weakness; involuntary twitching; severe weakness of skeletal muscles. Symptoms of exposure to material by major organ system: gastrointestinal: lack of appetite, nausea and vomiting, abdominal cramps, and diarrhea. Central nervous system: confusion, uncoordination, slurred speech, loss of reflexes, rapid irregular breathing, generalized convulsions, and coma. Cardiovascular: slowed heartbeat resulting in hypotension and fall in cardiac output.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Carbamate pesticides, solid, toxic, require a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. As for other carbamate pesticides, avoid breathing dusts and fumes from burning materials. Keep upwind. Avoid bodily contact with the material. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: As for other carbamate pesticides, extinguish fire using agent suitable for type of surrounding fire (material itself burns with difficulty). Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide, or dry chemical. Wear self-contained breathing apparatus when fighting fires. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Physostigmine*. Washington, DC: Chemical Emergency Preparedness Program

Picloram P:0710

Molecular Formula: $C_6H_3Cl_3N_2O_2$

Synonyms: Amdon; Amdon grazon; 4-Aminotrichloropicolinic acid; 4-Amino-3,5,6-trichloro-2-picolinic acid; 4-Amino-3,5,6-trichloropicolinic acid; 4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid; 4-Amino-3,5,6-trichloropyridine-2-carboxylic acid; 4-Amino-3,5,6-trichlorpicolinsaeure (German); ATCP; Borolin; K-Pin; NCI-C00237; NSC 233899; Picolinic acid, 4-Amino-3,5,6-trichloro-; 2-Pyridine carboxylic acid, 4-amino-3,5,6-trichloro-; Tordon; Tordon 10K; Tordon 22K; Tordon 101 mixture; 3,5,6-Trichloro-4-aminopicolinic acid

CAS Registry Number: 1918-02-1

RTECS® Number: TJ7525000
UN/NA & ERG Number: UN2588/151
EC Number: 217-636-1
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Available Data, *not classifiable as carcinogenic to humans*, Group 3, 1991.
US EPA, FIFRA 1998 Status of Pesticides: RED completed.
Banned or Severely Restricted (Sweden) (UN).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Safe Drinking Water Act: MCL, 0.5 mg/L; MCLG, 0.5 mg/L; Regulated chemical (47 FR 9352) as pichloram.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Picloram is a colorless powder with a chlorine-like odor. Molecular weight = 241.46; Freezing/Melting point = (decomposes) 219.8°C; Vapor pressure = 6×10^{-7} mmHg at 36.7°C. Poor solubility in water.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those involved in the manufacture, formulation, or application of the herbicide.
Incompatibilities: This material is acidic. Reacts with hot concentrated alkali (hydrolyzes), strong bases. Attacks some metals.
Permissible Exposure Limits in Air
OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.
NIOSH REL: See Appendix D of the *NIOSH Pocket Guide*.
ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.
No TEEL available.
Australia: TWA 10 mg/m^3; STEL 20 mg/m^3, 1993; Belgium: TWA 10 mg/m^3; STEL 20 mg/m^3, 1993; Denmark: TWA 10 mg/m^3, 1999; Finland: TWA 10 mg/m^3; STEL 20 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Russia: STEL 2 mg/m^3, 1993; Switzerland: MAK-W 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.
Russia set a MAC of 0.03 mg/m^3 for ambient air on a once-daily basis and 0.02 mg/m^3 on a daily average basis. Several states have set guidelines or standards for picloram in ambient air[60] ranging from 0.1−0.2 mg/m^3 (North Dakota) to 0.16 mg/m^3 (Virginia) to 0.2 mg/m^3 (Connecticut) to 0.238 mg/m^3 (Nevada).
Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust; Method #0600 (respirable dust).
Permissible Concentration in Water: The US EPA has set a lifetime health advisory of 0.49 mg/L. Russia set a MAC of 10.0 mg/L in surface water. States which have set guidelines for Picloram in drinking water[61] include Kansas at 0.175 mg/L and Maine at 0.3 mg/L.
Determination in Water: Fish Tox = 703.55815000 ppb (VERY LOW).
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause nausea.
Long Term Exposure: Picloram should be handled as a carcinogen—with extreme caution. It may damage the testes. May affect the kidneys and liver. In animals: liver, kidney changes. Human Tox = 500.00000 ppb (VERY LOW).
Points of Attack: Eyes, skin, respiratory system, liver, kidneys. Cancer site in animals: liver, uterus, pituitary gland.
Medical Surveillance: Liver and kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures over *10 mg/m³*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and

storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, bases, and metals. A regulated, marked area should be established where this chemical is handled, used, or stored. The use of picloram has been restricted. Be sure that your operation follows regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This chlorinated brush killer is usually formulated with 2,4-D and the disposal problems are similar. Incineration at 1000°C for 2 s is required for thermal decomposition. Alternatively, the free acid can be precipitated from its solutions by addition of a mineral acid. The concentrated acid can then be incinerated and the dilute residual solution disposed in an area where several years' persistence in the soil can be tolerated.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Picloram*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Picloram*. Trenton, NJ

Picolines P:0720

Molecular Formula: C_6H_7N

Synonyms: *2-Picoline (o-isomer):* AI3-2409; AI3-24109; α-Methylpyridine; 2-Methylpyridine; Metilpiridina (Spanish); NSC 3409; α-Picoline; *o*-Picoline; 2-Picoline; Picoline; Pyridine, 2-methyl-; Pyridine, methyl-

3-Picoline (m-isomer): β-Picoline; *m*-Picoline; β-Methylpyridine; *m*-Methylpyridine; 3-Methylpyridine; Pyridine, 3-methyl

4-Picoline (p-isomer): γ-Picoline; *p*-Picoline; γ-Methylpyridine; *p*-Methylpyridine; 4-Methylpyridine; Pyridine, 4-methyl

CAS Registry Number: 109-06-8 (2-Picoline); 108-99-6 (3-Picoline); 108-89-4 (4-Picoline); 1333-41-1 (mixed isomers)

RTECS® Number: TJ4900000 (2-Picoline); TJ5000000 (3-Picoline); UT5425000 (4-Picoline)

UN/NA & ERG Number: UN2313/129

EC Number: 203-643-7 [*Annex I Index No.:* 613-036-00-2] (2-Picoline); 203-636-9 (3-Picoline); 203-626-4 [*Annex I Index No.:* 613-037-00-8] (4-Picoline); 215-588-6 (methylpyridine or mixed isomers)

Regulatory Authority and Advisory Bodies

(2-Picoline)

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

o-isomer:

US EPA Hazardous Waste Number (RCRA No.): U191.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*2-picoline*): Hazard Symbol: Xn; Risk phrases: R10; R20/21/22; R36/37; Safety phrases: S2; S26; S36; (*4-picoline*) Hazard Symbol: T; Risk phrases: R10; R20/22; R24; R36/37/38; Safety phrases: S1/2; S26; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters (*all isomers*).

Description: Picolines are colorless liquids with a strong, unpleasant, pyridine-like odor. Odor threshold is 0.023 ppm. "Picoline" is often used as mixed isomers and physical data for the other isomers are listed. The *o*-isomer is the most heavily regulated (see above). Molecular weight = 93.14; Specific gravity (H_2O:1) = 0.96 at 25°C;

Boiling point = 129°C (*o*-isomer); 143−144°C (*m*-isomer); 145°C (*p*-isomer); Freezing/Melting point = −70°C (*o*-isomer); −18°C (*m*-isomer); 3.7°C (*p*-isomer); Flash point = 39°C (oc) (*o*-isomer); 37.8°C (cc) (*m*-isomer); 57°C (*p*-isomer); Autoignition temperature = 535°C (*o*-isomer). Explosive limits (*o*-isomer): LEL = 1.4%; UEL = 8.6%. Hazard Identification (based on NFPA-704 M Rating System): (*2-isomer*) Health 3, Flammability 2, Reactivity 0; *(3- and 4-isomer*s) Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description (*o*-isomer): Mutagen, Primary Irritant; (*m*-isomer): Tumorigen, Primary Irritant. Picolines are used as intermediates in pharmaceutical manufacture, pesticide manufacture, and in the manufacture of dyes and rubber chemicals. It is also used as a solvent.

Incompatibilities: Reacts with oxidants and strong acids. Attacks copper and its alloys.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

AIHA WEEL: 2 ppm, [skin] TWA; 5 ppm STEL (15 min) [skin], *as picolines.*

2-picoline

TEEL-0: 2 ppm

PAC-1: 5 ppm

PAC-2: 5 ppm

PAC-3: 300 ppm

3-picoline

TEEL-0: 2 ppm

PAC-1: 5 ppm

PAC-2: 125 ppm

PAC-3: 600 ppm

Russia: 5 mg/m^3.[43] (*o*-isomer)

Permissible Concentration in Water: There are no US criteria but the maximum allowable concentration in Class I waters for the production of drinking water has been set in Russia at 0.05 mg/L.[43] The EPA has suggested[32] a permissible ambient goal of 316 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.2 (all isomers)

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Exposure can cause nausea, vomiting, diarrhea, and abdominal pain. *Inhalation:* May cause irritation to mouth, nose, and throat. Odor is very disagreeable above 30 ppm. However, people often become insensitive to the odor after a period of time, so odor detection cannot be relied upon as an indication of exposure. Exposure far above the OEL may cause you to pass out. Levels of 8000 ppm caused death in all exposed rats within 1.5 h. *Skin:* Readily absorbed and may contribute to symptoms. Irritation with rash or burning sensation on contact. May cause severe irritation if not promptly removed. *Eyes:* May cause severe irritation. *Ingestion:* Irritation and upset of digestive system may occur. Muscle weakness, loss of coordination, diarrhea, and unconsciousness may result. Animal studies suggest that death may occur by ingestion of 1−2 fluid ounces for a 150-lb person.

Long Term Exposure: Repeated exposure to picoline can cause headache, dizziness, weakness, loss of coordination, double vision, and coma. Animal studies suggest that symptoms similar to those listed under ingestion would occur. Liver and kidney damage may also occur. Corrosive substances can irritate the lungs; bronchitis may develop.

Points of Attack: Skin, eyes, liver and kidneys, lungs.

Medical Surveillance: Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode. A respirator providing protection against organic vapors may be of use to sensitive individuals and during entry or escape from a contaminated area.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, acid chlorides, chloroformates, copper metals, and alloys. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Picolines require a shipping label of "FLAMMABLE LIQUID." They fall in DOT Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (April 30, 1980). *2-Picoline: Health and Environmental Effects Profile No. 148*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Picoline(s)*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August, 1999). *Hazardous Substances Fact Sheet: Picoline*. Trenton, NJ

Picric acid P:0730

Molecular Formula: $C_6H_3N_3O_7$

Common Formula: $C_6H_2(NO_2)_3OH$

Synonyms: Acide picrique (French); Acido picrico (Spanish); Carbazotic acid; C.I. 10305; 2-Hydroxy-1,3,5-trinitrobenzene; Lyddite; Melinite; Nitroxanthic acid; PA; Pertite; Phenol trinitrate; Phenol, 2,4,6-trinitro-; Picral; Picronitric acid; Pikrinsaeure (German); Shimose; Trinitrophenol; Trinitrofenol (Spanish); 1,3,5-Trinitrophenol; 2,4,6-Trinitophenol

CAS Registry Number: 88-89-1

RTECS$^{®}$ Number: TJ7875000

UN/NA & ERG Number: UN0154 (dry or wetted with <30% water, by mass)/112; UN3364 (wetted *with not <10%* water, by mass)/113; UN1344 (wetted with not <30% water, by mass)/113

EC Number: 201-865-9 [*Annex I Index No.:* 609-009-00-X]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

An OSHA Class A Explosive (1910.109).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, T; R3; R4; R23/24/25; Safety phrases: S1/2; S28; S35; R36/37; R45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Picric acid is a pale yellow, odorless solid. Usually found in solution with 10−20% water. *Must be kept wetted; the crystalline form is highly unstable.* The dry crystal form is explosive upon rapid heating or mechanical shock.

Molecular weight = 229.12; Specific gravity (H_2O:1) = 1.76 at 25°C; Boiling point = (explodes above 300°C); Freezing/Melting point = 122.2°C; Vapor pressure = 1 mmHg at 25°C; Flash point = 150°C; Autoignition temperature = (explodes) 300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 4; (*wet*): Health 2, Flammability 2, Reactivity 2. Slightly soluble in water; solubility = 1%.

Potential Exposure: Compound Description: Mutagen. Picric acid is used in the synthesis of dye intermediates and in manufacturing picrates; in the manufacture of explosives, rocket fuels, fireworks, colored glass, matches, electric batteries, and disinfectants. It is also used in the pharmaceutical and leather industries, in copper and steel etching, forensic chemistry, histology, textile printing, and photographic emulsions.

Incompatibilities: Violent reaction with oxidizers and reducing materials. Air or oxygen is not required for decomposition. Shock-sensitive compounds can be formed on contact with plaster, concrete. An explosive mixture results when the aqueous solution crystallizes. May explosively decompose from heat, shock, friction, or concussion. Copper, lead, zinc and other metals, or their salts can form other salts that are initiators and much more sensitive to shock than this chemical. Corrodes metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.37 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 mg/m^3 TWA [skin].

NIOSH REL: 0.1 mg/m^3 TWA [skin]; 0.3 mg/m^3 STEL.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA.

NIOSH IDLH: 75 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 75 mg/m^3

DFG MAK: 0.1 mg/m^3, inhalable fraction; [skin] danger of skin sensitization; Carcinogen Category 3B.

Australia: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, [skin], 1999; Belgium: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; Hungary: TWA 0.1 mg/m^3; STEL 0.2 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Norway: TWA 0.1 mg/m^3, 1999; the Philippines: TWA 0.1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.3 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.2 mg/m^3, [skin], 1999; Turkey: TWA 0.1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3. Several states have set guidelines or standards for picric acid in ambient air[60] ranging from 0.33 μg/m^3 (New York) to 1.0 μg/m^3 (Florida, South Carolina) to 1.0−3.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada). Russia set a MAC of 10 μg/m^3 for ambient air on a once-daily basis.

Determination in Air: Collection on a mixed cellulose ester membrane filter, extraction with aqueous methanol measurement by high-performance liquid chromatography with UV detector. See NIOSH (II-4), Method #S-228.

Permissible Concentration in Water: To protect human health: no criteria set due to insufficient data.[6] Russia[35, 43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 2.0.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: LD_{50} = (oral-rat) 200 mg/kg. Irritates the eyes, skin, and respiratory tract. Corneal injury may occur from exposure to picric acid dust and solutions. Dust or fume may cause eye irritation which may be aggravated by sensitization. Inhalation of high concentrations of dust by one worker caused temporary coma followed by weakness, myalgia, anuria, and later polyuria. Following ingestion of picric acid, there may be headache, vertigo, nausea, vomiting, diarrhea, yellow coloration of the skin, hematuria, and albuminuria. High doses may cause destruction of erythrocytes, hemorrhagic nephritis, and hepatitis. High doses which cause systemic intoxication will color all tissues yellow, including the conjunctive and aqueous humor, and cause yellow vision.

Long Term Exposure: Picric acid dust or solutions are potent skin sensitizers. The cutaneous lesions which appear usually on exposed areas of the upper extremities consist of dermatitis with erythema and vesicular eruptions. Desquamation may occur following repeated or prolonged contact. Skin usually turns yellow upon contact, and areas around nose and mouth as well as the hair are most often affected. May cause liver effects, hepatitis, hematuria (blood in the urine), albuminuria, kidney effects, nephritis.

Points of Attack: Eyes, skin, kidneys, liver, blood.

Medical Surveillance: NIOSH lists the following tests: liver function tests; urinalysis (routine). Preplacement and periodic medical examinations should focus on skin disorders (such as hypersensitivity, atopic dermatitis) and liver and kidney function. Examination by a qualified allergist. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene™, and Nitrile are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m^3*): 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators]. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 75 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Explosive. Color Code—Red (*wet*): Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in an explosion-proof refrigerator away from oxidizers, reducing agents, and metals. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Trinitrophenol or picric acid, dry or wetted with <30% water, by mass, requires a shipping label of "EXPLOSIVES" It falls in Hazard Class 4.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. More powerful than TNT, picric acid explodes above 572°F/300°C. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration in a rotary kiln incinerator equipped with particulate abatement and wet scrubber devices.[22]

Reference

US Environmental Protection Agency. (1980). *Nitrophenols: Ambient Water Quality Criteria*. Washington, DC

Picrotoxin P:0740

Molecular Formula: $C_{30}H_{34}O_{13}$
Synonyms: Cocculin; Cocculus; Coques du levant (French); Fish berry; Indian berry; Oriental berry; Picrotin, compounded with picrotoxinin (1:1); Picrotoxine
CAS Registry Number: 124-87-8
RTECS® Number: TJ9100000
UN/NA & ERG Number: UN3172/153
EC Number: 204-716-6
Regulatory Authority and Advisory Bodies
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 500 lb (227 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Picrotoxin is an odorless crystalline solid with a very bitter taste. Molecular weight = 602.64; Freezing/Melting point = 203°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in cold water; soluble in boiling water.
Potential Exposure: An alkaloid poison and convulsant. Used in medicine as a central nervous system stimulant and antidote for barbiturate poisoning. Reportedly, this material is not currently regarded as a useful therapeutic agent since it is not a selective respiratory stimulant.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 3 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 15 mg/m^3
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Highly toxic and a dose of 20 mg may produce symptoms of severe poisoning. A human lethal dose of 1.5 mg/kg has been reported. It is an alkaloid convulsant poison. Picrotoxin is a powerful stimulant and affects all portions of the central nervous system. At doses approaching convulsant levels, signs and symptoms include salivation, elevated blood pressure, frequent vomiting, rapid breathing.
Points of Attack: Central nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away. Where possible, automatically transfer material from drums or other storage containers to process containers.
Shipping: Toxins, extracted from living sources, require a shipping label of "POISONOUS/TOXIC MATERIALS". It falls in Hazard Class 6.1 and Packing Group I.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. If water pollution occurs, notify appropriate authorities. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly

trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam for small fires. Use water spray, fog, or foam for large fires. Move container from fire area if this can be done without risk. Isolate hazard area and deny entry. Wear positive pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Picrotoxin*. Washington, DC: Chemical Emergency Preparedness Program

Pindone P:0760

Molecular Formula: $C_{14}H_{14}O_3$

Common Formula: $C_6H_4(CO)_2CHCOC(CH_3)_3$

Synonyms: Chemrat; *tert*-Butyl valone; 1,3-Dioxo-2-pivaloy-lindane; Pival®; Pivalyl; 2-Pivalyl-1,3-indandione; Pivalyl Valone®; Pivaldione (French)

CAS Registry Number: 83-26-1

RTECS® Number: NK6300000

UN/NA & ERG Number: UN2588/151

EC Number: 201-462-8 [*Annex I Index No.:* 606-016-00-X]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25 R48/25;R50/53; Safety phrases: S1/2; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pindone is a bright yellow crystalline solid. Almost odorless. Molecular weight = 230.28; Specific gravity (H_2O:1) = 1.06 at 25°C; Boiling point = decomposes; Freezing/Melting point = 110°C. Practically insoluble in water; solubility = 0.002% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical. Pindone is used as an anticoagulant and rodenticide. Those involved in manufacture, formulation, and application of this chemical.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg/m^3 TWA.

NIOSH REL: 0.1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 mg/m^3 TWA.

NIOSH IDLH: 100 mg/m^3.

No TEEL available.

Australia: TWA 0.1 mg/m^3, 1993; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1999; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3. Several states have set guidelines or standards for pindone in ambient air[60] ranging from 1.0−3.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Nosebleeds (epistaxis), excessive bleeding of minor cuts and bruises, smoky urine, black tarry stools, abdominal and back pain. Reduced blood clotting which leads to hemorrhaging; symptoms resembling warfarin: depressed formation of prothrombin and capillary fragility; leading to hemorrhages.

Points of Attack: Blood prothrombin.

Medical Surveillance: NIOSH lists the following tests: blood plasma, Prothrombin Time; Complete blood count; urinalysis (routine), red blood cells/count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 mg/m³:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m³*): 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m³:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: Pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." (Packing Group III): It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Remove all sources of ignition and dampen spilled material with 60–70% ethanol to avoid airborne dust, then transfer material to a suitable container. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Piperazine P:0770

Molecular Formula: $C_4H_{10}N_2$; $C_4H_{12}Cl_2N_2$

Common Formula: $C_4H_{10}N_2 \cdot 2HCl$; $C_4H_{10}N_2$ HCl (monochloride)

Synonyms: Antiren; *N*,*N*-Diethylene diamine; 1,4-Diethylenediamine; Dihydrochloride salt of diethylenediamine; Dispermine; Dowzene; Hexahydro-1,4-diazine; Hexahydropyrazine; Lumbrical; Piperazidine; Piperazin (German); Piperazine dihydrochloride; Piperazine hydrochloride; Pyrazine hexahydride

CAS Registry Number: 110-85-0; 142-64-3 (hydrochloride)

RTECS® Number: TL4025000 (hydrochloride); TK7800000

UN/NA & ERG Number: UN2579/153

EC Number: 203-808-3 [*Annex I Index No.:* 612-057-00-4]; 205-551-2 [*Annex I Index No.:* 612-241-00-4] (hydrochloride)

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration) 0.1% (Piperazine and Piperazine dihydrochloride).

European/International Regulations: Hazard Symbol: Xn, C; Risk phrases: R34; R42/43; R62; R63; Safety phrases: S1/2; S22; S26; S36/37/39; S45; (*hydrochloride*): Hazard Symbol: Xn, C, N; Risk phrases: R36/38; R42/43; R62; R63; R52/53; Safety phrases: S1/2; S22; S36/37; S45; S61; S63 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Piperazine and Piperazine dihydrochloride, are white to cream-colored needles or powder with a characteristic ammonia-like odor. Combustible solids that do not easily ignite. Molecular weight = 86.16 (piperazine); 159.08 (dihydrochloride); Boiling point = 146°C; Freezing/Melting point = 106°C; 335°C (*dihydrochloride*); Flash point = 110°C. Hazard Identification (based on NFPA-704 M Rating System): (*piperazine*) Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description (Piperazine): Agricultural Chemical; Drug, Human Data; Primary Irritant; (dihydrochloride) Agricultural Chemical; Mutagen. Piperazine is used to manufacture anthelmintics, antifilarials, antihistamines, and tranquilizers; the dihydrochloride is used in the manufacture of fibers, pharmaceuticals, and insecticides. They are used as an intermediate in the manufacture of pesticides, rubber chemicals, and fibers. Also, piperazine is widely available, effective, and safe when used on an occasional basis against ascaride infections. It is also considerably cheaper than other anthelminthic drugs. In some countries where ascariasis is not endemic and where piperazine was used predominantly for the treatment of pinworn, it has been withdrawn from use on the grounds that other effective drugs are now available. Clinical dosages occasionally induce transient neurological signs and, in some circumstances, the drug may generate small amounts of *nitrosamine* in the stomach, which at considerably greater dosage in experimental animals has been demonstrated to have a carcinogenic potential.

Incompatibilities: Violent reaction with strong oxidizers and dicyanofurazan. Incompatible with nitrogen compounds, carbon tetrachloride. Attacks aluminum, copper, nickel, magnesium, and zinc.

Permissible Exposure Limits in Air

ACGIH TLV (*piperazine and piperazine dihydrochloride*): *2010 Notice of intended change*: 0.1 mg/m^3 measured as inhalable fraction and vapor TWA; Danger of sensitization; not classifiable as a human carcinogen.

NIOSH REL (*dihydrochloride*): 5 mg/m^3 TWA.

Piperazine

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK (*piperazine*): Danger of skin and airway sensitization.

Denmark: TWA 0.1 ppm (0.35 mg/m^3), 1999; Norway: TWA 0.1 ppm (0.3 mg/m^3), 1999; Sweden: NGV 0.1 ppm (0.3 mg/m^3), KTV 0.3 ppm (1 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003.

Dihydrochloride

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA.

DFG MAK: Danger of skin and airway sensitization; No numerical value established. Data may be available.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3, 2003.

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Piperazine can affect you when breathed in and by passing through your skin. Piperazine is a corrosive chemical and eye contact can cause severe irritation and burns. Skin contact can cause irritation or a skin allergy, with rash at even very low exposure levels. Exposure can cause a lung allergy to develop, with cough and wheezing triggered by even low exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposures can cause weakness, tremors, visual changes, and trigger seizures. It can also interfere with the ability of the blood to carry oxygen, causing headaches, dizziness, and cyanosis, a bluish color to the skin and lips.

Long Term Exposure: Repeated exposure to piperazine dihydrochloride can cause skin sensitization and asthma-like allergy.

Points of Attack: Lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Piperazine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where piperazine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Piperazine requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Piperazine is a combustible solid. Use dry chemical, water spray, or alcohol foam extinguishers. Piperazine dihydrochloride may burn but does not readily ignite. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases, including nitrogen oxides and hydrogen chloride (hydrochloride), are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (September 2004). *Hazardous Substances Fact Sheet: Piperazine Dihydrochloride*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Piperazine*. Trenton, NJ

Piperidine P:0780

Molecular Formula: $C_5H_{11}N$

Synonyms: Azacyclohexane; Cyclopentimine; Cypentil; Hexahydropyridine; Hexazane; Pentamethyleneimine; Peperidin (German)

CAS Registry Number: 110-89-4

RTECS$^®$ Number: TM3500000

UN/NA & ERG Number: UN2401/132

EC Number: 203-813-0 [*Annex I Index No.:* 613-027-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R11; R23/24; R34; Safety phrases: S1/2; S16; S26; S27; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Piperidine is a clear, colorless liquid with an amine-like odor. Molecular weight = 85.17; Boiling point = 106°C; Freezing/Melting point = −7°C; Flash point = 16°C. Soluble in water.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Primary Irritant. Piperidine is used in agriculture and pharmaceuticals; as an intermediate for rubber accelerators; as a solvent; as a curing agent for rubber and epoxy resins; catalyst for condensation reactions; as an ingredient in oils and fuels; as a complexing agent; in the manufacture of local anesthetics; in analgesics; pharmaceuticals, wetting agents; and germicides; in synthetic flavoring. Not registered as a pesticide in the United States.

Incompatibilities: Piperidine is a medium strong base. Reacts violently with oxidizers.

Permissible Exposure Limits in Air

AIHA WEEL: 1 ppm TWA [skin].

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **6.6** ppm

PAC-2: **33** ppm

PAC-3: **110** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

United Kingdom: TWA 1 ppm/3.5 mg/m^3 [skin].

Russia[43] MAC (work-place air) 0.2 mg/m^3.

Permissible Concentration in Water: Russia[43] set a MAC of 0.06 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Sore throat, coughing, labored breathing, and dizziness occur after inhalation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure may cause increased blood pressure. May cause permanent injury after short exposure to small amounts. Ingestion may involve both irreversible and reversible changes. 30−60 mg/kg may cause symptoms in humans. Symptoms upon oral administration include weakness, nausea, vomiting, salivation, labored respiration, muscular paralysis, and asphyxiation. Redness, pain, and burns occur upon contact with skin.

Long Term Exposure: Irritating substances may cause lung irritation; bronchitis may develop. May affect the liver and kidneys.

Points of Attack: Lungs, blood, liver, kidneys.

Medical Surveillance: Monitor blood pressure. Lung function tests. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Piperidine requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors; do not get water inside container. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if you can do it without risk. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low area. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Poisonous gases, including nitrogen oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Piperidine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September, 1999). *Hazardous Substances Fact Sheet: Piperidine*. Trenton, NJ

Pirimifos-ethyl P:0790

Molecular Formula: $C_{13}H_{24}N_3O_3PS$

Synonyms: *O*-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] *O*,*O*-diethyl phosphorothioate; 2-Diethylamino-6-methylpyrimidin-4-yl diethylphosphorothionate; *O*,*O*-Diethyl *O*-(2-diethylamino-6-methyl-4-pyrimidinyl) phosphorothioate; Diethyl *O*-(2-diethylamino-6-methyl-4-pyrimidinyl) phosphorothioate; Diethyl 2-dimethylamino-4-methylpyrimidin-6-yl phosphorothionate; Ethyl pirimiphos; Fernex; Phosphorothioic acid, *O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl] *O*,*O*-diethyl ester; PP211; Primicid; Primifosethyl; Primotec; Prinicid; R 42211; Solgard

CAS Registry Number: 23505-41-1

RTECS® Number: TF1610000

UN/NA & ERG Number: UN3278 (organophosphorus compound, toxic n.o.s.)/151

EC Number: 245-704-0 [*Annex I Index No.:* 015-099-00-6]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R25; R50/53; Safety phrases: S1/2; S23; S36/37; S45S; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pirimifos-ethyl is a straw-colored liquid. Molecular weight = 333.43; It decomposes at 130°C; no boiling point can be determined; Vapor pressure = 0.0003 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Decomposes in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this organophosphate soil insecticide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 60 mg/m^3

Determination in Water: Fish Tox = 1.70268000 ppb MATC (HIGH)

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: As with other organophosphorus pesticides, symptoms are secondary to cholinesterase inhibition: headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Other signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox; 1.40000 ppb (HIGH).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. As with other organophosphorus pesticides, stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Remove all ignition sources. Ventilate area of spill or leak. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day	0.3/0.4
Night	0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200

Then: Protect persons downwind (miles/kilometers)

Day	1.6/2.6
Night	2.8/4.5

Fire Extinguishing: This material may burn but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases, including nitrogen oxide, phosphorus oxides, and sulfur oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Pirimiphos-Ethyl*. Washington, DC: Chemical Emergency Preparedness Program

Platinum and compounds P:0800

Molecular Formula: Pt

Synonyms: Elemental platinum; Platin (German); Platinum black

CAS Registry Number: 7440-06-4 (Platinum metal); 16941-12-1 (Chloroplatinic acid); 10025-65-7 (Platinous chloride); 13454-96-1 [Platinum(IV) chloride]; 592-06-3 (Platinum cyanide)

RTECS® Number: TP2160000 (Platinum metal); FW7040000 (Chloroplatinic acid); TP2275000 (Platinous chloride); TP2275500 (Platinum(IV) chloride)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric: UN2545 (powder, dry)/135; UN2507 (*chloroplatinic acid*)/ 154

EC Number: 231-116-1 (platinum)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Carcinogenicity (Platinum(IV) chloride): EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; *D. melanogaster* sex-linked lethal.

WGK (German Aquatic Hazard Class): Nonwater polluting agent. (*metal*)

Description: Platinum is a soft, ductile, malleable, silver-white metal. It is found in the metallic form and as the arsenide, sperrylite. It forms complex soluble salts, such as Na_2PtCl_6. It also forms halides. Metallic platinum is insoluble in water. Platinum(IV) chloride is red-brown crystals or powder. Molecular weight = 195.09; 336.89 [Platinum(IV) chloride] Freezing/Melting point = (decomposes) 370°C. Soluble in water.

Potential Exposure: Compound Description (metal): Drug, Tumorigen, (platinum(IV) chloride) Mutagen; Reproductive Effector; Primary Irritant. Platinum and its alloys are utilized because of their resistance to corrosion and oxidation, particularly at high temperatures; their high electrical conductivity; and their excellent catalytic properties. They are used in relays, contacts and tubes in electronic equipment, in spark plug electrodes for aircraft, and windings in high-temperature electrical furnaces. Platinum alloys are used for standards for weight, length, and temperature measurement. Platinum and platinum catalysts (e.g., hexachloroplatinic acid, H_2PtCl_6) are widely used in the chemical industry in persulfuric, nitric, and sulfuric acid production, in the synthesis of organic compounds and vitamins, and for producing higher octane gasoline. They are coming into use in catalyst systems for control of exhaust pollutants from automobiles. They are used in the equipment for handling molten glass and manufacturing fibrous glass; in laboratory, medical, and dental apparatus; in electroplating; in photography; in jewelry; and in X-ray fluorescent screens. Because platinum complexes are used as antitumor agents, the potential for carcinogenic activity is present; tests to clarify this aspect should be conducted. While low levels of emissions of platinum particulate have been observed from some catalyst-equipped automobiles, the major potential source of Pt is from the disposal of spent catalysts.

Incompatibilities: Platinum metal is incompatible with aluminum, acetone, arsenic, ethane, hydrazine, hydrogen peroxide, lithium, phosphorus, selenium, tellurium, various fluorides. Platinum(IV) chloride and finely divided powders are incompatible with oxidizers.

Permissible Exposure Limits in Air

OSHA PEL (*soluble salts, as Pt*) 0.002 mg[Pt]/m^3 TWA.

NIOSH REL (*metal*): 1 mg/m^3; (*soluble salts, as Pt*): 0.002 mg[Pt]/m^3 TWA.

ACGIH TLV®[1] (*soluble salts, as Pt*): 1 mg/m^3 (metal); 0.002 mg[Pt]/m^3 TWA.

NIOSH IDLH: 4 mg [Pt]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 4 mg/m^3

DFG MAK (*chloroplatinates*): 0.002 mg[Pt]/m^3 Ceiling Concentration (peak should not be exceeded); danger of skin and airway sensitization.

Protective Action Criteria (PAC) 16941-12-1, Dihydrogen hexachloroplatinate.

TEEL-0: 0.0042 mg/m^3

PAC-1: 0.25 mg/m^3

PAC-2: 1.5 mg/m^3

PAC-3: 8.4 mg/m^3

Australia: TWA 1 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3, 1993; Finland: TWA 1 mg/m^3, 1999; France: VME 1 mg/m^3, 1999; Hungary: TWA 0.001 mg/m^3; STEL 0.002 mg/m^3, 1993; Norway: TWA 0.002 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Switzerland: MAK-W 0.002 mg[Pt]/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg/m^3. Several states have set guidelines or standards for platinum in ambient air[60] ranging from 0.1 μg/m^3 (Nevada) to 0.4−20.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (North Dakota) to 330.0 μg/m^3 (Virginia).

Platinum(IV)chloride

Arab Republic of Egypt: TWA 0.002 mg[Pt]/m^3 (*dust*), 1993; Australia: TWA 0.002 mg[Pt]/m^3, 1993; Austria: MAK 0.002 mg[Pt]/m^3, 1999; Belgium: TWA 0.002 mg [Pt]/m^3, 1993; Hungary: STEL 0.002 mg[Pt]/m^3, 1993; Norway: TWA 0.002 mg[Pt]/m^3, 1999; the Philippines: TWA 0.002 mg[Pt]/m^3, 1993; Switzerland: MAK-W 0.002 mg[Pt]/m^3, 1999; United Kingdom: LTEL 0.002 mg [Pt]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.002 mg[Pt]/m^3

Platinum cyanide

Protective Action Criteria (PAC)

TEEL-0: 0.00253 mg/m^3

PAC-1: 0.0076 mg/m^3

PAC-2: 0.0127 mg/m^3

PAC-3: 5.07 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #7300, #7303, Elements by ICP; #8310, Metals in urine; #8005, Elements in blood or tissue, OSHA Analytical Method ID-121; ID-130-SG; NIOSH II(7), Method S-19, Soluble salts.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Metal dust and fume may cause irritation of the eyes, skin, and respiratory tract. Metal particles in the eye can cause scratching and possible damage. Hazards arise from the dust, droplets, spray, or mist of complex salts of platinum but not from the metal itself. These salts are sensitizers of the skin, nasal mucosa, and bronchi, and cause allergic phenomena. One case of contact dermatitis from wearing a ring made of platinum alloy is recorded.

Long Term Exposure: Characteristic symptoms of poisoning occur after 2−6 months of exposure and include pronounced irritation of the throat and nasal passages, which results in violent sneezing and coughing; bronchial irritation, which causes respiratory distress; and irritation of the skin, which produces cracking, bleeding, and pain. Respiratory symptoms can be so severe that exposed individuals may develop status asthmaticus. After recovery, most individuals develop allergic symptoms and experience further asthma attacks when exposed to even minimal amounts of platinum dust or mists. Mild cases of dermatitis involve only erythema and urticaria of the hands and forearms. More severe cases affect the face and neck. All pathology is limited to allergic manifestations. EPA research efforts indicate that platinum is more active biologically and toxicologically than previously believed. It methylates in aqueous media, establishing a previously unrecognized biotransformation and distribution mechanism.

Points of Attack: Respiratory system, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). In preemployment and periodic physical examinations, the skin, eyes, and respiratory tract are most important. Any history of skin or pulmonary allergy should be noted, as well as exposure to other irritants or allergens, and smoking history. Periodic assessment of pulmonary function may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When chloroplatinic acid has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear appropriate splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (for soluble Pt salts): *Up to 0.05 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 4 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye iritation and damage; eye protection needed.

Storage: Color Code—White (*chloroplatinic acid)*: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Chloroplatinic acid, solid, is the only soluble salt cited. This compound requires a shipping label of “CORROSIVE.” It falls in Hazard Class 8 and Packing Group III. Fulminating platinum is also cited. Its Hazard class is “FORBIDDEN.”

Dry powder, in bulk, requires a shipping label of “SPONTANEOUSLY COMBUSTIBLE.” It falls in Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemicals appropriate for metal fires. *Do not use water*. Poisonous gases are produced in fire, including Pt. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Catalyst disposal is expected to be the largest contributor of Pt to the environment. The value of the metal would help to offset the cost of reclaiming the Pt from discarded catalysts. If direct vehicular emissions of Pt are found to be significant, particulate taps, which are available at reasonable cost, may provide a technological solution. In any event, recovery and recycling is the preferred technique for both health and economic reasons. Details of platinum recovery and recycling from plating wastes, platinum metal refinery effluents, spent catalysts, and precious metals scrap have been published.

References

US Environmental Protection Agency. (April 1974). *A Literature Search and Analysis of Information Regarding Uses, Production, Consumption, Reported Medical Cases and Toxicology of Platinum and Palladium*, Report PB-238,546. Research Triangle Park, NC

National Academy of Sciences. (1977). Medical and Biologic Effects and Environmental Pollutants: Platinum Group Metals. Washington, DC

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 74−75

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Platinous Chloride*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Platinum Tetrachloride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 2002). *Hazardous Substances Fact Sheet: Platinum*. Trenton, NJ

Polybrominated biphenyls (PBBs)

P:0810

Molecular Formula: $C_{12}H_4Br_6$

Common Formula: $Br_3C_6H_2{-}C_6H_2Br_3$

Synonyms: Decabromobiphenyl; Firemaster BP-6®; Firemaster FF-1®; HBB; NCI-C53634; 2,4,5,2′,4′,5′-Hexabromobiphenyl; PBBs; PBB (BP-6); PBB (FF-1); Polybrominated biphenyl (BP-6); Polybrominated biphenyl (FF-1); Tetrabromo(tetrabromophenyl)benzene

CAS Registry Number: 36355-01-8 (hexabromobiphenyl); 27858-07-7 (octabromobiphenyl); 59536-65-1 [Firemaster BP-6

Polybrominated biphenyls category include the following:

p-Bromodiphenyl ether	101-55-3
Decabromobiphenyl	13654-09-6
Decabromodiphenyl ether	1163-19-5
p,p′Dibromodiphenyl ether	2050-47-7
Hexabromobiphenyl	59080-40-9
Hexabromo-1,1′-biphenyl	36355-01-8
Hexabromodiphenyl ether	36483-60-0
Nonabromodiphenyl ether	63936-56-1
Octabromobiphenyl	27858-07-7
Octabromobiphenyl	61288-13-9
Octabromodiphenyl ether	32536-52-0
Pentabromodiphenyl ether	32534-81-9
Polybrominated biphenyl	59536-65-1
Polybrominated biphenyl mixture	67774-32-7
Tetrabromodiphenyl ether	40088-47-9
Tribromodiphenyl ether	49690-94-0

RTECS® Number: DV5330000 (hexabromobiphenyl); LK5060000 (Firemaster BP-6); LK5065000 (Firemaster FF-1)

UN/NA & ERG Number: UN3152 (Polyhalogenated biphenyls, solid)/171; UN3151 (Polyhalogenated biphenyls, liquid)/171

EC Number: 252-994-2 (hexabromobiphenyl); 248-696-7 (octabromobiphenyl or [tetrabromo(tetrabromophenyl)benzene]; 237-137-2 (decabromobiphenyl)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen.

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 5: Any combination of the following substances resulting from a chemical reaction (as well as the individual chemicals): Tetrabromodiphenyl ether (CAS:40088-47-9); Pentabromodiphenyl ether (CAS: 32534-81-9); Hexabromodiphenyl ether (CAS: 36483-60-0); Heptabromodiphenyl ether (CAS: 68928-80-3); Octabromodiphenyl ether (CAS: 32536-52-0); Nonabromodiphenyl ether (CAS: 63936-56-1). For details, see the Proposed Significant New Use Rule (69 FR 70404, December 6, 2004).

Banned or Severely Restricted (Canada, USA) (UN)[13] (Germany, EEC) (UN).[35]

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (50); 8250 (100).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88; Reproductive toxin 10/1/94.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (67774-32-7).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [(13654-09-6 (deca-); 36355-01-8 (hexa-); 27858-07-7 (octa-)].

List of Stockholm Convention POPs: Annex A (Elimination) included in the same category are the following: hexabromobiphenyl (CAS 59080-40-9); hexabromobiphenyl ether (CAS 59080-40-9) and heptabromodiphenyl ether (CAS 68928-80-3); Tetrabromodiphenyl ether CAS (40088-47-9); and Pentabromodiphenyl ether (CAS 32534-81-9).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: PBBs do not occur as natural products. Hexabromobiphenyl is the predominant isomer. These materials are heavy, highly brominated compounds. Typical is hexabromobiphenyl, $Br_3C_6H_2{-}C_6H_2Br_3$: Molecular weight = 627.62; decomposes at 300°C to 400°C. It will be used as an illustrative example of such compounds. PBBs are produced by direct bromination of biphenyl, and it could be anticipated that very complex mixtures of compounds differing from each other both in number of bromine atoms per molecule and by positional isomerism are formed. The possibility also exists (analogous to the PCBs) that halogenated dibenzofurans (e.g., Brominated dibenzofurans) may be trace contaminants in certain PBB formulations. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0.

Potential Exposure: The polybrominated biphenyls (PBBs) are inert substances and have been employed, primarily as fire retardants. For example, the PBBs were incorporated into thermoplastics at a concentration of about 15% to increase the heat stability of the plastic to which it is added. In 1973, 1−2 tons of PBBs, a highly toxic flame retardant, were accidentally mixed with an animal feed supplement and fed to cattle in Michigan. Contamination also resulted from traces of PBBs being discharged into the environment at the manufacturing site and at other facilities involved in handling PBBs. Approximately 250 dairy and 500 cattle farms were quarantined, tens of thousands of swine and cattle and more than one million chickens were destroyed, and lawsuits involving hundreds of millions of dollars were instituted. Before the nature of the contamination was recognized, many of the contaminated animals had been slaughtered, marketed, eaten; and eggs and milk of the contaminated animals were also consumed. Thus, large numbers of people have been exposed to PBBs; they are persistent in the environment and are concentrated in body fat. While commercial manufacture and distribution of PBBs have currently ceased, the full extent of the problem has not yet been assessed.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

The accidental contamination, in 1973, of animal feed and livestock throughout Michigan by polybrominated biphenyl flame retardants (Firemaster BP-6) has stimulated extensive studies of the potential for water contamination, transport, bioaccumulation, biological and toxicological nature of this class of environmental agent. While no immediate adverse health effects were noted in several thousand Michigan farm families that consumed milk and dairy products contaminated with PBBs, it is not possible to determine at this date any chronic or delayed effects that might be attributed to the PBBs or the potential ability of this chemical to cause birth defects.

Firemaster FF-1 (Firemaster BP-6 containing 2% of calcium trisilicate)—a mixture of pentabromobiphenyl, hexabromobiphenyl, and heptabromobiphenyl, with hexabromobiphenyl being the major component—administered by gavage produced neoplastic nodules and hepatocellular carcinomas in female Sherman strain rats. In another bioassay, Firemaster FF-1, also administered by gavage, was carcinogenic to Fisher 344 rats and B6C3F1 mice of each sex, inducing neoplastic nodules, hepatocellular carcinomas, and chloangiocarcinomas in rats and hepatocellular carcinomas in mice.

Long Term Exposure: Confirmed carcinogen. Experimental teratogenic and reproductive effects. Mutation data reported.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Polyhalogenated biphenyls, liquid, require a shipping label of "CLASS 9." They fall in Hazard Class 9 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire, including bromine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (December 1979). *Status Assessment of Toxic Chemicals: Polybrominated Biphenyls*, Report EPA-600/2-79-210k. Washington, DC

National Toxicology Program. (1982). *NTP: Technical Report on the Toxicology and Carcinogenesis Bioassay of Polybrominated Biphenyl Mixture (Firemaster FF-1)*, Technical Report Series No. 244, NIH Publication No. 82-1800. Research Triangle Park, NC

Polychlorinated biphenyls (PCBs)

P:0820

Molecular Formula: $C_{12}H_{10-X}Cl_X$

Synonyms: Aroclor; Aroclor 1221; Aroclor 1232; Aroclor 1242; Aroclor 1248; Aroclor 1254; Aroclor 1260; Aroclor 1262; Aroclor 1268; Aroclor 2565; Aroclor 4465; Biphenyl, Chlorinated; 1,1′-Biphenyl, chloro derivs.; Biphenyl, polychloro-; Chlophen; Chlorextol; Chlorinated biphenyl; Chlorinated diphenyl; Chlorinated diphenylene; Chloro biphenyl; Chloro 1,1-biphenyl; Clophen; Dykanol; Diphenyl, chlorinated; Fenclor; Inerteen; Kanechlor; Kanechlor 300; Kanechlor 400; Kanechlor 500; Montar; Noflamol; PCB; PCBS; Phenochlor; Phenoclor; Polychlorobiphenyl; Pyralene; Pyranol; Santotherm; Santotherm FR; Sovol; the rminol FR-1

CAS Registry Number: 1336-36-3 (Aroclor PCBs); 53469-21-9; *(alt.)* 11104-29-3 (Aroclor 1242) (42% Cl); 12672-29-6 (Aroclor 1248) (48% Cl); 11097-69-1 (Aroclor 1254) (54% Cl); 11096-82-5 (Aroclor 1260) (60% Cl); 37324-23-5 (Aroclor 1262) (62% Cl); 11100-14-4 (Aroclor 1268) (68% Cl); 55720-99-5 (PCB oxide)

RTECS® Number: TQ1350000; TQ1356000 (Aroclor 1242) (42% Cl); TQ1358000 (Aroclor 1248) (48% Cl); TQ1360000 (Aroclor 1254) (54% Cl); TQ1362000 (Aroclor 1260) (60% Cl); TQ1364000 (Aroclor 1262) (62% Cl); TQ1366000 (Aroclor 1268) (68% Cl)

UN/NA & ERG Number: UN2315/171

EC Number: 215-648-1 [*Annex I Index No.:* 602-039-00-4] (PCBs)

Regulatory Authority and Advisory Bodies

Carcinogenicity: (*1336-36-3*): Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1998; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 6.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] *as PCBs*.

Aroclor 1242 NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen; IARC *(PCB)*: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1987; EPA *(PCB)*: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Aroclor 1254 NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; IARC *(PCB)*: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1987; EPA *(PCB)*: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

US EPA Gene-Tox Program, Negative: Cytogenetics—male germ cell; Rodent dominant lethal (Aroclor 1242); Negative: SHE—clonal assay; Rodent dominant lethal; Negative: Sperm morphology—mouse; Inconclusive: Mammalian micronucleus (Aroclor 1254).

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A.

Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.10; Nonwastewater (mg/kg), 10, total PCBs, sum of all PCB isomers, or all AROCLORS.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (50); 8250 (100).

Safe Drinking Water Act: MCL, 0.0005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

California Proposition 65 Chemical: Cancer 10/1/89; Reproductive toxin 1/1/91; (containing ≥60% chlorine by molecular weight) 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

Note: The EPA requires the following: All PCB transformer locations must be cleared of stored combustible materials (solvents, paints, paper, etc.). All PCB transformers must be registered with the local fire department. All PCB-containing equipment must be posted with a large yellow label and the exterior door of the vault, machinery room door and any other means of exit must also be marked with PCB yellow ID labels. All PCB-containing transformers must be inspected every 3[3] weeks; leaks must be repaired within 2[2] days and reported to the EPA within 5[5] days. In order to prevent fires, EPA recently required that high-voltage network transformers be removed and that enhanced electrical protection be added on many types of PCB transformers in commercial buildings.

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release) *as PCBs*.

European/International Regulations: Hazard Symbol (*PCB*): Xn, N; Risk phrases: R33; R50/53; Safety phrases: S2; S35; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Arochlor 1242 is a colorless to light yellow-colored viscous liquid with a mild, hydrocarbon odor. Molecular weight = 258 (approx.); Specific gravity (H_2O:1) = 1.39 at 25°C; Boiling point = 325−366°C; Freezing/Melting point = −18°C; Vapor pressure = 0.001 mmHg at 25°C. Insoluble in water. Arochlor 1254 is a colorless to pale-yellow, viscous liquid (resinous state) or solid (below 10°C) with a mild, hydrocarbon odor. Molecular weight = 326 (approx.); Specific gravity (H_2O:1) = 1.39 at 25°C; Boiling point = 365−390°C; Freezing/Melting point = −18°C; Vapor pressure = 0.00006 mmHg at 25°C. Insoluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. $C_{12}H_{10-x}Cl_x$, diphenyl rings, in which one or more hydrogen atoms are replaced by a chlorine atom. Most widely used are chlorodiphenyl (42% chlorine), containing 3 chlorine atoms in unassigned positions, and chlorodiphenyl (54% chlorine) containing 5 chlorine atoms in unassigned positions. These compounds are light, straw-colored liquids with typical chlorinated aromatic odors; 42% chlorodiphenyl is a mobile liquid and 54% chlorodiphenyl is a viscous liquid. Insoluble in water. Polychlorinated biphenyls are prepared by the chlorination of biphenyl and hence are complex mixtures containing isomers of chlorobiphenyls with different chlorine contents. It should be noted that there are 209 possible compounds obtainable by substituting chlorine for hydrogen from 1−10 different positions on the biphenyl ring system. An estimated 40−70 different chlorinated biphenyl compounds can be present in each of the higher chlorinated commercial mixtures. For example, Aroclor 1254 contains 69 different molecules, which differ in the number and position of chlorine atoms. It should also be noted that certain PCB commercial mixtures (no longer produced in the United States) but produced in France, Germany, and Japan have been shown to contain other classes of chlorinated derivatives, e.g., chlorinated naphthalenes and chlorinated dibenzofurans. The possibility that naphthalene and dibenzofuran contaminate the technical biphenyl feedstock used in the preparation of the commercial PCB mixtures cannot be excluded.

Potential Exposure: Compound Description (Aroclor 1242): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; (Aroclor 1254) Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. PCBs are mixtures of individual chemicals which are no longer produced in the United States but are still found in the environment. Chlorinated diphenyls are used alone and in combination with chlorinated naphthalenes. They are stable, thermoplastic, and nonflammable; they are used in heat transfer and hydraulic fluids, lubricants, and insecticide formulations; they found use in insulation for electric cables and wires; in the production of electric condensers; as additives for extreme pressure lubricants; and as a coating in foundry use. Polychlorinated biphenyls (PCBs, first introduced into commercial use more than 45 years ago) are one member of a class of chlorinated aromatic organic compounds which are of increasing concern because of their apparent ubiquitous dispersal, persistence in the environment, and tendency to accumulate in food chains, with possible adverse effects on animals at the top of food webs, including man.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

1336-36-3 (Aroclor PCBs); (42% Cl)
TEEL-0: 0.04 mg/m^3
PAC-1: 0.125 mg/m^3
PAC-2: 0.75 mg/m^3
PAC-3: 500 mg/m^3

12674-11-2 (Aroclor 1016)
TEEL-0: 12.5 mg/m^3
PAC-1: 40 mg/m^3
PAC-2: 300 mg/m^3
PAC-3: 500 mg/m^3

53469-21-9; (Aroclor 1242) (42% Cl)
TEEL-0: 1 mg/m^3
PAC-1: 1 mg/m^3
PAC-2: 1 mg/m^3

PAC-3: 500 mg/m^3
11104-28-2 (Aroclor 1221) (21% Cl); 11141-16-5 (Aroclor 1232) (32% Cl); 12672-29-6 (Aroclor 1248) (48% Cl)
TEEL-0: 3 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 60 mg/m^3
PAC-3: 500 mg/m^3
11097-69-1 (Aroclor 1254) (54% Cl)
TEEL-0: 0.5 mg/m^3
PAC-1: 35 mg/m^3
PAC-2: 250 mg/m^3
PAC-3: 400 mg/m^3
11096-82-5 (Aroclor 1260) (60% Cl); (Aroclor 1261/1262) (61% Cl)
TEEL-0: 0.4 mg/m^3
PAC-1: 1.25 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 500 mg/m^3
37324-23-5 (Aroclor 1262) (62% Cl)
TEEL-0: 0.6 mg/m^3
PAC-1: 1.5 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 500 mg/m^3
11100-14-4 (Aroclor 1268) (68% Cl)
TEEL-0: 0.0125 mg/m^3
PAC-1: 0.04 mg/m^3
PAC-2: 0.3 mg/m^3
PAC-3: 500 mg/m^3
OSHA PEL: 1 mg/m^3 TWA [skin]
NIOSH REL: 0.001 mg/m^3 TWA (The REL also applies to other PCBs); A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 1 mg/m^3 TWA [skin].
DFG MAK: 0.1 ppm/1.1 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; Carcinogen Category 3B; Pregnancy Risk Group B.
NIOSH IDLH: potential occupational carcinogen 5 mg/m^3.
Australia: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], carcinogen, 1993; Austria: MAK 0.1 ppm (1 mg/m^3), [skin], suspected carcinogen, 1999; Belgium: TWA 1 mg/m^3; STEL 2 mg/m^3, [skin], 1993; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, [skin], 1993; France: VME 1 mg/m^3, [skin], 1999; Japan: 0.1 mg/m^3, [skin], 2A carcinogen, 1999; the Netherlands: MAC-TGG 1 mg/m^3, [skin], 2003; the Philippines: TWA 1 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3, 1999; Sweden: NGV 0.01 mg/m^3, KTV 0.3 mg/m^3, [skin], carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (1 mg/m^3), [skin], 1999; United Kingdom: TWA 0.1 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg/m^3 [skin]
54% chlorine
OSHA PEL: 0.5 mg/m^3 TWA [skin].
NIOSH REL: 0.001 mg/m^3 (applies to all PCBs) TWA [skin]. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
DFG MAK: 0.05 ppm/0.70 mg/m^3 TWA; Peak Limitation Category II(8) [skin]; Carcinogen Category 3B; Pregnancy Risk Group B.
NIOSH IDLH: 5 mg/m^3.
Australia: TWA 0.5 mg/m^3; STEL 1 mg/m^3, [skin], Carcinogen, 1993; Austria: MAK 0.05 ppm (0.5 mg/m^3), [skin], suspected carcinogen, 1999; Belgium: TWA 0.5 mg/m^3; STEL 1 mg/m^3, [skin], 1993; France: VME 0.5 mg/m^3, [skin], 1999; Japan: 0.1 mg/m^3, [skin], 2A carcinogen, 1999; Norway: TWA 0.01 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, [skin], 2003; Poland: MAC (TWA) 1 mg/m^3, 1999; Sweden: NGV 0.1 mg/m^3, KTV 0.3 mg/m^3, [skin], carcinogen, 1999; Switzerland: MAK-W 0.05 ppm (0.5 mg/m^3), [skin], 1999; Turkey: TWA 1 mg/m^3, [skin], 1993; United Kingdom: TWA 0.1 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic has set a TWA of 0.5 mg/m^3 and a ceiling value of 1.0 mg/m^3.
PCB oxide
0.5 mg/m^3, inhalable fraction [skin].
Several states have set guidelines or standards for PCB's in ambient air[60] as follows (all in μg/m^3).

Determination in Air: Use NIOSH Analytical Method #5503, Polychlorobiphenyls; #8004, Polychlorobiphenyls in serum; #PV-2089, Chlorodiphenyl (42% Chlorine); #PV-2088, Chlorodiphenyl (54% Chlorine).

Permissible Concentration in Water: To protect freshwater aquatic life: 0.014 μg/L as a 24-h average. To protect saltwater aquatic life: 0.030 μg/L as a 24-h average. To protect human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 0.00079 μg/L.[6] The EPA has set a maximum contaminant level of 0.0005 milligrams PCBs per liter of drinking water (0.0005 mg/L). The EPA requires that spills of 1 lb or more of PBCs be reported to the EPA.

Determination in Water: Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 6.25 (54% Chlorine) (estimated).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Inhalation of fume or vapor and percutaneous absorption of liquid, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May produce irritation to nose, throat, and lungs. The vapors can cause coughing and/or difficulty in breathing. Levels above 10 mg/m^3 are reported to be unbearable. Inhalation may contribute significantly to all symptoms of long-term exposure. *Skin:* Absorption moderate. Contributes significantly to all symptoms of long-term exposure. Sensitized individuals may develop a rash after 2 days exposure by contact or inhalation. *Eyes:* May produce irritation and burns. Levels of

10 mg/m^3 are severely irritating. *Ingestion:* Absorption in digestive system contributes significantly to all symptoms of long-term exposure. There are no reported deaths of humans due to a single ingestion. However, experiments in animals suggest that ingestion of 6−10 fluid ounces would cause death to a healthy a 150-lb adult.

Long Term Exposure: Repeated or prolonged contact with skin may cause acne-like skin rash (chloroacne). The substance may cause liver damage. High exposure can damage the nervous system. PCBs are readily absorbed into the body by all routes of exposure. They may persist in tissues for years after exposure stops. The symptoms below may be due to PCBs or to chemical contaminants. High levels of PCB vapor, 1−10 mg/m^3, may produce burning feeling in eyes, nose, and face; dry throat; lung and throat irritation; nausea, dizziness, and aggravation of acne. These may be felt immediately or be delayed weeks or months. Chemical acne, black heads, dark patches on skin, and unusual eye discharge have been reported by all routes of exposure. Although some sensitive individuals have reported these effects after 2 days, onset may not occur for months. These effects may last for months. Digestive disturbance have been reported in some individuals. PCBs may impair the function of the immune system. High levels of PCBs have been shown to produce cancer and birth defects in laboratory animals. Whether PCBs produce these effects in humans is not known.

Points of Attack: Liver, skin, nervous system. Cancer site in animals: liver.

Medical Surveillance: NIOSH lists the following tests: Adipose Tissue; whole blood (chemical/metabolite); blood serum; blood plasma; liver function tests. Before beginning employment and at regular times after that, the following are recommended: Serum Triglycerides level. Examination of the skin. Examination of the nervous system. Nerve conduction studies should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. *Chlorodiphenyl* (42% chlorine) 53469-21-9. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): butyl rubber gloves, suits, boots; Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots; Viton™ gloves, suits; Saranex™ coated suits, Barricade™ coated suits; Responder™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. *Chlorodiphenyl* (54% chlorine) 11097-69-1. Prevent skin contact. **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): butyl rubber gloves, suits, boots; Neoprene™ rubber gloves, suits, boots; Teflon™ gloves, suits, boots; Viton™ gloves, suits, Saranex™ coated suits, Barricade™ coated suits; Responder™ suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): 4H™ and Silver Shield™ gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document: #77-225, *Occupational Exposure to Polychlorinated Biphenyls.*

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with these chemicals you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Polychlorinated biphenyls require a shipping label of “CLASS 9.” They fall in DOT Hazard Class 9 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Spills of 1[1] lb or more must be reported to the EPA.

Fire Extinguishing: PCBs may burn but do not easily ignite. Poisonous gases, including dioxin and chlorinated dibenzofurans, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration at 1648°C with scrubbing to remove any chlorine-containing products. In addition, some chemical waste landfills have been approved for PCB disposal. More recently, treatment with metallic sodium has been advocated which yields a low molecular weight polyphenylene and sodium chloride.

References

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Portland cement P:0830

Molecular Formula: Ca_2O_4Si; $Al_2Ca_3O_6$; Ca_3O_5Si; $Al_2Ca_4Fe_2O_{10}$

Common Formula: $2CaO \cdot SiO_2$; $3CaO \cdot Al_2O_3$; $3CaO \cdot SiO_2$; $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$

Synonyms: Cement; Hydraulic cement; Portland cement silicate

CAS Registry Number: 65997-15-1; 68475-76-3 (flue dust, portland cement)

RTECS® Number: VV8770000

EC Number: 266-043-4; 270-659-9 (flue dust, portland cement)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Description: Portland cement is a class of hydraulic cements containing tri- and dicalcium silicate in addition to varying amounts of alumina, tricalcium aluminate, and iron oxide. The quartz content of most is below 1%. The average composition of regular Portland cement is as follows: CaO (64.0%); SiO_2 (21.0%); Al_2O_3 (5.8%); Fe_2O_3 (2.9%); MgO (2.5%); Alkali oxides (1.4%); SO_3 (1.7%). Freezing/Melting point = >1050°C. Reacts with water.

Potential Exposure: Cement is used as a binding agent in mortar and concrete (a mixture of cement, gravel, and sand). Potentially hazardous exposure may occur during both the manufacture and use of cement.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

OSHA PEL: 50 mppcf TWA or 15 mg/m^3, total dust TWA; 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3, total dust TWA; 5 mg/m^3 TWA, respirable fraction.

ACGIH TLV®[1]: 1 mg/m^3, respirable fraction TWA the value is for particulate matter containing no asbestos and <1% crystalline silica (free SiO_2), not classifiable as a human carcinogen.

NIOSH IDLH: 5000 mg/m^3.

No TEEL available.

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Sweden: NGV 10 mg/m^3 (total dust), 1999; Sweden: NGV 5 mg/m^3 (respirable dust), 1999; Switzerland: MAK-W 6 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3, total inhalable dust, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3 for particulate matter containing no asbestos and <1% crystalline silica (free SiO_2).

Determination in Air: NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust; OSHA Analytical Method ID-207, Portland cement (total dust).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and nose with cough, expectoration, exertional dyspnea (breathing difficulty), wheezing.

Long Term Exposure: May cause chronic bronchitis. Exposure may produce cement dermatitis which is usually due to primary irritation from the alkaline, hygroscopic, and abrasive properties of cement. Chronic irritation of the eyes and nose may occur. In some cases, cement workers have developed an allergic sensitivity to constituents of cement, such as hexavalent chromate. It is not unusual for cement dermatitis to be prolonged and to involve covered areas of the body. No documented cases of pneumoconiosis or other systemic manifestations attributed to finished Portland cement exposure have been reported. Conflicting reports of pneumoconiosis from cement dust appear related to exposures that occurred in mining, quarrying, or crushing silica-containing raw materials.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Preemployment and periodic medical examinations should stress significant respiratory problems, smoking history, and allergic skin sensitivities. The eyes should be examined. Patch test studies may be useful in dermatitis cases.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent prolonged skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 50 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 100 mg/m^3:* 95XQ (APF = 10) (any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100) or Sa (APF = 10) (any supplied-air respirator). *Up to 250 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 500 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 5000 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishers suitable for surrounding fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill. In some cases, recovery of cement from cement kiln dust or ready-mix concrete residues may be economic, and the technology is available.

Potassium metal P:0840

Molecular Formula: K

Synonyms: Elemental potassium; Kalium

CAS Registry Number: 7440-09-7

RTECS® Number: TS6460000

UN/NA & ERG Number: UN2257/130; UN1420 (metal alloys)/138; metal powder, in bulk, may be pyrophoric: UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-119-8 [*Annex I Index No.:* 019-001-00-2]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R14; R34; Safety phrases: S1/2; S5 (If appropriate); S8; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Potassium is a soft silvery metal. Molecular weight = 39.10; Boiling point = 774°C; Freezing/Melting point = 64°C; Autoignition temperature = 441°C. Hazard Identification (based on NFPA-704 M Rating System) *(lump)*: Health 3, Flammability 3, Reactivity 3₩. Reacts violently with water.

Potential Exposure: Used as a reagent and in sodium–potassium alloys which are used as high-temperature heat transfer media.

Incompatibilities: Air contact causes spontaneous ignition. Violent reaction with water, forming heat, spattering, corrosive potassium hydroxide, and explosive hydrogen. The heat from the reaction can ignite the hydrogen that is generated. A powerful reducing agent. Violent reaction with oxidizers, organic materials, carbon dioxide, heavy metal compounds, carbon tetrachloride, halogenated hydrocarbons, easily oxidized materials, and many other substances. Store under nitrogen, mineral oil, or kerosene. Oxidizes and forms unstable peroxides under storage conditions. Potassium metal containing an oxide coating is an extremely dangerous explosion hazard and should be removed and destroyed.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.075 mg/m^3

PAC-1: 0.2 mg/m^3

PAC-2: 1.5 mg/m^3

PAC-3: 300 mg/m^3

Permissible Concentration in Water: No criteria set. (Reacts with water).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium can affect you when breathed in. Inhalation of dusts or mists can irritate the eyes, nose, throat, and lungs with sneezing, coughing, and sore throat. Higher exposures may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. Skin and eye contact can cause severe burns leading to permanent damage.

Long Term Exposure: Prolonged exposure to fumes can cause sores of the inner nose and nasal septum. Fumes can irritate the lungs; bronchitis may develop.

Points of Attack: Lungs, skin

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water. Continue without stopping for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately.

Skin Contact: Quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately.

Breathing: Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to potassium, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive mode or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe (*lump*): Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium must be stored to avoid contact with carbon monoxide and moisture, compounds of heavy metals (such as silver oxide and silver chloride) and carbon tetrachloride since violent reactions occur. Store under nitrogen, mineral oil, or kerosene. Sources of ignition, such as smoking and open flames, are prohibited where potassium metal is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Potassium requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group II. Potassium, metal alloys, requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group II. For Metal powder, flammable, n.o.s. the required label is "SPONTANEOUSLY COMBUSTIBLE." They fall in Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium is spontaneously combustible. Use dry chemical, dry graphite, soda ash, or lime extinguishers. *Do not use water*, carbon dioxide, or foam. Potassium may ignite in the presence of moisture or itself if exposed to air. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Potassium.* Trenton, NJ

Potassium arsenate P:0850

Molecular Formula: AsH_2KO_4

Common Formula: KH_2AsO_4

Synonyms: Arsenic acid, Monopotassium salt; Arseniato potasico (Spanish); Macquer's salt; Monopotassium arsenate; Monopotassium dihydrogen arsenate; Potassium acid arsenate; Potassium arsenate, monobasic; Potassium dihydrogen arsenate; Potassium hydrogen arsenate

CAS Registry Number: 7784-41-0

RTECS$^{®}$ Number: CG1100000

UN/NA & ERG Number: UN1677/151

EC Number: 232-065-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1987.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 2/27/87.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

As arsenic compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganics 0.1%; organics 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

California Proposition 65 Chemical: (*inorganic arsenic*) Cancer 2/27/87.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Potassium arsenate is a colorless to white crystalline solid. Molecular weight = 180.04; Specific gravity = 3.74; Boiling point = 463°C; Freezing/Melting point = 288°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1.

Potential Exposure: Compound Description: Tumorigen. Potassium arsenate is used in the textile, tanning, preserving hides; in the textile printing and paper industries; and as an insecticide in fly baits, especially for fly paper; as laboratory reagent.

Incompatibilities: A weak base. Reacts with strong oxidizers, bromine azide, acids and decomposes on contact with strong acids producing acetic acid fumes. Arsine, a very deadly gas, can be released in the presence of acid, acid mists, or hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018].

NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.

NIOSH IDLH: potential occupational carcinogen 5 mg [As]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.024 mg/m^3

PAC-1: 0.35 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 12 mg/m^3

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on a daily average basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105.

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons but has set a guideline of 50 μg/L[61] for drinking water.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Potassium arsenate can affect you when breathed, and may enter through skin. Potassium arsenate is a carcinogen; handle with extreme caution. Eye contact causes irritation, burns and red, watery eyes. Skin contact can cause burning, itching, and rash. Breathing can cause irritation with sneezing and coughing. High or repeated exposures can cause disturbed sleep, with numbness and weakness of arms and legs; and can cause poor appetite; nausea, cramps, and if severe, vomiting and diarrhea.

Long Term Exposure: Long-term exposure can cause ulcer or hole in the nasal septum; hoarseness and sore eyes also occur. Repeated exposure can cause nervous system damage. Repeated skin contact can cause thickened skin and/or patchy area of darkening and loss of pigment.

Points of Attack: Nervous system, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: examination of the nose, skin, eyes, nails, nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a workday). At NIOSH recommended exposure levels, urine arsenic should not be greater than 50−100 μg/L of urine. After suspected overexposure, repeat these tests. Also, examine your skin periodically for abnormal growths. Skin cancer from arsenic is easily cured when detected early.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL has been used. For milder poisoning penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposures. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where potassium arsenate is handled, used, or stored as required by OSHA Standard 29 CFR 1910.1018 for inorganic arsenic. Potassium arsenate must be stored to avoid contact with acids. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Potassium arsenate itself does not burn. Poisonous gases are produced in fire, including arsenic trioxide and potassium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 101−103

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Potassium Arsenate*. Trenton, NJ

Potassium arsenate P:0860

Molecular Formula: As_2HKO_4

Common Formula: $KAsO_2 \cdot HAsO_2$; $AsH_3O_3 \cdot xK$

Synonyms: Arsenito potasico (Spanish); Arsenous acid, potassium salt; Arsenite de potassium (French); Arsonic acid, potassium salt; Fowler's solution (liquid); Kaliumarsenit (German); NSC 3060; Potassium metaarsenite

CAS Registry Number: 13464-35-2; 1332-10-1 (solution)

RTECS® Number: CG3800000

UN/NA & ERG Number: UN1678/154

EC Number: 236-680-2 [*Annex I Index No.:* 033-002-00-5] (potassium arsenite); 233-337-9 (potassium arsonate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, Animal Inadequate Evidence, 1980.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg) (10124-50-2).

Reportable Quantity (RQ): 1 lb (0.454 kg) (10124-50-2).
Arsenic compounds:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.
Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganics 0.1%; organics 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.
California Proposition 65 Chemical: Cancer 2/27/87.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as arsenic, water-soluble compounds, n.o.s.
Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).
European/International Regulations: Hazard Symbol: T, N; Risk phrases: (*as arsenic compound*) R45; R23/25; R50/53; R53; Safety phrases: S1/2; S20/21; S28; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Highly water polluting.

Description: Potassium arsenite is a white crystalline solid. Decomposes below Freezing/Melting point at 300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Human Data. Potassium metaarsenite is used in veterinary medicine; and for chronic dermatitis in man. Potassium arsenite reduces silver salt to metallic silver during mirror silvering. Currently, it is probably not being used for this purpose.

Incompatibilities: A weak base. Reacts with acids and decomposes on contact with strong acids producing acetic acid fumes. Arsine, a very deadly gas, can be released in the presence of acid or acid mist. Incompatible with alkaloidal salts, strong oxidizers, bromine azide, hypophosphites, sulfites in acid solution, iron salts, heavy metals and heavy metal compounds. Hydrogen gas can react with inorganic arsenic to form the highly toxic gas, arsine.

Permissible Exposure Limits in Air
OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018].
NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.
ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.
NIOSH IDLH: potential occupational carcinogen 5 mg [As]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.0533 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 14 mg/m^3
PAC-3: 26.7 mg/m^3
DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1.
Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on a daily average basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air: [60] 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (inorganic arsenic): #7300, #7301, #7303, #7900, #9102; OSHA Analytical Methods ID-105.

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic on a human health basis. EPA[61] has set a guideline for drinking water of 50 μg/L of arsenic.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can cause irritation with a burning sensation; itching. High exposure can cause loss of appetite; garlic or metallic taste; nausea, vomiting, and muscle cramps. May affect the central nervous system, digestive tract, circulatory system, causing loss of fluids and electrolytes; may cause collapse, shock, and death. Very toxic: probable oral lethal dose in humans is 50−500 mg/kg, or between 1 teaspoonful and 1 oz for a 150-lb adult. Nausea, vomiting, and diarrhea result from arsenic ingestion. Patient may go into collapse and shock with weak, rapid pulse, cold sweat, coma, and death. Exposure at low level may result in death.

Long Term Exposure: May cause liver damage, cirrhosis, jaundice. A skin allergen. Repeated or prolonged contact may cause skin sensitization. Itching or skin pigmentation changes may occur. May affect the peripheral nervous system, causing weakness in the hands and feet. May cause an ulcer in the inner nose, perforation of the nasal septum, and cirrhosis. This substance is carcinogenic to humans. Chronic arsenic poisoning may manifest itself by loss of appetite; cramps, nausea, constipation, or diarrhea.

Points of Attack: Liver, skin.

Medical Surveillance: Liver function testing. Examination of the nervous system. Examination of the nose, eyes, nails, and skin. Test for urine arsenic. Arsenic should not be greater than 100 μg/g of creatinine in the urine. Tests are most accurate at the end of a workday and may be inaccurate within 2 days of eating shellfish. If abnormal growths are detected on the skin, they can be easily cured when detected early.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where potassium arsenite is handled, used, or stored as required by OSHA Standard 29 CFR 1910.1018 for inorganic arsenic. Store in tightly closed containers in a cool, well-ventilated area away from acids, acid fumes, alkaloidal salts, strong oxidizers, bromine azide, hypophosphites, sulfites in acid solution, iron salts, heavy metals and heavy metal compounds. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Potassium arsenite (solid) requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid inhalation and skin contact. Dike far ahead of spill for later disposal. Do not touch spilled material; stop leak if you can do it without risk. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agents suitable for surrounding fire. Potassium arsenite itself does not burn. Keep unnecessary people away; stay upwind; keep out of low areas. Wear full protective clothing and self-contained breathing apparatus. Poisonous gases are produced in fire, including arsenic, phosgene, and potassium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Potassium Arsenite*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Potassium Arsenite*. Trenton, NJ

Potassium bromate P:0870

Molecular Formula: $BrKO_3$

Common Formula: $KBrO_3$

Synonyms: Bromato potasico (Spanish); Bromic acid, potassium salt

CAS Registry Number: 7758-01-2

RTECS® Number: EF8725000

UN/NA & ERG Number: UN1484/140

EC Number: 231-829-8 [*Annex I Index No.:* 035-003-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

California Proposition 65 Chemical: Cancer 1/1/90.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations: Hazard Symbol: T, O; Risk phrases: R45; R9; R25; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Potassium bromate is a white crystalline solid. Molecular weight = 167.01; Decomposes at 370°C; Freezing/Melting point = 350°C; also reported at 435°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. Potassium bromate is used as animal feed additive, food additive; flavor and packaging material; as a laboratory reagent; and oxidizing agent.

Incompatibilities: A strong oxidizer. Reacts violently with combustibles, organics, reducing agents, powdered metals, metal sulfides, carbon, sulfur, phosphorus, ammonium salts, oxidizers. Incompatible with aluminum, copper.

Permissible Exposure Limits in Air

AIHA WEEL: 0.1 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 60 mg/m^3

United Kingdom: carcinogen, 2000.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium bromate can affect you when breathed in and may enter the body through the skin. Skin and eye contact can cause irritation, and burns may occur with prolonged contact. Breathing the mist or dust can irritate the nose, throat, and bronchial tubes, causing sneezing and coughing. Overexposure can cause kidney damage. Ingestion may affect the gastrointestinal tract and central nervous system.

Long Term Exposure: This substance is possibly carcinogenic to humans. May affect the nervous system causing headache, irritability, impaired thinking, and personality changes. May cause kidney damage. May cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, kidneys, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Examination of the nervous system. Interview for brain damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to potassium bromate, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium bromate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and other incompatible materials listed above since violent reactions can occur. Protect storage containers against physical damage. Avoid storage on wood floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium bromate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use only water. Do not use chemical or carbon dioxide extinguishers. Poisonous gases are produced in fire, including bromine, potassium oxide, and oxygen, which increases fire hazard. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 70−71

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Potassium Bromate*. Trenton, NJ

Potassium chlorate P:0880

Molecular Formula: $ClKO_3$

Common Formula: $KClO_3$

Synonyms: Berthollet's salt; Chlorate de potassium (French); Chlorate of potash; Chloric acid, Potassium salt; Fekabit; Kaliumchlorat (German); Oxymuriate of potash; Pearl ash; Potash chlorate; Potassium (chlorate de) (French); Potassium oxymuriate; Potcrate; Salt of tartar

CAS Registry Number: 3811-04-9

RTECS$^®$ Number: FO0350000

UN/NA & ERG Number: UN2427 (solution)/140; UN1485 (solid)/140

EC Number: 223-289-7[017-004-00-3]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

FDA—over-the-counter drug.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Potassium chlorate is a white crystalline solid. Molecular weight = 122.55; Boiling point = decomposes below BP at 400°C; Freezing/Melting point = 360°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Human Data. Potassium chlorate is used in the manufacture of soap, glass, pottery, and many potassium salts; as an oxidizing agent, in explosives, matches, textile printing; disinfectants, and bleaching.

Incompatibilities: A strong oxidizer. Decomposes on heating above 400°C, on contact with strong acids producing toxic fumes including chlorine dioxide, chlorine fumes, and oxygen. Violent reaction with combustibles, oxidizers, strong acids, and reducing materials. Attacks many metals in the presence of water.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 12.5 mg/m^3
PAC-1: 40 mg/m^3
PAC-2: 300 mg/m^3
PAC-3: 350 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium chlorate can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Prolonged contact can cause eye and skin burns and possible permanent damage. Exposure lowers the ability of the blood to carry oxygen (methemoglobinemia). This can result in a bluish color to skin and lips, headache, dizziness, collapse, and even death. Breathing the dust or mist can cause nose and throat irritation with sneezing, coughing, and sore throat. High exposure may cause kidney damage.

Long Term Exposure: May cause lung damage; bronchitis may develop. Repeated exposures may affect the kidneys and central nervous system.

Points of Attack: Lungs, kidneys, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: A blood test for methemoglobin level. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to potassium chlorate, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium chlorate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Protect storage containers from physical damage. Avoid storage on wood floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Potassium chlorate requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II. Potassium chlorate, *aqueous solution*, requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use water spray only. Do not use dry chemical, halon, foam, or carbon dioxide extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (October 2004). *Hazardous Substances Fact Sheet: Potassium Chlorate*. Trenton, NJ

Potassium chloroplatinates P:0890

Molecular Formula: Cl_4K_2Pt (tetra-); Cl_6K_2Pt (hexa-)

Common Formula: K_2PtCl_4; K_2PtCl_6

Synonyms: *tetra-:* Dipotassium tetrachloroplatinate; Potassium tetrachloroplatinate(II); Tetrachlorodipotassium platinate

hexa-: Dipotassium hexachloroplatinate; Hexachlorodipotassium platinate*;* Hexachloroplatinate(2-) dipotassium; Platinic potassium chloride; Potassium chloroplatinate; Potassium hexachloroplatinate(IV); Potassium hexachloroplatinate(4 +); Potassium platinic chloride

CAS Registry Number: 16921-30-5 (*hexa-*); 10025-99-7 (*tetra-*)

RTECS® Number: PT1650000 (*hexa-*); TP1850000 (*tetra-*)

UN/NA & ERG Number: UN3290 [Toxic solid, corrosive, inorganic, n.o.s., (*Platinium (IV) potassium chloride*)]/154

EC Number: 240-979-3 [*Annex I Index No.:* 078-007-00-3] (dipotassium hexachloroplatinate); 233-050-9 [*Annex I Index No.:* 078-004-00-7] (dipotassium tetrachloroplatinate)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations (*hexa-*): Hazard Symbol: T; Risk phrases: R25; R41; R42/43; Safety phrases: S1/2; S22; S26; S36/37/39; S53; S45; (*tetra-*): Hazard Symbol: T; Risk phrases: R25; R38; R41; R42/43; Safety phrases: S2; S22; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Potassium tetrachloroplatinate(II), K_2PtCl_4 is a ruby-red crystalline solid and Potassium hexachloroplatinate (IV), K_2PtCl_6 is an orange-yellow solid. Molecular weight = 485.89 (*hexa-*); 415.09 (*tetra-*); Freezing/Melting point = (decomposes) at 250°C (*hexa-*). Hazard Identification (based on NFPA-704 M Rating System): (*hexa-*) Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: These materials are used in photography.

Permissible Exposure Limits in Air

OSHA PEL: 0.002 mg[Pt]/m^3 TWA

NIOSH REL: 0.002 mg[Pt]/m^3 TWA

ACGIH TLV®[1]: 1 0.002 mg[Pt]/m^3 TWA

NIOSH IDLH: 4 mg [Pt]/m^3

No TEEL available

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

Several states have set guidelines or standards for platinum in ambient air[60] ranging from 0.1 μg/m^3 (Nevada) to 0.4-20.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (North Dakota) to 330.0 μg/m^3 (Virginia).

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts)

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium chloroplatinates can affect you when breathed in. Severe allergy can develop to potassium chloroplatinates. Symptoms include asthma (with cough, wheezing, and/or shortness of breath), runny nose, and/or skin rash, sometimes with hives. If allergy develops, even small future exposure can trigger significant symptoms. Some persons exposed to this type of chemical have developed lung scarring. Family members can develop allergy to dust carried home on work clothing. It may irritate the eyes, nose, and throat. High exposure may cause irritability and even seizures.

Long Term Exposure: May cause skin sensitization and dermatitis and/or asthma-like allergy. Tetrachloroplatinates are mutagens.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray every 3 years should be considered if above tests are not normal. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (for soluble Pt salts): *Up to 0.05 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 4 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

* Substance cause eye irritation and damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solid, corrosive, inorganic, n.o.s., (*Platinium (IV) potassium chloride*) requires a shipping label of "POISONOUS/TOXIC MATERIALS, CORROSIVE." It falls in DOT/UN Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals may burn but do not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chlorides and potassium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Potassium Tetrachloroplatinate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Potassium Hexachloroplatinate*. Trenton, NJ

Potassium chromate P:0900

Molecular Formula: CrK_2O_4; $Cr_2K_2O_7$
Common Formula: K_2CrO_4; $K_2Cr_2O_7$
Synonyms: *chromate:* Bipotassium chromate; Chromate of potassium; Dipotassium chromate; Dipotassium monochromate; Neutral potassium chromate; Potassium chromate (VI); Tarapacaite
dichromate: Bichromate of potash; Chromic acid, dipotassium salt; Dipotassium dichromate; Iopezite; Kaliumdichromat (German); Potassium bichromate; Potassium dichromate(VI)
CAS Registry Number: 7789-00-6; 7778-50-9 (dichromate)
RTECS® Number: GB2940000 (chromate); HX7680000 (dichromate)
UN/NA & ERG Number: UN1479/140
EC Number: 232-140-5 [*Annex I Index No.:* 024-006-00-8]; 231-906-6 [*Annex I Index No.:* 024-002-00-6] (dichromate)
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.
US EPA Gene-Tox Program, Positive: SHE—clonal assay; *In vitro* cytogenetics—nonhuman; Positive: *B. subtilis* rec assay; Positive: CHO gene mutation (dichromate).
US EPA, FIFRA, 1998 Status of Pesticides: Supported.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as chromate; 0.1% as dichromate.
Water Pollution Standard Proposed (EPA).[6]
Hazardous Substance (EPA) (RQ = 1000/454).[4]
Priority Toxic Pollutant (EPA).[6]
As chromium compounds:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations (*chromate*): Hazard Symbol: T+, N; Risk phrases: R49; R46; R36/37/38; R43; R50/53; Safety phrases: S53; S45; S60; S61; (*dichromate*). Hazard Symbol: T+, N; Risk phrases: R45; R46; R60; R61; R8; R21; R25; R26; R34; R42/43;R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Potassium chromate(VI) is a yellow crystalline solid. Molecular weight = 194.20; Freezing/Melting point = 971°C. Soluble in water. Potassium dichromate(VI) is a yellowish-red crystalline solid. Molecular weight = 294.20; Boiling point = decomposition at 500°C; Freezing/Melting point = 398°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Potassium chromate is used in printing, photomechanical processing, chrome-pigment production, and wool preservative methods; to make dyes, pigments, inks, and enamels; as an oxidizing agent, analytical reagent; in electroplating, explosives.
Incompatibilities: A powerful oxidizer. Violent reactions with combustibles, organics, powdered metals, or easily oxidizable substances. Contact with hydrazine causes explosion.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.0187 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 56 mg/m^3
OSHA PEL: 0.1 mg[CrO_3]/m^3 Ceiling Concentration.
NIOSH REL: 0.001mg[CrO_3]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid; *tert*-butyl chromate; zinc chromate; and chromyl chloride) to be potential occupational carcinogens.
ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.
DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.
NIOSH IDLH: 15 mg[Cr(VI)]/m^3.
United Kingdom: carcinogen, 2000; the former USSR-UNEP/IRPTC joint project[43] give a MAC of 0.01 mg/m^3 in work-place air. Connecticut[60] has set a guideline of 0.25 μg/m^3 for chromium trioxide in ambient air; Sweden[35] for potassium chromate at 0.02 mg/m^3 as a TWA in work-place air. North Carolina[60] has set a guideline of zero for ambient air for both compounds.
7778-50-9 (dichromate)
Protective Action Criteria (PAC)
TEEL-0: 0.0141 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 42.4 mg/m^3
Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.
Permissible Concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. To protect human health, the limits are trivalent chromium (in chromates): 170 μg/L and hexavalent chromium (in dichromates) 50 μg/L.
Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by

colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium (VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μm filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium chromates can affect you when breathed in. It can also pass into inner layers of the skin. Eye contact can cause severe damage with possible loss of vision. Irritation of nose, throat, and bronchial tubes can occur, with cough and/or wheezing. Skin contact can cause severe irritation, deep ulcers, or an allergic skin rash.

Long Term Exposure: Potassium chromate is a human carcinogen. Potassium chromates can cause a sore or perforated nasal septum; with bleeding, discharge or crusting. May cause skin allergy. Can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: examination of the nose and skin. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Also, check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. (As chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 $\mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation, For *potassium dichromate*, Neoprene™ and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium chromates must be stored to avoid contact with combustible, organic, or other easily oxidized materials (such as paper, wood, sulfur, aluminum, hydrazine, and plastics) since violent reactions occur. A regulated, marked area should be established where potassium chromate is handled, used, or stored. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Oxidizing solid, n.o.s. requires a shipping label of "OXIDIZER." They fall in DOT Hazard Class 5.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. Keep potassium dichromate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chromium and potassium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 71−73 (1981) and 8, No. 5, 86−94 (1988) (Potassium Chromate)

New Jersey Department of Health and Senior Services. (September 1996). *Hazardous Substances Fact Sheet: Potassium Dichromate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Potassium Chromate*. Trenton, NJ

Potassium cyanide P:0910

Molecular Formula: CNK

Common Formula: KCN

Synonyms: Cianuro potasico (Spanish); Cyanide of potassium; Cyanure de potassium (French); Hydrocyanic acid, Potassium salt; Kalium-cyanid (German)

CAS Registry Number: 151-50-8

RTECS® Number: TS8750000

UN/NA & ERG Number: UN1680/157

EC Number: 205-793-3

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P098.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as cyanide compounds, inorganic, n.o.s.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Potassium cyanide is available as white lumps, granular powder, or colorless solution. It may be shipped as capsules, tablets, or pellets. Toxic hydrogen cyanide gas released by potassium cyanide has a distinctive, mild, bitter almond odor, but many people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. Molecular weight = 65.12; Specific gravity (H_2O:1) = 1.55 at 20°C; Boiling point = 1625°C; Freezing/Melting point = 633.9°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Soluble in water; solubility = 72% at 25°C.

Potential Exposure: Compound Description: Organometallic, Mutagen; Reproductive Effector; Human Data. Used in electroplating, steel hardening, extraction of precious metals form ores, as a fumigant, in insecticides, a reagent in analytical chemistry.

Incompatibilities: Potassium cyanide decomposes on contact with water, humidity, carbon dioxide, strong acids (such as hydrochloric, sulfuric, and nitric acids), and acid salts, producing highly toxic and highly flammable hydrogen cyanide gas. Potassium cyanide absorbs water from air (is hygroscopic or deliquescent); the aqueous solution is a strong base. Incompatible with organic anhydrides, isocyanates, alkylene oxides, epichlorohydrin, aldehydes, alcohols, glycols, phenols, cresols, caprolactum, strong oxidizers, nitrogen trichloride, sodium chlorate. Attacks aluminum, copper, zinc in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 5.3 mg/m^3

PAC-1: **5.3** mg/m^3

PAC-2: **19** mg/m^3

PAC-3: **40** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

NIOSH IDLH: 25 mg[CN]/m^3.

Skin contact may contribute significantly in overall exposure. Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg [CN]/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 mg/m^3 [skin]. Russia[43] has set a MAC value of 0.009 mg/m^3 for ambient air in residential areas on a momentary basis and 0.004 mg/m^3 on a daily average basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μg/m^3 (New York) to 50.0 μg/m^3 (Florida and North Dakota) to 80.0 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut and South Dakota) to 125 μg/m^3 (South Carolina) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide.[18]

Permissible Concentration in Water: In 1976 the EPA criterion was 5.0 μg/L for freshwater and marine aquatic life and wildlife. As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for man is 8.4 mg/day.[6] On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L, and Germany 50 μg/L as drinking water standards. Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters; and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes. The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Potassium cyanide is corrosive to the eyes, skin, and the respiratory tract. Contact can cause skin and eye burns, and possible permanent eye damage. Inhalation can cause lung irritation with coughing, sneezing, and difficult breathing; slow gasping respiration. Corrosive if swallowed. These substances may affect the central nervous system. Symptoms include headaches, confusion, nausea, pounding heart, weakness, unconsciousness, and death.

Long Term Exposure: Repeated or prolonged contact with potassium cyanide may cause thyroid gland enlargement and interfere with thyroid function. May cause nosebleed and sores in the nose; changes in blood cell count. May cause central nervous system damage with headache, dizziness, confusion; nausea, vomiting, pounding heart, weakness in the arms and legs, unconsciousness, and death. May affect liver and kidney function.

Points of Attack: Liver, kidneys, skin, cardiovascular system, central nervous system, thyroid gland.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep under observation for 24−48 h as symptoms may return. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be

worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. *Note to physician:* For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care. *Note to physician:* For severe poisoning BAL [British Anti-Lewisite, Dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, acid salts, oxidizers, light, and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Potassium cyanide require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. This chemical has a lower explosive limit; ventilate closed spaces before entering them. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances: Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line). UN 1680 (Potassium cyanide) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: KCN is not combustible itself but it decomposes in the presence of moisture, damp air, or carbon dioxide, producing highly toxic and flammable hydrogen cyanide gas and oxides of nitrogen. NO acidic dry chemical extinguishers. NO hydrous agents. NO water. NO carbon dioxide. Use dry chemical and foam on surrounding fires. Vapors are heavier than air and may collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not allow water to enter open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 h. Then flush to sewer with large volumes of water.[22]

Reference

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Potassium Cyanide*. Trenton NJ

Potassium dichloro-isocyanurate P:0920

Molecular Formula: $C_3Cl_2KN_3O_3$

Common Formula: $KCl_2(NCO)_3$

Synonyms: ACL-59; Dichloroisocyanuric acid, potassium salt; Dichloro-*s*-triazine-2,4,6(1H,3H,5H)-trione potassium deriv; 1,3-Dichloro-*s*-triazine-2,4,6(1H,3H,5H)trione potassium salt; Dichlor-*s*-triazin-2,4,6(1H,3H,5H)trione potassium; Isocyanuric acid, dichloro-, potassium salt; Potassium dichloro-*s*-triazinetrione; Potassium troclosene; *s*-Triazine-2,4,6(1H,3H,5H)-trione, dichloro-, potassium deriv; 1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro-, potassium salt; Troclosene potassium

CAS Registry Number: 2244-21-5

RTECS® Number: XZ1850000

UN/NA & ERG Number: UN2465 (Dichloroisocyanuric acid salts)/140

EC Number: 218-828-8 [*Annex I Index No.*: 613-030-00-X]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R31; R36/37; R50/53; Safety phrases: S2; S8; S26; S41; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Potassium dichloroisocyanurate is a white crystalline solid with a chlorine odor. Molecular weight = 237.07; Freezing/Melting point = (decomposes) 250°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2. Oxidizer. Reacts with water; Slightly soluble; solubility = 10−50 mg/mL at 20°C.[NTP]

Potential Exposure: Potassium dichloroisocyanurate is used in household bleaches, dishwashing compounds, and detergents.

Incompatibilities: A strong oxidizer; violent reaction with reducing agents, combustibles, organics, easily chlorinated or oxidized materials, ammonia, urea, other nitrogen compounds, calcium hypochloride, other alkalies, and moisture.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium dichloroisocyanurate can affect you when breathed in. Exposure can severely irritate the eyes. It can also irritate the nose, throat, and air passages. Contact can cause skin and eye irritation.

Long Term Exposure: May cause lung irritation and damage.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to potassium dichloroisocyanurate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing

apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.
Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustibles (like wood, paper, and oil), ammonia, urea, other nitrogen compounds, calcium hypochlorite, other alkalis, and moisture. Do not store on wooden floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.
Shipping: Dichloroisocyanuric acid, dry requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. *Do not use water*. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Potassium dichloroisocyanurate is not flammable. Potassium dichloroisocyanurate is a strong oxidizer and a dangerous fire hazard on contact with combustibles (such as wood, paper, and oil). Poisonous gases are produced in fire, including chlorine gas, potassium oxide, and oxides of nitrogen. Use dry chemical, or CO_2 extinguishers. Use water to keep fire-exposed containers cool. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2002). *Hazardous Substances Fact Sheet: Potassium Dichloroisocyanurate*. Trenton, NJ

Potassium ferrocyanide P:0930

Molecular Formula: $C_6K_4N_6Fe$
Common Formula: $K_4Fe(CN)_6$
Synonyms: Ferrate(4-), hexacyano-, tetrapotassium; Ferrate (4-), hexakis(cyano-C)-, tetrapotassium, (OC-6-11)-; Potassium ferrocyanate; Potassium ferrocyanide; Potassium hexacyanoferrate; Potassium hexacyanoferrate(II); Tetrapotassium ferrocyanide; Tetrapotassium hexacyanoferrate; Tetrapotassium hexacyanoferrate(II); Tetrapotassium hexacyanoferrate(4-)
CAS Registry Number: 13943-58-3
RTECS® Number: LI8219000
UN/NA & ERG Number: Not regulated.
EC Number: 237-722-2

Regulatory Authority and Advisory Bodies

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Tetrapotassium hexacyanoferrate is a lemon-yellow crystalline solid. Molecular weight = 368.37; Boiling point = (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 2.
Potential Exposure: Used in dyeing, tempering steel, explosives, process engraving, and lithography.
Incompatibilities: Acids or acid fumes may cause release of highly toxic cyanide fumes. Reacts violently with ammonia, copper nitrate; sodium nitrite or chromate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 11.8 mg/m^3

PAC-1: 35.4 mg/m^3
PAC-2: 59 mg/m^3
PAC-3: 59 mg/m^3
OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.
NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min Ceiling Concentration.
ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.
NIOSH IDLH: 25 mg[CN]/m^3.

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for man is 8.4 mg/day.[6] On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L and Germany 50 μg/L as drinking water standards. Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes. The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Insufficient data are available on the effect of this substance on human health. However, this is a cyanide compound; therefore, utmost care must be taken. May cause eye irritation. May be harmful if swallowed. Animal studies suggest that the lethal dose is 4−8 oz for an adult.

Long Term Exposure: No information available.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved half-face, dust/mist respirator. *For emergencies or instances where the exposure levels are not known*, use a full-face positive-pressure, air-supplied respirator operated in the positive-pressure mode, or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode. *Note:* Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store away from incompatible materials listed above. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Potassium Ferrocyanide*. Albany, NY: Bureau of Toxic Substance Assessment

Potassium fluoride P:0940

Molecular Formula: FK

Common Formula: KF

Synonyms: Fluorure de potassium (French); Potassium fluorure (French)

CAS Registry Number: 7789-23-3

RTECS® Number: TT0700000

UN/NA & ERG Number: UN1812/154

EC Number: 232-151-5 [*Annex I Index No.*: 009-005-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Potassium fluoride is a white crystalline solid. Molecular weight = 58.10; Boiling point = 1505°C; Freezing/Melting point = 860°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Potassium fluoride is used in etching glass, as a preservative, and as an insecticide.

Incompatibilities: Strong acids.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 7.65 mg/m^3

PAC-1: 7.65 mg/m^3

PAC-2: 30 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Russia[43] has set a MAC value of 0.03 mg/m^3 for soluble fluorides in ambient air in residential areas on a momentary basis and 0.01 mg/m^3 on a daily average basis. Several states have set limits for fluoride in ambient air[60] ranging from as low as 2.85 μg/m^3 (Iowa) to as high as 60,000 μg/m^3 (Kentucky). The reader is referred to the entry on "Fluorides" for more detail.

Permissible Concentration in Water: Fluoride is a safe drinking water act-regulated chemical (47FR9352, 56FR 3594); MCL = 4.0 mg/L; MCLG = 4.0 mg/L; SMCL = 2.0 mg/L. The state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium fluoride can affect you when breathed in. Inhalation of dust or mist can cause severe irritation and burns of the eyes and skin. May cause permanent eye damage. Inhalation can cause irritation of the nose and throat causing sneezing, coughing, and sore throat. High exposure can irritate the lungs, causing a buildup of fluid in the lungs. This can cause death.

Long Term Exposure: These effects do not occur at the levels of fluorides used in water to prevent cavities. Repeated exposure can cause fluoride to buildup in the body. Can irritate the lungs; bronchitis may develop. Repeated exposure can cause fluoride to build up in the body causing stiffness, brittle bones, and crippling. Prolonged contact can cause sores in the nose and perforated septum.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium fluoride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) since violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including potassium oxide and fluorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Potassium Fluoride*. Trenton, NJ

Potassium hydroxide P:0950

Molecular Formula: HKO
Common Formula: KOH
Synonyms: Caustic potash; Hidroxido potasico (Spanish); Hydroxide de potassium (French); Kaliumhydroxid (German); KOH; LYE; Potassa; Potasse caustique (French); Potassium hydrate; Potassium (hydrixyde de) (French)
CAS Registry Number: 1310-58-3
RTECS® Number: TT2100000
UN/NA & ERG Number: UN1813 (solid)/154; UN1814 (solution)/154
EC Number: 215-181-3 [*Annex I Index No.:* 019-002-00-8]
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 1000 lb (454 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Potassium hydroxide is a white deliquescent solid. Molecular weight = 56.11; Specific gravity (H_2O:1) = 2.04 at 25°C; Boiling point = 1324°C; Freezing/Melting point = 380°C; also reported at 405°C (varies with water content). Hazard Identification (based on NFPA-704 M Rating System) (*45%*): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility = 107% at 15°C; reaction.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Primary Irritant. Used in the manufacture of other potassium compounds and in the general use of KOH as an alkali.

Incompatibilities: A strong base. Violent reaction with acids, water, metals (when wet), halogenated hydrocarbons, maleic anhydride. Heat is generated if KOH comes in contact with water and carbon dioxide from the air. Corrosive to zinc, aluminum, tin, and lead in the presence of moisture, forming a combustible/explosive hydrogen gas. Can absorb water from air and give off sufficient heat to ignite surrounding combustible materials.

Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 2 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 2 mg/m^3 Ceiling Concentration.
Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 125 mg/m^3
Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: STEL 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3, 1999; Japan: STEL 2 mg/m^3, 1999; Norway: TWA 2 mg/m^3, 1999; the Netherlands: MAC 2 mg/m^3, 2003; Switzerland: MAK-W 2 mg/m^3, 1999; United Kingdom: STEL 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 2 mg/m^3. Several states have set guidelines or standards for KOH in ambient air[60] ranging from 16.0 μg/m^3 (Virginia) to 20 μg/m^3 (North Dakota) to 48 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7401, alkaline Dusts.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Potassium hydroxide can affect you when breathed in. Potassium hydroxide is highly corrosive. Eye contact causes immediate severe burns and can lead to blindness. Skin contact causes severe skin burns. Exposure can irritate the nose, throat, and airways, causing sneezing, coughing, and sores in the nose. Higher levels can irritate the lungs and cause a buildup of fluid (pulmonary edema). This can cause death. Ingestion may be fatal; causes epigastrium, hermatemesis, collapse, and stricture of esophagus.

Long Term Exposure: May cause sores in the nose and perforation of the nasal septum. May cause lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 45 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For solutions of 30−70%, natural rubber; Neoprene™, nitrile, nitrile + PVC, Neoprene™ + natural rubber, and polyethylene are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, or wear dust-proof goggles and face shield when working with powders or dusts unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 2 mg/m^3, use a NIOSH/MSHA- or European Standard EN 149-approved full-face-piece respirator with a high-efficiency particulate filter. More protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White Stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium hydroxide must be stored to avoid contact with water or moisture and metals since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, explosives, combustible materials, and organic peroxides. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Potassium hydroxide, solid or solution, requires a shipping label of "CORROSIVE." The solid falls in DOT Hazard Class 8 and Packing Group II. The solution falls in DOT Hazard Class 8 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium hydroxide may ignite surrounding material if it absorbs water. Extinguish fire using an agent suitable for type of surrounding fire. Potassium hydroxide itself does not burn. Poisonous gases are produced in fire, including potassium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilute with large volume of water, neutralize and flush to sewer.[22]

Reference

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Potassium Hydroxide*. Trenton, NJ

Potassium nitrate P:0960

Molecular Formula: KNO_3

Synonyms: Kaliumnitrat (German); Niter; Nitre; Nitric acid, potassium salt; Saltpeter; Vicknite

CAS Registry Number: 7757-79-1

RTECS® Number: TT3700000

UN/NA & ERG Number: UN1486/140

EC Number: 231-818-8

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Potassium nitrate is an odorless, white or colorless crystalline powder with a salty taste. Molecular weight = 179.31; Boiling point = (decomposes) 400°C; Freezing/Melting point = 334°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3 (Oxidizer). Highly soluble in water; solubility = 36% at 25°C.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector. Used to make explosives, gunpowder, fireworks, rocket fuel, matches, fertilizer, fluxes, glass manufacture; and as a diuretic.

Incompatibilities: A powerful oxidizer. Dangerously reactive and friction- and shock-sensitive when mixed with organic materials and many materials. Violent reactions with reducing agents, chemically active metals, charcoal, trichloroethylene.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.4 mg/m^3
PAC-1: 1.25 mg/m^3
PAC-2: 7.5 mg/m^3
PAC-3: 500 mg/m^3
Russia: STEL 5 mg/m^3, 1993.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause eye and skin irritation. Inhalation can cause respiratory tract irritation, coughing, and wheezing. High levels of exposure can interfere with the blood's ability to carry oxygen, causing headache, dizziness, cyanosis, methemoglobinemia, with blue color to the skin and lips. Higher levels can cause breathing difficulty, collapse, and death.

Long Term Exposure: There is limited evidence that this chemical can damage the developing fetus.

Points of Attack: Blood.

Medical Surveillance: Blood test for methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all other materials. Do not store on wooden floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations. See also 29 CFR 1910.101 for specific regulations on storage of compressed gas cylinders.

Shipping: Potassium nitrate requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Potassium Nitrate*. Trenton, NJ

Potassium nitrite P:0970

Molecular Formula: KNO_2

Synonyms: Kaliumnitrat (German); Niter; Nitre; Nitrous acid, Potassium salt; Saltpeter; Vicknite

CAS Registry Number: 7758-09-0

RTECS® Number: TT3750000

UN/NA & ERG Number: UN1488/140

EC Number: 231-832-4 [*Annex I Index No.*: 007-011-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R22; R35; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Potassium nitrite is a white to yellowish crystalline solid. Molecular weight = 85.11; Boiling point = decomposition starts at 350°C; explosion at 535°C; Freezing/Melting point = 441°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 2 (Oxidizer). Soluble in water; solubility = 280 g/100 mL.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Human Data. Potassium nitrite is used in chemical analysis, as a food additive; in fertilizers; in medications as a vasodilator and as antidote for cyanide poisoning.

Incompatibilities: A strong oxidizer. Reacts violently with combustible and reducing materials. Heat above 530°C may cause explosion. Incompatible with cyanide salts; boron, ammonium sulfate, potassium amide, and acids. Decomposes on contact with even weak acids, producing toxic nitrogen oxide fumes.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.04 mg/m^3

PAC-1: 0.1 mg/m^3

PAC-2: 0.75 mg/m^3

PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium nitrite can affect you when breathed in. Contact can cause eye and skin burns. Breathing the dust or mist can irritate the nose, throat, and lungs, and may cause cough with phlegm. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High levels can affect the vascular system and interfere with the ability of the blood to carry oxygen (methemoglobinemia), causing headaches, weakness, dizziness, and cyanosis, a bluish color to the skin and lips. Higher levels can cause troubled breathing, collapse, and even death.

Long Term Exposure: Repeated skin contact causes dermatitis, drying, and cracking. May cause lung irritation; bronchitis may develop. There is limited evidence that potassium nitrite may damage the developing fetus.

Points of Attack: Eyes, skin, blood, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin. Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to potassium nitrite, use a NIOSH/MSHA- or European

Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, cyanide salts, boron, ammonium sulfate, and potassium amide. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Potassium nitrite requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium nitrite out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not burn but may ignite other combustible materials. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Potassium Nitrite*. Trenton, NJ

Potassium permanganate P:0980

Molecular Formula: $KMnO_4$

Synonyms: Cairox; Chameleon mineral; C.I. 77755; Condy's crystals; Kaliumpermanganat (German); Permanganic acid, potassium salt; Permanganate de potassium (French); Permanganate of potash; Permanganato potasico (Spanish); Potassium (permanganate de) (French); Purple salt

CAS Registry Number: 7722-64-7

RTECS® Number: SD6475000

UN/NA & ERG Number: UN1490/140

EC Number: 231-760-3 [*Annex I Index No.:* 025-002-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

US EPA Gene-Tox Program, Negative: *In vitro* cytogenetics—nonhuman; *N. crassa*—reversion; Negative: *B. subtilis* rec assay.

US EPA, FIFRA 1998 Status of Pesticides: Pesticide subject to registration or re-registration.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: O, Xn, N; Risk phrases: R8; R22; R36/37/38; R42/43; Safety phrases: S2; S22; S24; S26; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Potassium permanganate is a dark purple crystalline solid. Molecular weight = 158.04; Freezing/Melting point = (decomposition, with evolution of oxygen) <240°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Highly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Potassium permanganate is used in solutions as a disinfectant, topical antibacterial agent; deodorizer, bleaching agent; and in air and water purification.

Incompatibilities: Potassium permanganate is a powerful oxidizing agent, that is, it will initiate a fire or explosion if brought into contact with reducing materials, combustibles, organic materials; strong acids; or oxidizable solid, liquid, or gas; glycerine, ethylene glycol, polypropylene, hydroxylamine, hydrogen trisulfide, antimony, arsenic, sulfuric acid, hydrogen peroxide, phosphorus, and any finely divided combustible material. It will decompose, and release oxygen if brought into contact with heat, alcohol, acids, ferrous salts, iodides and oxalates.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration.

NIOSH: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL.

ACGIH TLV®[1]: TWA 0.2 mg[Mn]/m^3, inorganic compounds.

NIOSH IDLH: 500 mg[Mn]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.575 mg/m^3

PAC-1: 8.63 mg/m^3

PAC-2: 14.4 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C.

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 0.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg[Mn]/m^3, short-term exposure limit 0.6 mg[Mn]/m^3, 1993; Japan: 0.3 mg[Mn]/m^3, respirable dust, 1999; Poland: MAC (TWA) 0.3 mg[Mn]/m^3; MAC 5 mg[Mn]/m^3, 1999; Sweden: NGV 1 mg[Mn]/m^3, KTV 2.5 mg[Mn]/m^3 (respirable dust), 1999; Sweden: NGV 2.5 mg[Mn]/m^3, KTV 5 mg[Mn]/m^3 (total dust), 1999; United Kingdom: LTEL 5 mg[Mn]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Mn]/m^3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Irritates the respiratory tract, causing coughing and chest tightness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Concentrated solutions may cause severe irritation and burns. Dilute solutions can cause brown staining of the skin and hardening of outer skin layer. Penetration is poor. *Eyes:* Concentrated solution or crystalline material can cause severe irritation and damage that may be permanent. *Ingestion:* Dilute solutions (1%) may cause burning of the throat, nausea, vomiting, and stomach pain. Concentrations of 2–3% may cause anemia and swelling of the throat with a possibility of suffocation. More concentrated solutions may result in above symptoms plus the onset of kidney damage and circulatory collapse. The probable lethal dose is 1½ teaspoons (10 g) for a 150-lb (70 kg) adult.

Long Term Exposure: May cause mutations and might pose a cancer risk or reproduction hazard. May cause lung effects.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests (for manganese and fume): whole blood (chemical/metabolite); biologic tissue/biopsy; Complete blood count; chest X-ray; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine). For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give egg whites and milk. A tracheotomy may be required if swelling in throat blocks air. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium permanganate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), any organic material, or any other combustible or oxidizable solid, liquid, or gas since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect containers from physical damage. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Potassium permanganate requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Liquid:* Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Dry material:* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. *Large spills:* Clean up should be performed by trained personnel. Cover the weak reducing agents, such as sodium thiosulfate, bisulfites, or ferrous salts. Bisulfites or ferrous salts need an additional promoter of three molar sulfuric acids to accelerate reaction. Transfer slurry or sludge to large container of water and neutralize with soda ash. Keep potassium permanganate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium permanganate does not burn. However, it is a powerful oxidizer. Potassium permanganate decomposes at 240°C/464°F and releases oxygen which will greatly intensify an ongoing fire. Use dry chemical or carbon dioxide extinguishers. Poisonous gases are produced in fire, including potassium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with reducing agent, neutralize and flush to sewer.[22]

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report*, 8, No. 4, 2–12

New Jersey Department of Health and Senior Services. (February 1986). *Hazardous Substances Fact Sheet: Potassium Permanganate*. Version 2 and 3. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 2002). *Hazardous Substances Fact Sheet: Potassium Permanganate*. Trenton, NJ

Potassium persulfate P:0990

Molecular Formula: $K_2O_8S_2$

Common Formula: $K_2S_2O_8$

Synonyms: Anthion; Dipotassium peroxodisulphate; Dipotassium persulfate; Potassium persulphate; Potassium peroxydisulphate; Potassium peroxydisulfate; Peroxydisulfuric acid, Disodium salt

CAS Registry Number: 7727-21-1

RTECS$^{®}$ Number: SE0400000

UN/NA & ERG Number: UN1492/140

EC Number: 231-781-8 [*Annex I Index No.:* 016-061-00-1] [dipotassium peroxodisulphate]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R8; R22; R36/37/38; R42/43; Safety phrases: S2; S22; S24; S26; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Potassium persulfate is a colorless or white, odorless crystalline material. Molecular weight = 272.34; Boiling point = 109.5°C; Freezing/Melting point = (decomposes) $<100°C$. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3. Oxidizer. Soluble in water.

Potential Exposure: Potassium persulfate is used as a bleaching and oxidizing agent; it is used in redox polymerization catalysts; in the defiberizing of wet strength paper and in the desizing of textiles. Soluble in water.

Incompatibilities: A strong oxidizer. Combustible, organic or other readily oxidizable materials, sulfur, metallic dusts, such as aluminum dust, chlorates, and perchlorates. Attacks chemically active metals. Keep away from moisture.

Permissible Exposure Limits in Air

ACGIH: 0.1 mg $[S_2O_8]/m^3$ TWA *as persulfates*.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 350 mg/m^3

Permissible Concentration in Water: No criteria set. (Aqueous solution decomposes even at room temperature).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium persulfate can affect you when breathed in. Breathing the dust or mist can cause eye, nose, and throat irritation with sneezing, coughing, and sore throat. Contact with skin and eyes can cause burns and permanent damage. Prolonged or repeated exposures may lead to sores of the inner nose. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause sores of the inner nose. Skin contact may cause skin rash, with dryness and cracking. May cause lung irritation.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA- or European Standard EN 149-approved dust mask when dust is encountered. Where there is potential for exposures *over 5 mg/m³*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium persulfate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong oxidizers (such as chlorine, bromine, and fluorine), and chemically active metals (such as potassium, sodium, magnesium, and zinc) since violent reactions occur. Protect storage against physical damage. Store in tightly closed containers in a cool, well-ventilated area away from moisture. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Potassium persulfate requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium persulfate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including oxides of sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volumes of reducing agents (e.g., bisulfites). Neutralize with soda ash and drain into sewer with abundant water.

Reference

New Jersey Department of Health and Senior Services. (May 1986). *Hazardous Substances Fact Sheet: Potassium Persulfate*. Trenton, NJ

Potassium silver cyanide P:1000

Molecular Formula: AgC_2KN_2

Common Formula: $KAg(CN)_2$

Synonyms: Cianuro de plata y potasio (Spanish); Dicyano potassium argentate; Potassium dicyanoargentate; Silver potassium cyanide

CAS Registry Number: 506-61-6

RTECS® Number: TT5775000

UN/NA & ERG Number: UN1588/157

EC Number: 208-047-0 (potassium dicyanoargentate)

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P099.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): $X + CN^-$ where $X = H^+$ or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, Cyanide compounds, inorganic, n.o.s.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Silver compounds:

Clean Water Act: Section 307 Toxic Pollutants as silver and compounds.

RCRA Section 261 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Potassium silver cyanide is a white crystalline solid. Molecular weight = 199.01; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Potassium silver cyanide is used in silver plating; as a bactericide; and in the manufacture of antiseptics. Not registered as a pesticide in the United States.

Incompatibilities: Contact with acid, acid fumes, water, steam, or when heated to decomposition emits toxic and flammable cyanide vapors. May be light sensitive.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

NIOSH IDLH: 25 mg[CN]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0184 mg/m^3

PAC-1: 2.5 mg/m^3
PAC-2: 18.4 mg/m^3
PAC-3: 18.4 mg/m^3
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide.[18]

Permissible Concentration in Water: In 1976 the EPA criterion was 5.0 μg/L for freshwater and marine aquatic life and wildlife. As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for man is 8.4 mg/day.[6]

On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L, and Germany 50 μg/L as drinking water standards. Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters; and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes.

The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: The primary health hazard is as a cyanide. It is poisonous and may be fatal if inhaled, swallowed, or absorbed through the skin. Fire may produce irritating or poisonous gases. As a cyanide, massive doses may produce, without warning, sudden loss of consciousness and prompt death from respiratory arrest. Smaller but still lethal doses result in illness that may be prolonged for one or more hours. Other symptoms may include numbness in throat, salivation, nausea, anxiety, dizziness, irregular breathing, odor of bitter almonds may be noted on breath, blood pressure may rise, slowing of the heartbeat, sensation of constriction in the chest, unconsciousness followed by violent convulsions and paralysis. LD_{50} = (oral-rat) 21 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Cyanides, inorganic, solid, n.o.s. require a shipping label of “POISONOUS/TOXIC MATERIALS.” They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered

material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam for *small fire*s; and water spray, fog, or foam for *large fires*. Move containers of this material away from fire area if this can be done without risk. Isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Fight fire from maximum distance. Dike fire control water for later disposal. Do not scatter the material. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Potassium Silver Cyanide*. Washington, DC: Chemical Emergency Preparedness Program

Potassium sulfide P:1010

Molecular Formula: K_2S

Synonyms: Dipotassium monosulfide; Dipotassium sulfide; Hepar sulfurous; Potassium monosulfide

CAS Registry Number: 1312-73-8

RTECS® Number: TT6000000 (anhydrous); TT6008000 (hydrated)

UN/NA & ERG Number: UN1382 (anhydrous)/135; UN1847 (hydrated)/153

EC Number: 215-197-0 [*Annex I Index No.:* 016-006-00-1]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: C; Risk phrases: R31; R34; R50; Safety phrases: S1/2; S26; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Potassium sulfide is a brownish-red crystalline solid. Molecular weight = 110.26; Freezing/Melting point = 840°C. Soluble in water.

Potential Exposure: Potassium sulfide is used as a reagent in analytical chemistry; and in pharmaceutical preparations.

Incompatibilities: May explosively decompose from shock, friction, or concussion. May spontaneously ignite on contact with air. The aqueous solution is a strong base; reacts violently with strong acids and acid fumes. The solid material decomposes on contact with acids producing hydrogen sulfide, and oxidizers producing sulfur dioxide.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Potassium sulfide can affect you when breathed in. Breathing the dust or mist can irritate the eyes, nose, and throat with sneezing, coughing, and sore throat. Potassium sulfide is a corrosive chemical and contact with skin and eyes can cause burns. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Corrosive materials can cause lung problems; bronchitis may develop. Prolonged exposure can lead to sores or ulcers of the inner lining of the nose.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to potassium sulfide use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposures and liquid potassium sulfide, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Potassium sulfide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where potassium sulfide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Protect storage against physical damage.

Shipping: Anhydrous potassium sulfide requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.2 and Packing Group II. Potassium sulfide, hydrated with not <30% water of crystallization requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen sulfide and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Potassium Sulfide*. Trenton, NJ

Procarbazine & procarbazine hydrochloride P:1020

Molecular Formula: $C_{12}H_{19}N_3O$

Common Formula: $CH_3NHNHCH_2C_6H_4CONHCH(CH_3)_2$

Synonyms: Ibenzmethyzine; 2-(*p*-Isopropyl carbamoyl benzyl)-1-methylhydrazine; *N*-Isopropyl-α-(2-methylhydrazino)-*p*-toluamide N isopropyl; Matulane; 4-[(2-Methylhydrazino)methyl]-*N*-isopropylbenzamide; 1-[Methyl-2-(-isopropylcarbamoyl)benzyl]hydrazine; MIH; Natulan; NSC-77213; PCB; RO 4-6467

hydrochloride: Ibenzmethyzine hydrochloride; Ibenzmethyzin hydrochloride; IBZ; 1-(*p*-Isopropylcarbamoylbenzyl)-2-methylhydrazine hydrochloride; 2-[*p*-(Isopropylcarbamoyl)benzyl]-1-methylhydrazine hydrochloride; *N*-Isopropyl-*p*-(2-methylhydrazinomethyl)benzamidehydrochloride; *N*-Isopropyl-α-(2-methylhydrazino)-*p*-toluamide hydrochloride; Matulane; MBH; *N*-(1-Methylethyl)-4-[(2-methylhydrazino)methyl]benzamide monohydrochloride; *p*-(*N*′-Methylhydrazinomethyl)-*N*-isopropylbenzamide hydrochloride; 1-Methyl-2-*p*-(isopropylcarbamoyl)-benzohydrazine hydrochloride; 1-Methyl-2-(*p*-isopropylcarbamoylbenzyl)hydrazine hydrochloride; MIH hydrochloride; Nathulane; Natulan; Natulanar; Natulan hydrochloride; NCI-C01810; NSC-77213; PCBhydrochloride; Procarbazin (German); RO 4-6467

CAS Registry Number: 671-16-9; 366-70-1 (hydrochloride)

RTECS® Number: XS4550000; XS472000 (hydrochloride)

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 211-582-2; 206-678-6 (hydrochloride)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: (hydrochloride) Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1998; NTP: Reasonably anticipated to be a human carcinogen; NTP: Report on Carcinogens, 2004; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat 1979.

California Proposition 65 Chemical: Cancer (methylhydrazine and its salts) 7/1/92; (procarbazine) 1/1/88; (procarbazine hydrochloride) cancer 1/1/88; Developmental/Reproductive toxin 7/1/90.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Procarbazine is a white to pale yellow crystalline powder with a slight odor. Molecular weight = 221.34. The hydrochloride has a similar description. Molecular weight = 257.80; Freezing/Melting point = 223−236°C (hydrochloride). Soluble in water.

Potential Exposure: Procarbazine is available in capsule form. The primary use of this drug is as an antineoplastic agent in the treatment of advanced Hodgkin's disease and oat-cell carcinoma of the lung. The hydrochloride compound is used in treatment. The FDA approved use of procarbazine hydrochloride in 1969 and indicated that the drug should be used as an adjunct to standard therapy. Possible exposure occurs during manufacture of the drug and direct exposure during its subsequent administration to patients. Some of the metabolites of procarbazine hydrochloride are both carcinostatic and carcinogenic.

Incompatibilities: When heated to decomposition, it produces hydrogen chloride and nitrogen oxides. Incompatible with strong acids, strong alkalies.

Permissible Exposure Limits in Air: No standard set.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Laboratory exposure of animals to procarbazine was studied by IP (intraperitoneal) injection. In rats, malignant lymphoma, adenocarcinoma of the mammary gland, and olfactory neuroblastomas were induced in statistically significant numbers. In mice, malignant lymphoma or leukemia, olfactory neuroblastomas, alveolar/bronchiolar adenoma, and adenocarcinoma of the uterus were induced in statistically significant numbers. Can cause nausea, vomiting, diarrhea, stomach pain, loss of appetite, and weight loss. Symptoms of exposure include[52]: nausea, vomiting, anorexia, dry mouth, dysphagia, diarrhea, constipation, chills and fever, sweating, weakness, edema, cough, dermatitis, jaundice, headache, insomnia, coma.

Long Term Exposure: A probable human carcinogen. There is some evidence that it causes cancer of the nervous system, blood-forming organs, breast, lung, uterus, and blood or bone marrow in humans. It has been shown to cause cancer in the same sites in animals. May damage the testes. The hydrochloride is a teratogen in animals and may decrease the body's ability to produce blood cells, causing reduced white blood cells with increased infection and general weakness, reduced platelets, causing bleeding when cut or bruised, and/or reduced blood cells (anemia).

Points of Attack: Blood.

Medical Surveillance: Complete blood count (CBC).

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or mild to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Dampen spilled material with water to avoid dust, than transfer material to a suitable container. Use absorbent dampened with water to pick up remaining material. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Cancer Institute. (1979). *Bioassay of Procarbazine for Possible Carcinogenicity*, DHHS Publication No. (NIH) 79-819. Springfield, VA: National Technical Information Service

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Procarbazine Hydrochloride*. Trenton, NJ

Promecarb P:1030

Molecular Formula: $C_{12}H_{17}NO_2$

Common Formula: $C_6H_3(CH_3)(OCONHCH_3)CH(CH_3)_2$

Synonyms: Carbamic acid, methyl-, *m-cym*-5-yl ester; Carbamic acid, 3-methyl-5-(1-methylethyl)phenyl-, methyl ester; Carbamic acid, *N*-methyl-, 3-methyl-5-isopropropylphenyl ester; Carbamult; Carbanilic acid, 3-isopropyl-5-methyl-, methyl ester; *m-cym*-5-yl-methylcarbamate; ENT27,300; ENT 27,300-A; EP316; 3-Isopropyl-5-methylcarbamic acid methyl ester; 3-Isopropyl-5-methylphenyl *N*-methylcarbamate; 5-Isopropyl-*m*-tolyl methyl-carbamate; Methylcarbamic acid *m-cym*-5-yl ester; *N*-Methylcarbamic acid 3-methyl-5-isopropylphenyl ester; 5-Methyl *m*-cumenyl methylcarbamate; 3-Methyl-5-isopropyl-*N*-methyl carbamate; (3-Methyl-5-isopropylphenyl)-*N*-methylcarbamat (German); 3-Methyl-5-isopropylphenyl-*N*-methyl carbamate; 3-Methyl-5-(1-methylethyl)phenol methylcarbamate; 3-Methyl-5-(1-methylethyl)phenyl-carbamic acid methyl ester; Minacide; Morton EP-316; Phenol, 3-methyl-5-(1-methylethyl)-, methylcarbamate; Schering 34615; UC 9880; Union Carbide UC-9880

CAS Registry Number: 2631-37-0

RTECS® Number: FB8050000

UN/NA & ERG Number: UN2757/151

EC Number: 220-113-0 [*Annex I Index No.:* 006-037-00-9]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P201.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] Reportable Quantity (RQ): 1000 lb (454 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R50/53; Safety phrases: S1/2; S24; S37; 45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Promecarb is a colorless, odorless, crystalline solid. Molecular weight = 207.30; Freezing/Melting point = 87−88°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, or application of this nonsystemic contact insecticide.

Incompatibilities: Alkalis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 16 mg/m^3

PAC-3: 25 mg/m^3

Determination in Water: Fish Tox = 33.48370000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Promecarb is highly toxic by ingestion and is absorbed through the intact skin. It is a reversible cholinesterase inhibitor and its effects are related to action on the nervous system. Diarrhea, nausea, vomiting, excessive salivation, headache, pinpoint pupils, and uncoordinated muscle movements are all common symptoms of exposure to carbamate insecticides.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous

system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox; 350.00000 ppb (VERY LOW).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline materials.

Shipping: Promecarb falls into the class of Carbamate pesticides, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Keep unnecessary people away; isolate hazard areas and deny entry. Stay upwind and keep out of low areas. Do not touch spilled material or breathe the dusts, vapors, or fumes from burning materials. Use water spray to reduce vapors. Do not handle broken packages without protective equipment. Wash away any material that may have contacted the body with soap and water. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. Dike far ahead of *large spills* for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Soil Adsorption Index (K_{oc}) = 200 (estimate).

Fire Extinguishing: Extinguish fire using an agent suitable for the surrounding fire, as the material itself burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide, or dry chemical. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Small quantities:* treat with alkali and then bury. *Large quantities:* incineration.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Promecarb*. Washington, DC: Chemical Emergency Preparedness Program

Pronamide P:1040

Molecular Formula: $C_{12}H_{11}Cl_2NO$

Synonyms: Benzamide, 3,5-dichloro-*N*-(1,1-dimethyl-2-propynyl); Campbell's Rapier; 3,5-Dichloro-*N*-(1,1-dimethyl-2-propynyl)benzamide; 3,5-Dichloro-*N*-(1,1-dimethylprop-2-ynyl)benzamide; 3,5-Dichloro-*N*-(1,1-dimethyl-propynyl) benzamide; *N*-(1,1-Dimethylpropynyl)-3,5-dichlorobenzamide; Kerb; Kerb50W; Kerb propyzamide 50; Propyzamide; Rapier

CAS Registry Number: 23950-58-5

RTECS® Number: CV3460000

UN/NA & ERG Number: UN3077/171

EC Number: 245-951-4 [*Annex I Index No.:* 616-055-00-4]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (USA) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U192.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.093; Nonwastewater (mg/kg), 1.5.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 5/1/96.

Hazard Symbols: Xn, N, Risk phrases: R40; R50/53, Safety phrases: S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pronamide is a colorless crystalline solid. Molecular weight = 256.14; Freezing/Melting point = 155−156°C; Vapor pressure = 0.0001 mmHg at 25°C. Insoluble in water; solubility = 15 mg/L.

Potential Exposure: Those involved in the manufacture, formulation, and application of this selective herbicide.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: The EPA has derived a lifetime health advisory of 0.052 mg/L (52 μg/L).

Determination in Water: Extraction with methylene chloride, separation by capillary-column gas chromatography; then measurement using a nitrogen−phosphorus detector. Fish Tox = 13901.63079000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. Inhalation can cause irritation of the respiratory tract with cough, phlegm, and/or chest tightness. The acute oral LD_{50} for male rats is 8350 mg/kg and for female rats is 5620 mg/kg (insignificantly toxic in both cases).

Long Term Exposure: Applying the criteria described in EPA's final guidelines for assessment of carcinogenic risk, pronamide has tentatively been classified in Group C: possible human carcinogen. This category is for substances with limited evidence of carcinogenicity in animals in the absence of human data. There is limited animal evidence of liver cancer. Human Tox = 22.72727 ppb (INTERMEDIATE).

Points of Attack: Cancer site in animals: liver.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, or water spray extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Pronamide*. Washington, DC: Office of Drinking Water

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Pronamide*. Trenton, NJ

Propachlor P:1045

Molecular Formula: $C_{11}H_{14}ClNO$

Common Formula: $(ClCH_2CO)N(C_6H_5)CH(CH_3)_2$

Synonyms: Acetamide, 2-chloro-*N*-isopropyl-; Acetamide, 2-chloro-*N*-(1-methylethyl)-*N*-phenyl-; Aclid; AI3-51503; Albrass; Bexton; Bexton 4L; Chloressigsaeure-*N*-isopropyl-anilid (German); α-Chloro-*N*-isopropylacetanilide; 2-Chloro-*N*-isopropylacetanilide; 2-Chloro-*N*-isopropyl-*N*-phenylacetamide; 2-Chloro-*N*-(1-methylethyl)-*N*-phenylacetamide; CIPA; CP31393; *N*-Isopropyl-α-chloroacetanilide; *N*-Isopropyl-2-chloroacetanilide; Niticid; Propachlore; Propacloro (Spanish); Ramrod; Ramrod 65; Satecid

CAS Registry Number: 1918-16-7

RTECS® Number: AE1575000

UN/NA & ERG Number: UN2588/151

EC Number: 217-638-2 [*Annex I Index No.:* 616-008-00-8]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 2/27/01.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R36; R43; R50/53; Safety phrases: S2; S24; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propachlor is a light tan solid. Molecular weight = 211.71; Boiling point = 110°C at 0.03 mm; Freezing/Melting point = 67−76°C; Flash point = about 316°C. Slightly soluble in water.

Potential Exposure: Those engaged in the manufacture, formulation, and application of this preemergence herbicide, which is used to combat annual grasses and broad-leaved weeds in corn, soybeans, cotton, sugar cane, and vegetable crops.

Incompatibilities: Incompatible with alkaline materials, strong acids; strong oxidizers. Attacks carbon steel.

Permissible Exposure Limits in Air Russia[35, 43] set a MAC of 0.5 mg/m^3 in work-place air.

Permissible Concentration in Water: Russia[35, 43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes and of zero in water for fishery purposes. The EPA has set a lifetime health advisory of 0.092 mg/L (92 μg/L). States which have set guidelines for propachlor in drinking water include Kansas at 700 μg/L and Maine at 200 μg/L.

Determination in Water: Fish Tox = 17.92643000 ppb MATC (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The maximal tolerated dosage of propachlor without adverse effect is reported as 133.3 mg/kg/day in both rats and dogs. Other workers reported slight organ pathology in rats, mice, and rabbits at 100 mg/kg/day or higher; this agrees approximately with the former data. Apparently, no long-term toxicity studies have been completed that would contribute information on reproductive effects or carcinogenic potential of propachlor or its degradation products, which include aniline derivatives. These studies are needed.

Long Term Exposure: May be a mutagen. Human Tox = 10.93750 ppb; Chronic Human Carcinogen Level (INTERMEDIATE).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 80.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis would yield *N*-isopropylaniline. However, incineration at 850°C together with flue gas scrubbing is the preferred disposal method.[22]

References

US Environmental Protection Agency. (August 1987). *Health Advisory: Propachlor*. Washington, DC: Office of Drinking Water

US Environmental Protection Agency. *Integrated Risk Information System (IRIS) Propachlor*. Washington, DC. Various dates. <http://www.epa.gov/IRIS/subst/0096.htm>

Propadiene P:1050

Molecular Formula: C_3H_4

Common Formula: $H_2C{=}C{=}CH_2$

Synonyms: Allene; Allylenel; Dimethylenemethane; 1,2-Propadiene; Propadieno (Spanish)

CAS Registry Number: 463-49-0

RTECS® Number: BA040000

UN/NA & ERG Number: UN2200/116

EC Number: 207-335-3 (allene)

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propadiene is a colorless, flammable gas or liquid with a sweet odor. Molecular weight = 40.07; Boiling point = −32°C; Freezing/Melting point = −137°C. Explosive limits: LEL = 2.1%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: Used in chemical synthesis and as a component in mixtures with methyl acetylene, which make up specialty welding gases.

Incompatibilities: Violent reaction with strong oxidizers, strong acids, nitrogen oxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 ppm

PAC-1: 125 ppm

PAC-2: 750 ppm

PAC-3: 4000 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1500, Hydrocarbons.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propadiene can affect you when breathed in. Exposure can cause irritation of the eyes, nose, and throat. Very high levels can cause you to feel dizzy, lightheaded, and to pass out. Extremely high levels could cause death. Contact with the liquid may cause frostbite.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to propadiene, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Propadiene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), and nitrogen oxides since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propadiene is handled, used, or stored. Wherever propadiene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store cylinders in well-ventilated areas away from potential heat sources. Protect cylinders from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Propadiene, inhibited, requires a shipping label of “FLAMMABLE GAS.” It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Propadiene*. Trenton, NJ

Propane P:1060

Molecular Formula: C_3H_8

Common Formula: $CH_3CH_2CH_3$

Synonyms: A-108; Dimethylmethane; Hydrocarbon propellent A-108; *n*-Propane; Propano (Spanish); Propyl hydride

CAS Registry Number: 74-98-6

RTECS® Number: TX2275000

UN/NA & ERG Number: UN1978/115; UN1075 (liquefied)/115

EC Number: 200-827-9 [*Annex I Index No.*: 601-003-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 60,000. *Note*: Facilities are not required to count propane in tanks of 10,000 lb or less. The higher threshold of 60,000 lb is set to focus on the screening of high-volume propane users; not on nonindustrial propane users.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: Hazard Symbol: F + ; Risk phrases: R12; Safety phrases: S2; S9; S16 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Propane is a colorless gas that is odorless when pure (a foul-smelling odorant is often added). The odor threshold is 2700 ppm. Molecular weight = 44.11; Boiling point = –42.2°C; Freezing/Melting point = −187.8°C; Relative vapor density (air = 1) = 1.55; Vapor pressure = 8.4 atm at 21; Flash point = flammable gas (−104°C); Autoignition temperature = 450°C. Explosive limits: LEL = 2.1%°C; UEL = 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.01%.

Potential Exposure: Compound Description: Agricultural Chemical. Propane is used as a household, industrial, and vehicle fuel; it is used as a refrigerant and aerosol propellant; it is used as an intermediate in petrochemical manufacture.

Incompatibilities: Flammable gas. Strong oxidizers may cause fire and explosions. Liquid attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.80 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/1800 mg/m^3 TWA.

NIOSH REL: 1000 ppm/1800 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm TWA as aliphatic hydrocarbon gas (C_1–C_4).

NIOSH IDLH: 2100 ppm [LEL].

Protective Action Criteria (PAC)*

TEEL-0: 1000 ppm

PAC-1: **5500** ppm

PAC-2: **17,000** ppm

PAC-3: **33,000** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 1000 ppm/1800 mg/m^3 TWA; Peak Limitation Category II(4); Pregnancy Risk Group D.

Australia: asphyxiant, 1993; Austria: MAK 1000 ppm (1800 mg/m^3), 1999; Belgium: asphyxiant, 1993; Denmark: TWA 1000 ppm (1800 mg/m^3), 1999; Finland: TWA 800 ppm (1100 mg/m^3), 1999; Hungary: asphyxiant, 1993; the Philippines: TWA 1000 ppm (1800 mg/m^3), 1993; Switzerland: MAK-W 1000 ppm (1800 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2500 ppm.

Determination in Air: By combustible gas meter NIOSH (II-2) Method #S-87; OSHA Analytical Methods PV-2077.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 120,000 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Very high levels may produce the following symptoms, primarily due to lack of oxygen: dizziness, lightheadedness, disorientation, headache, numbness, vomiting, unconsciousness, and death from suffocation. Narcotic at high levels. Contact with the liquid can cause frostbite.

Long Term Exposure: No effects reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, nitrile + PVC, Polyurethane, and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2100 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propane is handled, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of propane. Wherever propane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Propane; or Petroleum gases, liquefied; or Liquefied petroleum gas Propane, requires a shipping label of "FLAMMABLE GAS."$LD_{50 =}$ (oral-rat). They fall in DOT Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Propane*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 2004). *Hazardous Substances Fact Sheet: Propane*. Trenton, NJ

Propane sultone P:1070

Molecular Formula: $C_3H_6O_3S$

Synonyms: 3-Hydroxy-1-propanesulphonic acid sultone; 3-Hydroxy-1-propanesulphonic acid γ-sultone; 3-Hydroxy-1-propanesulphonic acid sulfone; 1,2-Oxathrolane 2,2-dioxide; 1-propanesulfonic acid-3-hydroxy-g-sultone; 1,3-Propanesultone; 1,2-Oxathiolane 2,2-dioxide; 1-Propanesulfonic acid-3-hydroxy-g-sulfone; Propane sultone

CAS Registry Number: 1120-71-4

RTECS® Number: RP5425000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 214-317-9 [*Annex I Index No.:* 016-032-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat EPA; Positive: Cell transform.—RLV F344 rat embryo EPA; Positive: Cell transform.—SA7/SHE; Host-mediated assay EPA; Positive: *E. coli* polA without S9; Histidine reversion—Ames test EPA; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis EPA; Positive: *S. pombe*—reversion EPA; Positive/dose response: *In vitro* SCE—nonhuman EPA; Positive/dose response: *In vitro* UDS—human fibroblast EPA; Inconclusive: SHE—clonal assay.

Banned or Severely Restricted (Sweden) (UN).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U193.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propane sultone is a white crystalline solid or a colorless liquid above 30°C. It releases a foul odor as it melts. Molecular weight = 122.15; Specific gravity (H_2O:1) = 1.39 at 25°C; Boiling point = 180°C at 30 mm; 155−157°C at 14 mm; Freezing/Melting point = 31°C; Flash point >113°C.[50] Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = 10%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Those involved in use of this chemical intermediate to introduce the sulfopropyl group ($-CH_2CH_2CH_2SO_3-$) into molecules of other products.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: Exposures by all routes should be carefully controlled to levels as low as possible. Confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.15 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 250 mg/m^3

DFG MAK: [skin] Carcinogen Category 2.

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Austria [skin], carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propane sultone in ambient air[60] ranging from zero (North Dakota) to 0.03 μg/m^3 (New York) to 3.0 μg/m^3 (Virginia).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory system. More irritating if heated.

Long Term Exposure: Potential occupational carcinogen. Other long-term effects are unknown at this time.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: skin, blood or bone marrow, brain or spine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 82–85

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: 1,2-Oxathiolane-2,2-Dioxide*. Trenton, NJ

Propanil P:1080

Molecular Formula: $C_9H_9Cl_2NO$

Common Formula: $Cl_2C_6H_3NHCOC_2H_5$

Synonyms: AI3-31382; BAY 30130; Chem rice; Crystal propanil-4; DCPA; *N*-(3,4-Dichlorophenyl)propanamide;

3′,4′-Dichlorophenylpropionanilide; 3′,4′-Dichloropropionanilide; 3,4-Dichloropropionanilide; Dichloropropionanilide; Dipram; DPA; Farmco propanil; FW-734; Herbax technical; Montrose propanil; NSC31312; Propanamide, *N*-(3,4-dichlorophenyl)-; Propanide; Propionanilide, 3′,4′-dichloro-; Propionic acid 3,4-dichloroanilide; Rogue; Stam; Stam LV10; Stam F-34; Stampede 3E; Stam supernox; Strel; Surpur; Synpran N; Vertac

CAS Registry Number: 709-98-8; *(alt.)* 11096-32-5

RTECS® Number: UE4900000

DOT ID and ERG Number: UN3077/171

EC Number: 211-914-6 [*Annex I Index No.:* 616-009-00-3]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; 1988, Negative: *Aspergillus*—forward mutation; *E. coli* pol A without S9; 1988, Negative: Histidine reversion—Ames test; 1988, Negative: *In vitro* UDS—human fibroblast; TRP reversion; 1988, Negative: *S. cerevisiae*—homozygosis.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: Priority List (55 FR 1470) as DCPA (and its acid metabolites).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R50; Safety phrases: S2; S22; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propanil is a colorless solid. The technical product is a brown crystalline solid. Molecular weight = 218.09; Specific gravity (H_2O:1) = 1.22 at 25°C; Freezing/Melting point = 92−93°C (pure); 88−91°C (technical grade); Freezing/Melting point (pure) = 89−92°C (pure); 85−89°C (technical grade). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water. Commercial formulations use carrier solvents that may change the physical properties shown.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Propanil is used as a postemergent herbicide for rice and spring wheat. Those involved in the manufacture, formulation, and application of this contact herbicide.

Permissible Exposure Limits in Air

No TEEL available.

Russia[43] set a MAC of 0.1 mg/m^3 in work-place air and has set a MAC value of 0.005 mg/m^3 for ambient air in residential areas on a once-daily basis and 0.001 mg/m^3 on a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Determination in Water: Fish Tox = 0.48990000 ppb (EXTRA HIGH). Octanol−water coefficient: Log K_{ow} = 3.1.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propanil is well tolerated by experimental animal on a chronic basis, and there is little or no indication of mutagenic or oncogenic properties of the compound. The highest no-adverse-effect concentration of propanil based on reproduction in the rat and acute, subchronic, and chronic studies in rats and dogs is 400 ppm in the diet. Based on this data, an ADI was calculated at 0.02 mg/kg/day. LD50 (oral-rat) 2756 mg/kg (male); 2343 mg/kg (female).

Long Term Exposure: Human Tox = 35.00000 ppb (INTERMEDIATE).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 149.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis in acidic or basic media yields the more toxic substance, 3,4-dichloraniline, and is not recommended.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Propargyl alcohol P:1090

Molecular Formula: C_3H_4O

Common Formula: $HC{\equiv}CCH_2OH$

Synonyms: AI3-24359; Alcohol propargilico (Spanish); Ethynylcarbinol; Ethynyl methanol; 1-Hydroxy-2-propyne; 3-Hydroxy-1-propyne; Methanol, ethynyl-; Propiolic alcohol; 1-Propyne-3-ol; 3-Propynol; 2-Propynol; 2-Propyn-1-ol; 1-Propyn-3-ol; Prop-2-yn-1-ol; 2-Propynyl alcohol; Propynyl alcohol

CAS Registry Number: 107-19-7

RTECS® Number: UK5075000

UN/NA & ERG Number: UN2929/131

EC Number: 203-471-2 [*Annex I Index No.:* 603-078-00-X]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P102.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R10; R23/24/25; R34; R51/53; Safety phrases: S1/2; S26; S28; S36; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Propargyl alcohol is a colorless liquid with a geranium-like odor. Molecular weight = 56.07; Specific gravity (H_2O:1) = 0.97 at 25°C; Boiling point = 119.9°C; Freezing/Melting point = −52°C; Flash point = 36°C. Explosive limits: LEL = 3.4%; UEL = 70%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. Propargyl alcohol is used as a corrosion inhibitor, soil fumigant, solvent, stabilizer, and chemical intermediate.

Incompatibilities: Violent reaction with phosphorus pentoxide, oxidizers. May polymerize under the influence of heat, oxidizers, peroxides, light. Attacks many plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.29 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 1 ppm/2.3 mg/m^3 TWA [skin].

Protective Action Criteria (PAC)*

TEEL-0: 1 ppm

PAC-1: **2.5** ppm

PAC-2: **16** ppm

PAC-3: **74** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm; 4.7 mg/m^3 TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group D.

Australia: TWA 1 ppm (2 mg/m^3), [skin], 1993; Austria: MAK 2 ppm (9 mg/m^3), [skin], 1999; Belgium: TWA 1 ppm (2.3 mg/m^3), [skin], 1993; Denmark: TWA 1 ppm (2.5 mg/m^3), [skin], 1999; Finland: TWA 1 ppm (2 mg/m^3); STEL 3 ppm (6 mg/m^3), [skin], 1999; France: VME 1 ppm (2 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 2 mg/m^3, [skin], 2003; the Philippines: TWA 1 ppm (1 mg/m^3), [skin], 1993; Russia: STEL 1 mg/m^3, 1993; Switzerland: MAK-W 1 ppm (2 mg/m^3), [skin], 1999; United Kingdom: TWA 1 ppm (2.3 mg/m^3); STEL 3 ppm, [skin], 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm [skin].

Determination in Air: Use OSHA Analytical Method 97.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propargyl alcohol can affect you when breathed and by passing through skin. Irritates the eyes, skin, and respiratory tract. Contact can severely burn the eyes, causing permanent damage. Skin contact can irritate the skin and allow dangerous amounts to enter the body. Affects the central nervous system. Exposure can cause you to feel dizzy, lightheaded, and to have trouble concentrating. High exposures can cause liver and kidney damage, coma, and death.

Long Term Exposure: Propargyl alcohol may damage the liver and kidneys.

Points of Attack: Skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propargyl alcohol must be stored to avoid contact with alkalis, mercury(II) sulfate; oxidizing materials and phosphonic anhydride since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propargyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propargyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Propargyl alcohol. Wherever propargyl alcohol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a

secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Propargyl Alcohol*. Trenton, NJ

Propargyl bromide P:1100

Molecular Formula: C_3H_3Br

Common Formula: $BrCH_2C{\equiv}CH$

Synonyms: γ-Bromoallylene; 3-Bromopropyne; 3-Bromo-1-propyne; Bromuro de propargilo (Spanish)

CAS Registry Number: 106-96-7

RTECS® Number: UK4375000

UN/NA & ERG Number: UN2345/130

EC Number: 203-447-1

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propargyl bromide is a colorless liquid with a sharp odor. Molecular weight = 118.97; Boiling point = 89−90°C; Freezing/Melting point = −61.07°C; Flash point = 10°C; Autoignition temperature = 324°C. Explosive limits: LEL = 3.0%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 4. Insoluble in water.

Potential Exposure: This material is used as a soil fumigant. Not registered as a pesticide in the United States.

Incompatibilities: Violent reaction with oxidizers. Becomes shock- or heat-sensitive when mixed with trichloronitromethane or chloropicrin. Detonates when heated to 220°C, or when heated while confined. May explode on contact with copper, copper alloys, mercury, silver.

Permissible Exposure Limits in Air

AIHA WEEL: 0.1 ppm TWA [skin]

Protective Action Criteria (PAC)

TEEL-0: 0.03 mg/m^3

PAC-1: 0.03 mg/m^3

PAC-2: 0.03 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is very poisonous if swallowed. If inhaled, may be harmful. Skin and eye contact may cause burns. Symptoms of exposure include skin irritation and tearing of the eyes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained

on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including bromine, are produced in fire. Wear self-contained breathing apparatus and full protective clothing. Move container from fire area if you can do it without risk. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propargyl Bromide*. Washington, DC: Chemical Emergency Preparedness Program

Propazine P:1110

Molecular Formula: $C_9H_{16}ClN_5$

Synonyms: 2,4-bis(Isopropylamino)-6-chloro-*s*-triazine; 2,4-Bis(propylamino)-6-chlor-1,3,5-triazin (German); 2-Chloro-4,6-bis(isopropylamino)-*s*-triazine; Gesamil®; MAXX-90; Milogard®; Plantulin; Primatol P; Propasin; Propazin; Prozinex

CAS Registry Number: 139-40-2

RTECS® Number: XY5300000

UN/NA & ERG Number: UN2753/151

EC Number: 205-359-9 [*Annex I Index No.:* 613-067-00-1]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R40; R50/53; Safety phrases: S2; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propazine is a colorless crystalline solid. Molecular weight = 229.75; Freezing/Melting point = 214°C; Vapor pressure = 1.3×10^{-7} mmHg at 20°C. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen; Reproductive Effector. Those involved in the manufacture, formulation, and application of this preemergence selective herbicide used to control annual broadleaf weeds and grasses.

Permissible Exposure Limits in Air

Russia[43] set a MAC of 5.0 mg/m^3 in work-place air and a MAC of 0.04 mg/m^3 in ambient air in residential areas both on a momentary and a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 1.0 mg/L in water bodies used for domestic purposes. The US EPA has determined a lifetime health advisory of 0.014 mg/L (14 μg/L) (see "References" below). States which have set guidelines for propazine in drinking water[61] include Kansas at 325 μg/L and Maine at 93 μg/L.

Determination in Water: Analysis of propazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen- and phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen–phosphorus detector. The method detection limit has not been determined for propazine, but it is estimated that the detection limits for analytes included in this method are in the range of 0.1–2 μg/L. Fish Tox = 938.12580000 ppb (VERY LOW). Octanol–water coefficient: Log $K_{ow} = 2.9$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. May be absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: May cause eye irritation. Contact dermatitis was reported in workers involved in propazine manufacturing. Poisonous if ingested. No other information on the health effects of propazine in humans was found in the available literature.

Long Term Exposure: May cause skin allergy. Human Tox = 10.00000 ppb (INTERMEDIATE).

Points of Attack: Skin.

Medical Surveillance: Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Triazine pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." The Hazard Class is 6.1 and Packing Group is III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 154.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory: Propazine*. Washington, DC: Office of Drinking Water

Propham P:1120

Molecular Formula: $C_{10}H_{13}NO_2$

Common Formula: $C_6H_5NHCOOCH(CH_3)_2$

Synonyms: Ban-hoe; Beet-kleen; Carbanilic acid, isopropyl ester; Chem-hoe; IPPC; Isopropyl carbanilate; Isopropyl carbanilic acid ester; Isopropyl-*N*-phenyl-carbamat (German); *o*-Isopropyl-*N*-phenyl carbamate; Isopropyl phenylcarbamate; Isopropyl-*N*-phenyl carbamate; Isopropyl-*N*-phenyurethan (German) Ortho grass killer; *N*-Phenylcarbamate d'isopropyle (French); Phenylcarbamic acid 1-methylethyl ester; *N*-Phenyl isopropyl carbamate; Premalox; Profam; Propham; Triherbide; Triherbide-IPC; Tuberit; Tuberite

CAS Registry Number: 122-42-9

RTECS® Number: ED9100000

UN/NA & ERG Number: UN2757/151

EC Number: 204-542-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Available Data*, not classifiable as carcinogenic to humans*, Group 3, 1987.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U363.

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 1000 lb (454 kg).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propham is a colorless crystalline solid. Molecular weight = 179.24; Freezing/Melting point = 87−88°C; 84°C (technical grade). Decomposition temperature = 150°C. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this grass-control herbicide.

Permissible Exposure Limits in Air: Russia[43] set a MAC of 2.0 mg/m^3 in work-place air and a MAC of 0.02 mg/m^3 in ambient air of residential areas both on a momentary and a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes. The EPA has set a lifetime health advisory of 0.12 mg/L.

Determination in Water: Analysis of propham is by a high-performance liquid chromatographic (HPLC) method applicable to the determination of certain carbamate and urea pesticides in water samples. This method requires a solvent extraction of approximately 1 L of sample with methylene chloride using a separatory funnel. The methylene chloride extract dried and concentrated to a volume of 10 mL or less. Compounds are separated by HPLC, and measurement is conducted with a UV detector. The method detection limit has not been determined for propham, but it is estimated that the detection limits for analytes included in this method are in the range of 1−5 μg/L. Fish Tox = 5112.55273000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Doses of 2000 mg/kg to rats produced loss of righting reflex, ptosis, piloerection, decreased locomotor activity, chronic pulmonary disease, rugation and irregular thickening of the stomach. The acute oral LD_{50} values in male and female rats were reported to be 3000 ± 232 mg/kg and 2360 ± 118 mg/kg, respectively. Carbamates are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 100.00000 ppb (VERY LOW).

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a

full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Carbamate pesticides, solid, toxic, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (August 1987). *Health Advisory: Propham*. Washington, DC: Office of Drinking Water

β-Propiolactone P:1130

Molecular Formula: $C_3H_4O_2$

Synonyms: Betaprone; BPL; Hydracrylic acid, β-lactone; 3-Hydroxypropionic acid lactone; NSC21626; 2-Oxetanone; Propanoic acid, 3-hydroxy-, β-lactone; 3-Propanolide; Propanolide; 1,3-Propiolactone; 3-Propiolactone; Propiolactone; β-Propionolactone; Propionolactone, b

CAS Registry Number: 57-57-8

RTECS$^®$ Number: RQ7350000

UN/NA & ERG Number: UN2810/153

EC Number: 200-340-1[*Annex I Index No.:* 606-031-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen; OSHA: Potential human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—focus assay; Positive: Cell transform.—SA7/SHE; Positive: *D. melanogaster*—reciprocal translocation; Positive: Host-mediated assay; L5178Y cells *In vitro*—TK test; Positive: *N. crassa*—forward mutation; *N. crassa*—reversion; Positive: *E. coli* polA without S9; Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *In vitro* UDS—human fibroblast; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; Positive/dose response: *In vitro* SCE—nonhuman; Negative: Sperm morphology—mouse; Inconclusive: Mammalian micronucleus; Positive: CHO gene mutation.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1013).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R45; R26; R36/38; Safety phrases: S53; S45. (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: β-Propiolactone is a colorless liquid which slowly hydrolyzes to hydracrylic acid and must be cooled to remain stable. Molecular weight = 72.07; Specific gravity (H_2O:1) = 1.15 at 25°C; Boiling point = (decomposes) 161.7°C; Freezing/Melting point = −33.3°C; Vapor pressure = 3 mmHg at 25°C; Flash point = 75°C. Explosive limits: LEL = 2.9%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Soluble in water; solubility = 37%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. β-Propiolactone is used as a chemical intermediate in synthesis of acrylic acid and esters, acrylate plastics; as a vapor sterilizing agent; phase disinfectant; and a viricidal agent.

Incompatibilities: Acetates, halogens, thiocyanates, thiosulfates, strong oxidizers, strong bases. May polymerize upon storage or due to warming. Stable if kept under refrigeration at 40−50°F/5−10°C.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices, and personal protective equipment, including respirators. See 29CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.5 ppm/1.5 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: Not determined. Potential occupational carcinogen.

Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 0.509 ppm
PAC-2: 5.09 ppm
PAC-3: 150 ppm

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 0.5 ppm (1.5 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.5 ppm (1.5 mg/m^3), carcinogen, 1993; Denmark: TWA 0.1 ppm (1.5 mg/m^3), 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Poland: MAC (TWA) 1 mg/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.5 ppm (1.5 mg/m^3), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propiolactone in ambient air[60] ranging from zero (North Dakota) to 5.0 μg/m^3 (New York) to 7.5 μg/m^3 (South Carolina) to 15 μg/m^3 (Florida and Virginia) to 22.5 μg/m^3 (Connecticut) to 36.0 μg/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion, skin absorption, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes. May cause corneal opacity and blindness. Irritates the respiratory tract. Contact with skin causes irritation, burns, and blistering; fluid from blisters may cause additional blistering of adjacent skin. Ingestion causes burns of mouth and stomach. The toxicity potential of this material via inhalation or ingestion is high; may cause death or permanent injury after very short exposures to small quantities.

Long Term Exposure: A potential occupational carcinogen. May cause frequent urination, dysuria, hematuria (blood in the urine). May affect the liver and kidneys.

Points of Attack: Kidneys, skin, lungs, eyes, liver. Cancer site in animals: liver, skin, and stomach.

Medical Surveillance: Based on its high toxicity and carcinogenic effects in animals, preplacement and periodic examinations should include a history of exposure to other carcinogens, alcohol and smoking habits, medication, and family history. The skin, eye, lung, liver, and kidney should be evaluated. Sputum cytology may be helpful in evaluating the presence or absence of carcinogenic effects. Kidney and liver function tests. Periodic lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for this chemical. Refer to OSHA Standard: *beta-Propiolactone, 29 CFR 1910.1013.*

Respirator Selection: Employees engaged in handling operations involving this chemical must be provided with, and required to wear and use, a half-mask filter-type respirator for dusts, mists, and fumes. A respirator affording higher levels of protection than this respirator may be substituted. *At any detectable concentration:* SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator or a freezer in glass containers and protect from air and light. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic liquids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 2, 57–60

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propiolactone, Beta-*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Beta-Propiolactone*. Trenton, NJ

Propionaldehyde P:1140

Molecular Formula: C_3H_6O

Common Formula: CH_3CH_2COH

Synonyms: Aldehyde propionique (French); Methylacetaldehyde; NCI-C61029; Propaldehyde; Propanal; *n*-Propanal; 1-Propanal; Propanaldehyde; 1-Propanone; Propional; Propionic aldehyde; Propyl aldehyde; Propylic aldehyde

CAS Registry Number: 123-38-6

RTECS$^{®}$ Number: UE0350000

UN/NA & ERG Number: UN1275/129

EC Number: 204-623-0 [*Annex I Index No.:* 605-018-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R36/37/38; Safety phrases: S2; S9; S16; S29 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propionaldehyde is a colorless liquid with a strong fruity odor. Molecular weight = 58.09; Boiling point = 49°C; Freezing/Melting point = −81°C; Flash point = −30°C; −9°C (oc); Autoignition temperature = 207°C. Explosive limits: LEL = 2.6%; UEL = 17%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Used as a synthetic flavoring; as a disinfectant and preservative; to make propionic acid; in plastic and rubber manufacturing; to make alkyl resins and plasticizers.

Incompatibilities: Incompatible with strong acids, amines. Violent reaction with strong oxidizers. Strong caustics; reducing agents can cause explosive polymerization. Can self-ignite if finely dispersed on porous or combustible material, such as fabric. Heat or ultraviolet light can cause decomposition.

Permissible Exposure Limits in Air
AIHA WEEL: 20 ppm TWA.
ACGIH TLV®[1]: 20 ppm/48 mg/m^3 TWA.
Protective Action Criteria (PAC)*
TEEL-0: 20 ppm
PAC-1: **45** ppm
PAC-2: **260** ppm
PAC-3: **840** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: NIOSH Analytical Method #2539, aldehydes, screening.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Irritates the skin causing a burning sensation and rash on contact. Inhalation can irritate the respiratory tract and may cause nosebleeds, sore throat, cough, and phlegm. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can irritate the lungs; bronchitis may develop. Testing has not been completed to determine the carcinogenicity of propionaldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function test. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Propionaldehyde requires a label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. *Do not use water*. Use dry chemical, carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: Propionaldehyde*. Trenton, NJ

Propionic acid P:1150

Molecular Formula: $C_3H_6O_2$

Common Formula: CH_3CH_2COOH

Synonyms: Acide propionique (French); Carbonyethane; Carboxyethane; Ethanecarboxylic acid; Ethylformic acid; Metacetonic acid; Methylacetic acid; Propanoic acid; Propionic acid Grain preserver; Prozoin; Pseudoacetic acid; Sentry grain preserver; Tenox P grain preservative

CAS Registry Number: 79-09-4

RTECS® Number: UE5950000

UN/NA & ERG Number: UN1848/132

EC Number: 201-176-3 [*Annex I Index No.:* 607-089-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: Pesticide subject to registration or re-registration.

FDA—over-the-counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S23; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propionic acid is a colorless liquid with a pungent odor. The odor threshold is 0.16 ppm. Molecular weight = 74.09; Specific gravity (H_2O:1) = 0.99 at 25°C; Boiling point = 141°C; Freezing/Melting point = –21°C; Vapor pressure = 3 mmHg at 25°C; Flash point = 52.2°C (cc); 57°C (oc); Autoignition temperature = 465°C. Explosive limits: LEL = 2.9%; UEL = 12.1%.[17] Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Primary Irritant. Propionic acid is used in the manufacture of inorganic propionates and propionate esters which are used as mold inhibitors, electroplating additives, emulsifying agents, flavors, and perfumes. It is an intermediate in pesticide manufacture, pharmaceutic manufacture; and in the production of cellulose propionate plastics. Also, used as grain preservative.

Incompatibilities: The substance is a medium strong acid. Incompatible with sulfuric acid, strong bases, ammonia, isocyanates, alkylene oxides, epichlorohydrin. Reacts with bases, strong oxidizers, and amines, causing fire and explosion hazard. Attacks many metals forming flammable/explosive hydrogen gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.03 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 10 ppm/30 mg/m^3 TWA; 15 ppm/45 mg/m^3 STEL.

ACGIH TLV®[1]: 10 ppm/30 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 15 ppm

PAC-2: 15 ppm

PAC-3: 350 ppm

DFG MAK: 10 ppm/31 mg/m^3 TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group C.

Australia: TWA 10 ppm (30 mg/m^3); STEL 15 ppm, 1993; Austria: MAK 10 ppm (30 mg/m^3), 1999; Belgium: TWA 10 ppm (30 mg/m^3); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (30 mg/m^3), 1999; Finland: TWA 10 ppm, [skin], 1999; France: VME 10 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 31 mg/m^3, 2003; Russia: STEL 20 mg/m^3, 1993; Sweden: NGV 10 ppm (30 mg/m^3), KTV 15 ppm (45 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (30 mg/m^3), KZG-W 20 ppm (60 mg/m^3), 1999; United Kingdom: TWA 10 ppm (31 mg/m^3); STEL 15 ppm (46 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 ppm. Russia[43] set a MAC of 0.015 mg/m^3 for ambient air in residential areas (15 μg/m^3) on a momentary basis. Several states have set guidelines or standards for propionic acid in ambient air[60] ranging from 300−450 μg/m^3 (North Dakota) to 500 μg/m^3 (Virginia) to 600 μg/m^3 (Connecticut) to 714 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.31$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe eye burns, leading to permanent damage. Skin contact causes skin burns. Inhalation can cause irritation of the respiratory tract with mild cough; asthmatic response was found in medical reports of acute exposure of workers.

Long Term Exposure: May cause an asthma-like allergy. May irritate the lungs; may lead to lung damage.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if person is not having an attack at the time of the test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends Neoprene™, nitrile rubber and polyvinyl chloride as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in containers made of aluminum or stainless steel. Propionic acid will corrode steel. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), ignition sources, or heat. Outside or detached storage is preferred. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover spilled material with soda ash or sodium bicarbonate. Mix and add water. Neutralize and drain to sewer with plenty of water. Use water spray to dilute spill and disperse vapor. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with flammable solvent.

Reference

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Propionic Acid*. Trenton, NJ

Propionic anhydride P:1160

Molecular Formula: $C_6H_{10}O_3$

Synonyms: Methylacetic anhydride; Propanoic anhydride; Propionic acid anhydride; Propionyl oxide

CAS Registry Number: 123-62-6

RTECS® Number: UF9100000

UN/NA & ERG Number: UN2496/156

EC Number: 204-638-2 [*Annex I Index No.:* 607-010-00-X]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: Hazard Symbol: C; Risk phrases: R34; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propionic anhydride is a colorless liquid with a strong unpleasant odor. Molecular weight = 130.16; Boiling point = 167−169°C; Freezing/Melting point = −45°C; Flash point = 63°C; Autoignition temperature = 285°C. Explosive limits: LEL = 1.3%; UEL = 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Decomposes in water.

Potential Exposure: Used in the manufacture of perfumes, flavorings, alkyd resins; dyestuffs, pharmaceuticals; as an esterifying agent for fats, oils, and cellulose; dehydrating medium for nitrations and sulfonations.

Incompatibilities: Oxidizers, strong acids, strong bases, reducing agents, alcohols, and metals. Contact water forms propionic acid.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: High concentrations are dangerous to aquatic life. May be dangerous if it enters water intakes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Contact with liquid causes burns of skin. Ingestion causes burns of the mouth and stomach. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause skin allergy. Can irritate the lungs; bronchitis may develop.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Propionic anhydride requires a shipping label of “CORROSIVE” It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or polymer alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerator with afterburner.

Reference

New Jersey Department of Health and Senior Services. (July 1999). *Hazardous Substances Fact Sheet: Propionic Anhydride*. Trenton, NJ

Propionitrile P:1170

Molecular Formula: C_3H_5N

Common Formula: CH_3CH_2CN

Synonyms: Cianuro de etilo (Spanish); Cyanoethane; Ether cyanatus; Ethyl cyanide; Hydrocyanic ether; Propanenitrile; Propionic nitrile propylnitrile

CAS Registry Number: 107-12-0

RTECS® Number: UF9625000

UN/NA & ERG Number: UN2404/131

EC Number: 203-464-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
US EPA Hazardous Waste Number (RCRA No.): P101.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground.
Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (60); 8240 (5).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propionitrile is a colorless liquid with a pleasant, sweetish, ethereal odor. Molecular weight = 55.09; Specific gravity (H_2O:1) = 0.78 at 25°C; Boiling point = 97.2°C; Freezing/Melting point = − 91.7°C; Flash point = 2.2°C (cc). Explosive limits: LEL = 3.1%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1. Soluble in water; solubility = 12%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Primary Irritant. Used as a solvent in petroleum refining, as a chemical intermediate, a raw material for drug manufacture, and a setting agent.

Incompatibilities: Strong oxidizers and reducing agents; strong acids and bases. Hydrogen cyanide is produced when propionitrile is heated to decomposition. Reacts with acids, steam, warm water, producing toxic and flammable hydrogen cyanide fumes.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.25 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: TWA 6 ppm/14 mg/m^3.
ACGIH TLV®[1]: None.
Protective Action Criteria (PAC)*
TEEL-0: 6 ppm
PAC-1: 6 ppm
PAC-2: **7** ppm
PAC-3: **37** ppm

Determination in Air: Use NIOSH Analytical Method (IV).
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**. #1606.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact may cause burns to skin and eyes. May affect the iron metabolism, causing asphyxia. It is highly toxic. Forms cyanide in the body. This super toxic compound has a probable oral lethal dose in humans of less than 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150 lb) person. Exposure results in headache, dizziness, rapid pulse, deep, rapid breathing, nausea, vomiting, unconsciousness, convulsions, and possible death. May cause cyanosis (blue coloration of skin and lips caused by lack of oxygen).

Long Term Exposure: Chronic exposure over long periods may cause fatigue and weakness. Can cause same general symptoms as hydrogen cyanide but onset of symptoms is likely to be slower. May cause liver and kidney damage.

Points of Attack: In animals: liver, kidney damage.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. For engineering controls, see NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *60 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or Sa (APF = 10) (any supplied-air respirator). *150 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *300 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in an explosion-proof refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of ""FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen cyanide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alcoholic NaOH followed by calcium hypochlorite may be used. Incineration is also recommended.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (September 2, 1983). *Chemical Hazard Information Profile Draft Report: Propionitrile*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propionitrile*. Washington, DC: Chemical Emergency Preparedness Program

Propoxur P:1180

Molecular Formula: $C_{11}H_{15}NO_3$

Synonyms: 58-12-315; Arprocarb; BAY39007; BAY 5122; Bayer 39007; Bayer B 5122; Baygon; Blattanex; Blattosep; Bolfo; Boruho; Boruho 50; Brygou; Carbamic acid, methyl-, *o*-isopropoxyphenyl ester; Dalf dust; ENT25,671; Invisi-gard; IPMC; *o*-(2-Isopropoxyphenyl) *N*-methylcarbamate; *o*-Isopropoxyphenyl *N*-methylcarbamate; *o*-Isopropoxyphenyl methylcarbamate; 2-Isopropoxyphenyl

N-methylcarbamate; 2-Isopropoxyphenyl methylcarbamate; 2-(1-Methylethoxy)phenyl *N*-methylcarbamate; OMS 33; PHC; Phenol, 2-(1-methylethoxy)-, methylcarbamate; Propotox; Propoxylor; Sendran; Suncide; Tendex; Unden

CAS Registry Number: 114-26-1

RTECS® Number: FC3150000

UN/NA & ERG Number: UN2757/151

EC Number: 204-043-8 [*Annex I Index No.*: 006-16-00-4]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *B. subtilis* rec assay; TRP reversion; Negative: *S. cerevisiae* gene conversion; Inconclusive: *B. subtilis* rec assay.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U411.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 8/11/06.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R50/53; Safety phrases: S1/2; S37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propoxur is a colorless crystalline powder with a faint characteristic odor. Molecular weight = 209.27; Boiling point = N/A (decomposes); Freezing/Melting point = 91°C; Flash point ≥ 149°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Poor solubility in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Personnel engaged in the manufacture, formulation, and application of this carbamate agricultural chemical and pesticide.

Incompatibilities: Strong oxidizers, alkalis, heat, and moisture. Emits highly toxic methyl isocyanate fumes when heated to decomposition.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.5 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans. BEI$_A$ issued for Acetylcholinesterase-inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 20 mg/m^3

DFG MAK: 2 mg/m^3 measured as the, inhalable fraction TWA; Peak Limitation Category II(8).

Australia: TWA 0.5 mg/m^3, 1993; Austria: MAK 0.5 mg/m^3, 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.5 mg/m^3, 1999; Finland: TWA 0.5 mg/m^3; STEL 1.5 mg/m^3, 1993; France: VME 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 2 mg/m^3, 1999; Switzerland: MAK-W 0.5 mg/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for Baygon in ambient air[60] ranging from 5−20 μg/m^3 (North Dakota) to 8 μg/m^3 (Virginia) to 10 μg/m^3 (Connecticut) to 12 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Fish Tox = 168.01099000 MATC (LOW). Octanol−water coefficient: Log K_{ow} = 1.5.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propoxur can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic carbamate chemical. Exposure can cause severe carbamate poisoning, with symptoms of headaches, sweating, nausea and vomiting, diarrhea, muscle twitching, loss of coordination, and even death. May affect the nervous system, liver, kidneys. A cholinesterase inhibitor.

Long Term Exposure: Propoxur may cause mutations. Handle with extreme caution. It may damage the developing fetus. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 94.85095 ppb CHCL (Chronic Human Carcinogen Level) (LOW).

Points of Attack: Central nervous system, liver, kidneys, gastrointestinal tract, blood cholinesterase.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum and RBC cholinesterase levels (a test for the enzyme in the body affected by propoxur). These tests are useful only if done 1−2 hours after exposure and can return to normal before the person feels well. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 0.5 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, moisture, oxidizers, alkaline environments. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Carbamate pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 30.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Highly toxic gases are produced in fire, including methyl isocyanate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (July 2005). *Hazardous Substances Fact Sheet: Propoxur*. Trenton, NJ

n-Propyl acetate P:1190

Molecular Formula: $C_5H_{10}O_2$

Common Formula: $CH_3COOCH_2CH_2CH_3$

Synonyms: Acetate de propyle normal (French); Acetic acid, propyl ester; Acetic acid, *n*-propyl ester; 1-Acetoxypropane; Propyl acetate; *n*-Propyl acetate; 1-Propyl acetate; Propylacetate

Isopropyl Acetate—see separate record

CAS Registry Number: 109-60-4
RTECS® Number: AJ3675000
UN/NA & ERG Number: UN1276/129
EC Number: 203-686-1 [*Annex I Index No.:* 607-024-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F; Risk phrases: R1; R 36; R66; R67; Safety phrases: S2; S16; S26; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: *n*-Propyl acetate is a colorless liquid with a mild, fruity odor. The odor threshold is 70 mg/m^3[41] and 2.8 mg/m^3 (New Jersey Fact Sheet). Molecular weight = 102.15 (both isomers); Specific gravity (H_2O:1) = 0.84 at 25°C; Boiling point = 101.7°C; Freezing/Melting point = −92.2°C; Vapor pressure = 25 mmHg at 25°C; Flash point = 13°C; Autoignition temperature = 450°C. Explosive limits: LEL = 1.7% at 38°C; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: Compound Description (both isomers): Human Data; Primary Irritant. Propyl acetate is a used as a solvent for plastics and cellulose ester resins; perfume ingredient; component of food flavoring. It is also used as a chemical intermediate.

Incompatibilities: Contact with nitrates, strong oxidizers, strong alkalis, strong acids; may pose risk of fire and explosions. Attacks plastic.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/840 mg/m^3 TWA.

NIOSH REL: 200 ppm/840 mg/m^3 TWA; 250 ppm/1050 mg/m^3 STEL.

ACGIH TLV®[1]: 200 ppm/835 mg/m^3 TWA; 250 ppm/1040 mg/m^3 STEL.

NIOSH IDLH: 1700 ppm.

Protective Action Criteria (PAC)
TEEL-0: 200 ppm
PAC-1: 250 ppm
PAC-2: 250 ppm
PAC-3: 1700 ppm

DFG MAK: 100 ppm/420 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 200 ppm (840 mg/m^3); STEL 250 ppm, 1993; Austria: MAK 200 ppm (840 mg/m^3), 1999; Belgium: TWA 200 ppm (835 mg/m^3); STEL 250 ppm (1040 mg/m^3), 1993; Finland: TWA 200 ppm (840 mg/m^3); STEL 250 ppm (1050 mg/m^3), 1993; France: VME 200 ppm (840 mg/m^3), 1999; Hungary: TWA 200 mg/m^3; STEL 600 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 420 mg/m^3, 2003; Norway: TWA 100 ppm (420 mg/m^3), 1999; the Philippines: TWA 200 ppm (840 mg/m^3), 1993; Poland: MAC (TWA) 200 mg/m^3; MAC (STEL) 1000 mg/m^3, 1999; Russia: TWA 200 ppm; STEL 200 mg/m^3, 1993; Switzerland: MAK-W 200 ppm (840 mg/m^3), KZG-W 400 ppm, 1999; Turkey: TWA 200 ppm (840 mg/m^3), 1993; United Kingdom: TWA 200 ppm (849 mg/m^3); STEL 250 ppm (1060 mg/m^3); Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm.

Several states have set guidelines or standards for propyl acetate in ambient air[60] ranging from 8.4−10.5 mg/m^3 (North Dakota) to 14 mg/m^3 (Virginia) to 16.8 mg/m^3 (Connecticut) to 20 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1401, alcohols II; #1405, alcohols, Combined; OSHA Analytical Method 7, Organic Vapors.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.23.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *n*-Propyl acetate can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Very high levels are narcotic and may affect the nervous system and cause you to feel dizzy, lightheaded, and to pass out.

Long Term Exposure: Prolonged or repeated contact can cause drying and cracking of the skin.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: There is no special test for this substance. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber, polyvinyl alcohol, and Silvershield™ are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1700 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. *n*-Propyl acetate must be stored to avoid contact with nitrates, strong oxidizers (such as chlorine, bromine, and fluorine), and strong acids (such as hydrochloric, sulfuric, and nitric) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. *n*-Propyl acetate will dissolve some plastics and resins. Sources of ignition, such as smoking and open flames, are prohibited where *n*-propyl acetate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of *n*-propyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of *n*-propyl acetate.

Shipping: *n*-Propyl acetate requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: n-Propyl Acetate*. Trenton, NJ

Propyl alcohol P:1200

Molecular Formula: C_3H_8O (n-); $C_6H_{14}O$ (iso-)

Synonyms: Alcohol C-3; Alcool propylique (French); Ethyl carbinol; 1-Hydroxypropane; Optal; Osmosol extra; Propanol-1; 1-Propanol; *n*-Propanol; Propanole (German); Propyl alcohol; Propyl alcohol, *normal*; 1-Propyl alcohol; *n*-Propyl alkohol (German); Propylic alcohol *(iso-)* 2-Methylpentan-1-ol

CAS Registry Number: 71-23-8; 105-30-6 (iso-)

RTECS® Number: UH8225000 (n-)

UN/NA & ERG Number: UN1274 (*n*-propanol)/129

EC Number: 200-746-9 [*Annex I Index No.:* 603-003-00-0 (*n*-)]; 203-285-1 [2-methylpentan-1-ol]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *In vitro* SCE—nonhuman.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R47; R67; Safety phrases: S2; S7; S16; S26; S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: The two isomers of propyl alcohol are *n*-propyl alcohol and isopropyl alcohol. The odor threshold is 5.3 ppm[41] and 2.6 ppm (NJ). Both are colorless, volatile liquids. Isopropyl alcohol is discussed in a separate entry in this volume. *n*-Propanol: Molecular weight = 60.11; Specific gravity (H_2O:1) = 0.81 at 25°C; Boiling point = 97°C; Freezing/Melting point = −127°C; Vapor pressure = 15 mmHg at 25°C; Flash point = 22.2°C; Autoignition temperature = 412°C. Explosive limits: LEL = 2.2%; UEL = 13.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description (*n*-): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. *n*-Propyl alcohol is used as a solvent in lacquers, dopes; to make cosmetics, dental lotions, cleaners, polishes, and pharmaceuticals; as a surgical antiseptic. It is a solvent for vegetable oils, natural gums and resins; rosin, shellac, certain synthetic resins; ethyl cellulose and butyral; as a degreasing agent; as a chemical intermediate.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 200 ppm/500 mg/m^3 TWA.

NIOSH REL: 200 ppm/500 mg/m^3 TWA; 250 ppm/625 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 100 ppm/246 mg/m^3 TWA; Not Classifiable as a Human Carcinogen.

NIOSH IDLH: 800 ppm.

Protective Action Criteria (PAC)

TEEL-0: 200 ppm

PAC-1: 250 ppm

PAC-2: 250 ppm

PAC-3: 800 ppm

isopropanol

OSHA PEL: 400 ppm/980 mg/m^3 TWA.

NIOSH REL: 400 ppm/980 mg/m^3 TWA; 500 ppm/1225 mg/m^3 STEL

ACGIH TLV®[1]: 200 ppm/492 mg/m^3 TWA; 400 ppm/984 mg/m^3 STEL, Not Classifiable as a Human Cardinogen; BEI issued.

TEEL-0: 0.25 ppm

PAC-1: 0.75 ppm

PAC-2: 5 ppm

PAC-3: 150 ppm

DFG MAK: 200 ppm/500 mg/m^3 [skin]; BAT: 50 mg [Acetone]/L in blood or urine/end-of-shift as isopropyl alcohol.

Australia: TWA 200 ppm (500 mg/m^3); 200 ppm (492 mg/m^3) STEL [skin], 1993; Austria: MAK 200 ppm (500 mg/m^3), 1999; Belgium: TWA 200 ppm (492 mg/m^3); STEL 250 ppm, [skin], 1993; Denmark: TWA 200 ppm (500 mg/m^3), [skin], 1999; Finland: TWA 200 ppm (500 mg/m^3); STEL 250 ppm, [skin], 1999; France: VME 200 ppm (500 mg/m^3), 1999; Hungary: TWA 100 mg/m^3; STEL 200 mg/m^3, 1993; Norway: TWA 100 ppm (245 mg/m^3), 1999; Poland: MAC (TWA) 200 mg/m^3; MAC (STEL) 600 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Sweden: NGV 150 ppm (350 mg/m^3), KTV 250 ppm (600 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (500 mg/m^3), [skin], 1999; Turkey: TWA 200 ppm (500 mg/m^3), 1993; United Kingdom: TWA 200 ppm (500 mg/m^3); STEL 250 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm [skin]. Russia[35, 43] set a MAC value of 0.3 mg/m^3 for ambient air in residential areas[60] both on a momentary and a daily average basis. Several states have set guidelines or standards for propanol in ambient air[60] ranging from 0.67 mg/m^3 (Massachusetts) to 5.0−6.25 mg/m^3 (North Dakota) to 8.0 mg/m^3 (Virginia) to 10.0 mg/m^3 (Connecticut) to 11.905 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1401, alcohols.[18]

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 6900 μg/L based on health effects. Russia[35, 43] set a MAC of 0.25 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propyl alcohol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Prolonged skin contact can cause a burning sensation and rash. Exposure to high concentrations can affect the central nervous system and cause headaches, drowsiness, dizziness, and confusion; may cause ataxia, gastrointestinal pain, abdominal cramps, nausea, vomiting, diarrhea. High levels can cause unconsciousness.

Long Term Exposure: Repeated skin exposure may cause drying and cracking of the skin. Propyl alcohol may cause mutations. Handle with extreme caution. This chemical is listed by the state of New Jersey as a Special Health Hazard and a data sheet (listed below) states that this chemical may be a carcinogen in humans: It has been shown to cause liver carcinomas and sarcoma, spleen sarcoma, and leukemia in animals. It should be treated with caution.

Points of Attack: Eyes, skin, respiratory system, gastrointestinal tract, central nervous system. May cause liver damage. It may cause brain or nerve damage.

Medical Surveillance: Liver function tests. Evaluate for brain and nerve effects including cerebellar, autonomic and peripheral nervous systems, changes in memory, concentration, sleeping pattern, mood, headaches, and fatigue. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, Teflon™, nitrile, and polyvinyl acetate are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 800 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propyl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where propyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (March 31, 1983). *Chemical Hazard Information Profile Draft Report: n-Propanol*. Washington, DC

New Jersey Department of Health and Senior Services. (June 2005). *Hazardous Substances Fact Sheet: Propyl Alcohol*. Trenton, NJ

Propylamine P:1210

Molecular Formula: C_3H_9N

Common Formula: $CH_3CH_2CH_2NH_2$

Synonyms: 1-Aminopropane; 1-Iodopropane; Mono-*n*-propylamine; Monopropylamine; Propanamine; *n*-Propilamina (Spanish); Propylamine

CAS Registry Number: 107-10-8

RTECS® Number: UN9100000

UN/NA & ERG Number: UN1277/132

EC Number: 203-462-3

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U194.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: *n*-Propylamine is a water-white liquid with a strong irritating odor similar to that of ammonia. Molecular weight = 59.13; Specific gravity (H_2O:1) = 0.71 at 25°C; Boiling point = 49°C; Freezing/Melting point = −83°C; Flash point = < −37°C; Autoignition temperature = 318°C. Explosive limits: LEL = 2.0%; UEL = 10.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Propylamine is used to make textile resins, drugs, pesticides, and other chemicals.

Incompatibilities: Violent reaction with oxidizers and mercury, strong acids, organic anhydrides, isocyanates, aldehydes, nitroparaffins, halogenated hydrocarbons, alcohols, and many other compounds. Attacks many metals and alloys, especially copper. Aqueous solutions may attack glass.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 15 ppm

PAC-1: 50 ppm

PAC-2: 250 ppm

PAC-3: 250 ppm

Finland: STEL 5 ppm (12 mg/m^3), [skin], 1999; Russia[43] set a MAC of 5 mg/m^3 in work-place air. It should be recognized that propylamine can be absorbed through your skin, thereby increasing your exposure.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.2$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Propylamine can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. Propylamine can cause severe eye burns leading to permanent damage and blindness. Contact can cause severe skin burns. Breathing Propylamine can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. Overexposure may damage lungs, liver, kidneys, and heart muscle.

Long Term Exposure: Repeated lower exposure may damage the lungs, liver, kidneys, and/or heart muscle. Some amines cause skin or lung sensitization and allergy; however, it is not known if this chemical causes these allergies.

Points of Attack: Lungs, liver, kidneys, heart.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: tests for kidney and liver function. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and polyvinyl acetate are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to propylamine, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a MSHA/NOSH-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylamine is incompatible with strong acids (such as hydrochloric, sulfuric, and nitric), acid anhydrides, acid chlorides, strong oxidizers (such as chlorine, bromine, and fluorine), carbon dioxide, and triethynyl aluminum. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where Propylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propylamine. Wherever propylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective for fighting fires. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Reference

New Jersey Department of Health and Senior Services. (March 2001). *Hazardous Substances Fact Sheet: Propylamine*. Trenton, NJ

Propyl chloroformate P:1220

Molecular Formula: $C_4H_7ClO_2$

Common Formula: $ClCOOC_3H_7$

Synonyms: Carbonochloridic acid, Propyl ester; Chloroformic acid propyl ester; Propyl chlorocarbonate; *n*-Propyl chloroformate

CAS Registry Number: 109-61-5
RTECS® Number: LQ6830000
UN/NA & ERG Number: UN2740/155
EC Number: 203-687-7 [*Annex I Index No.*: 607-142-00-8]
Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, T; Risk phrases: R11; R23; R34; Safety phrases: S1/2; S16; S26; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propyl chloroformate is a colorless liquid. Molecular weight = 122.56; Boiling point = 114−116°C; Flash point = −50°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2₩. Insoluble in water; slowly decomposes.

Potential Exposure: Propyl chloroformate is used in organic synthesis; as an intermediate for polymerization initiators; military poison gas.

Incompatibilities: Oxidizers, water, and alcohol

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*
TEEL-0: 0.75 ppm
PAC-1: 2 ppm
PAC-2: **3.7** ppm
PAC-3: **11** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator; vapors cause tearing. Corrosive to eyes, skin, and mucous membranes. May cause burns and permanent eye damage. Poisonous: may be fatal if inhaled, swallowed, or absorbed through skin.

Long Term Exposure: May cause lung damage.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISON, CORROSIVE," It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.8/1.3

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride and chlorine, are produced in fire. *Small fires:* Dry chemical, carbon dioxide extinguishers. Move container from fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Spray cooling water on containers that are exposed to flames until after fire is out. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propyl Chloroformate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Propyl Chloroformate*. Trenton, NJ

Propylene P:1230

Molecular Formula: C_3H_6

Common Formula: $CH_2{=}CHCH_3$

Synonyms: Isobutylene; Methylethene; Methylethylene; NCI-C50077; Propene; 1-Propene; Propileno (Spanish)

CAS Registry Number: 115-07-1; *(alt.)* 676-63-1; *(alt.)* 33004-01-2

RTECS® Number: UC6470000

UN/NA & ERG Number: UN1077/115

EC Number: 204-062-1 [*Annex I Index No.:* 601-011-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: F+; Risk phrases: R12; Safety phrases: S2; S9; S16; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Propylene is a colorless gas with a slight odor. The odor threshold is 23 ppm. Molecular weight = 42.09; Specific gravity (H_2O:1) = 0.51 at 25°C; Boiling point = −47°C; Freezing/Melting point = −185°C; Flash point = Flammable gas (−72°C); Autoignition temperature = 455°C. Explosive limits: LEL = 2.0%; UEL = 11.1%. Hazard Identification (based on NFPA-704

M Rating System): Health 1, Flammability 4, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen. Propylene is used in the production of fabricated polymers, fibers, polypropylene resins, solvents, isopropyl alcohol, propylene dimer and trimer as gasoline components and detergent raw materials, propylene oxide, cumene, synthetic glycerol, isoprene, and oxo-alcohols.

Incompatibilities: Violent reaction with oxidizers and many other compounds. Able to form unstable peroxides; can polymerize, especially in heat, direct sunlight, oxidizers and other chemicals.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 500 ppm/860 mg/m^3 TWA, not classifiable as a human carcinogen.

Protective Action Criteria (PAC)
TEEL-0: 500 ppm
PAC-1: 1500 ppm
PAC-2: 10,000 ppm
PAC-3: 20,000 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Russia: STEL 100 mg/m^3, 1993; Switzerland: MAK-W 10,000 ppm (17,500 mg/m^3), 1999; United Kingdom: asphyxiant, 2000; the Netherlands: MAC-TGG 900 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[43] set a MAC of 3.0 mg/m^3 in ambient air in residential areas both on a momentary and a daily average basis.

The oxygen content should be tested regularly to ensure that it is at least 19% by volume.

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.8$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propylene can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out from lack of oxygen. Death can result. Contact with liquefied propylene can cause frostbite.

Long Term Exposure: Exposure may cause an irregular heartbeat. It may also damage the liver.

Points of Attack: Liver, heart, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Holter monitor (a special 24-h EKG to look for irregular heartbeat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to propylene is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in positive-pressure mode should be used in oxygen-deficient environments.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or direct sunlight. Sources of ignition, such as smoking and open flames, are prohibited where propylene is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of propylene. Wherever propylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Procedures for the handling, use, and storage of propylene cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Put on protective clothing and equipment. Remove tank or cylinder to an open area. Allow to bleed off slowly into atmosphere. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or liquid. Poisonous gases, including carbon dioxide and carbon monoxide, are produced in fire. Stop flow of gas. Use carbon dioxide or dry chemical. Use water spray, fog, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers and protect firefighters. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Propylene*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (May 2004). *Hazardous Substances Fact Sheet: Propylene*. Trenton, NJ

Propylene chlorohydrins P:1240

Molecular Formula: C_3H_7ClO

Common Formula: $CH_3CHClCH_2OH$

Synonyms: 2-Chloro-1-propanol; 2-Chloropropanol; β-Chloropropyl alcohol; 2-Chloropropyl alcohol; 1-Propanol, 2-chloro-; 1-Chloro-2-propanol with 2-chloro-1-propanol (127-00-4)

CAS Registry Number: 78-89-7 (2-chloropropan-1-ol); 127-00-4 (1-chloropropan-2-ol)

RTECS® Number: UA8925000

UN/NA & ERG Number: UN2611/131

EC Number: 201-154-3 (2-chloropropan-1-ol); 204-819-6 (1-chloropropan-2-ol).

Regulatory Authority and Advisory Bodies

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propylene chlorohydrin is a colorless liquid. Molecular weight = 94.55; Boiling point = 133−134°C; Flash point = 52°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

78-89-7 & 204-819-6

ACGIH TLV®[1]: 1 ppm/4 mg/m^3 [skin], not classifiable as a human carcinogen.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Propylene chlorohydrin can affect you when breathed in and by passing through your skin. Contact can severely irritate and may burn the eyes. Breathing propylene chlorohydrin can irritate the nose and throat. Contact can irritate the skin. Overexposure may cause you to be lightheaded, unsteady, and drowsy.

Long Term Exposure: No chronic health effects are known at this time.

Points of Attack: Skin, eyes.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to propylene chlorohydrin, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where propylene chlorohydrin is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen chloride and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (March 1998). *Hazardous Substances Fact Sheet: Propylene Chlorohydrin*. Trenton, NJ

Propylene glycol P:1250

Molecular Formula: $C_3H_8O_2$

Common Formula: $CH_3CHOHCH_2OH$

Synonyms: 1,2-Dihydroxypropane; Methyl ethylene glycol; Methyl glycol; 1,2-Propanediol

CAS Registry Number: 57-55-6

RTECS® Number: TY2000000

UN/NA & ERG Number: None assigned; UN1913 (combustible liquid; *Note*: must be preheated)/128

EC Number: 200-338-0

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: SHE—clonal assay.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

FDA—over-the-counter drug.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propylene glycol is a colorless, odorless, syrupy liquid. Molecular weight = 76.11; Boiling point = 188°C; Specific gravity (H_2O:1) = 1.04 at 25°C;

Freezing/Melting point = −59°C; Flash point = 99°C (cc); Autoignition temperature = 371°C. Explosive limits: LEL = 2.6%; UEL = 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1 (must be preheated), Reactivity 0; NJDHSS: Health 1, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Propylene glycol is used as a solvent, emulsifying agent, food and feed additive, flavoring agent; in the manufacturing of plastics; as a plasticizer, surface-active agent, antifreeze, solvent, disinfectant, hydroscopic agent; coolant in refrigeration systems; pharmaceutical; brake fluid; and many others.

Incompatibilities: Contact with oxidizing agents, such as permanganates or dichromates, can cause a violent reaction.

Permissible Exposure Limits in Air

AIHA WEEL: 10 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

United Kingdom: TWA 150 ppm, total vapor and particulates; STEL 10 mg/m^3, particulates, 2000.

Determination in Air: NIOSH Analytical Method #5523, Glycols.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.9$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Two fluid ounces (60 mL) has caused stupor which lasted for a few hours which was followed by complete recovery.

Long Term Exposure: A mild allergen. Repeated or prolonged contact may cause skin sensitization and allergy. Therapeutic doses given for over a year have been associated with seizures; no further seizures occurred upon withdrawal of medication.

Points of Attack: Skin.

Medical Surveillance: Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene, Nitrile + PVC, butyl rubber; polyvinyl chloride, Tychem® (from E.I. du Pont de Nemours & Company), Trellchem™, and Responder™ are among the recommended protective materials. Butyl rubber, Nitrile, Neoprene, and Neoprene + natural rubber are among the glove materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a well-ventilated area away from ignition sources. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Propylene Glycol*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (September 2009). *Hazardous Substances Fact Sheet: Propylene Glycol*. Trenton, NJ

Propylene glycol dinitrate P:1260

Molecular Formula: $C_3H_6N_2O_6$

Common Formula: $CH_3CHONO_2CH_2ONO_2$

Synonyms: PGDN; Propylene glycol-1,2-dinitrate; 1,2-Propanediol, dinitrate; 1,2-Propylene glycol dinitrate

Note: Otto fuel is primarily propylene glycol dinitrate.

CAS Registry Number: 6423-43-4; 106602-80-6 (otto fuel)

RTECS® Number: TY6300000

UN/NA & ERG Number: FORBIDDEN to be transported

EC Number: 229-180-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Propylene glycol dinitrate is an explosive, colorless, high-boiling liquid (solid below −8°C) with a disagreeable odor. Molecular weight = 166.11; Specific gravity (H_2O:1) = 1.23 at 25°C; Boiling point = (decomposes) 207°C at 760 mmHg; Freezing/Melting point = −7.8°C; Vapor pressure = 0.07 mmHg at 22°C. Flash point = 99°C. Strong oxidizer. Slightly soluble in water; solubility = 0.1%.

Potential Exposure: Compound Description: Human Data; Primary Irritant. Propylene glycol dinitrate has been used as a torpedo propellant. The explosion potential is similar to ethylene glycol dinitrate.

Incompatibilities: A strong oxidizer. Contact with ammonia compounds, amines, strong acids, reducing agents, combustible materials may result in fire and explosion. It is similar to ethylene glycol dinitrate in explosion potential. Propylene glycol dinitrate may explode if strongly shocked or heated.

Permissible Exposure Limits in Air

Conversion factor: 6.79 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.05 ppm/0.3 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.05 ppm/0.34 mg/m^3 TWA [skin]; BEI$_M$ issued for Methemoglobin inducers.

Protective Action Criteria (PAC)*

6423-43-4 (propylene glycol dinitrate) & 106602-80-6 (otto fuel which is primarily propylene glycol dinitrate)

TEEL-0: 0.05 ppm

PAC-1: **0.17** ppm

PAC-2: **1.0** ppm

PAC-3: **13** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.05 ppm/0.34 mg/m^3 TWA; Peak Limitation Category I(1) [skin].

Australia: TWA 0.05 ppm (0.3 mg/m^3), [skin], 1993; Austria: MAK 0.05 ppm (0.3 mg/m^3), [skin], 1999; Belgium: TWA 0.5 ppm (0.35 mg/m^3), [skin], 1993; Denmark: TWA 0.02 ppm (0.2 mg/m^3), [skin], 1999; Finland: TWA 0.02 ppm (0.2 mg/m^3); STEL 0.06 ppm, [skin], 1999; France: VME 0.05 ppm (0.3 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 0.3 mg/m^3, [skin], 2003; Sweden: NGV 0.1 ppm (0.7 mg/m^3), KTV 0.3 ppm (2 mg/m^3), [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.35 mg/m^3), [skin], 1999; United Kingdom: TWA 0.2 ppm (1.4 mg/m^3); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for propylene glycol dinitrate in ambient air[60] ranging from 3 μg/m^3 (North Dakota) to 5 μg/m^3 (Virginia) to 6 μg/m^3 (Connecticut) to 7 μg/m^3 (Nevada).

Determination in Air: See OSHA Analytical Method 43.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Propylene glycol dinitrate can affect you when breathed in and by passing through your skin. Exposure can cause headaches, stuffy nose, eye irritation, a "drunken" feeling with impaired balance, visual disturbance. Higher exposures can interfere with the ability of the blood to carry oxygen (methemoglobinemia). This causes cyanosis, a bluish color to the skin and can lead to death. Propylene glycol dinitrate can cause the blood pressure to drop rapidly. Human volunteers at 0.2 ppm exposure exhibited headaches and disruption in visually evoked response. At 0.5 ppm, marked impairment in balance was noted. At 1.5 ppm eye irritation occurred, in addition.[53]

Long Term Exposure: May cause liver and kidney damage.

Points of Attack: Eyes, central nervous system, blood, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood tests for methemoglobin level. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.05* ppm, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Explosive. Prior to working with this chemical you should be trained on its proper handling and storage. Propylene glycol dinitrate must be stored to avoid contact with ammonia compounds, amines, oxidizers, reducers, or combustible material since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and avoid shocking or jolting containers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dinitropropylene glycol is FORBIDDEN.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Propylene Glycol Dinitrate*. Trenton, NJ

Propylene glycol monomethyl ether P:1270

Molecular Formula: $C_4H_{10}O_2$

Common Formula: $CH_3OCH_2CHOHCH_3$

Synonyms: Dowtherm® 209; 1-Methoxy-2-hydroxypropane; 1-Methoxy-2-propanol; 2-Methoxy-1-methylethanol; PGME; Propylene glycol methyl ether

CAS Registry Number: 107-98-2

RTECS® Number: UB7700000

UN/NA & ERG Number: UN3092/129

EC Number: 203-539-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol $R\text{—}(OCH_2CH_2)_n\text{—}OR'$, where $n = 1$, 2, or 3; R = alkyl or aryl groups; $R' = R$, H, or groups which when removed, yield glycol ethers with the structure: $R\text{—}(OCH_2CH)_n\text{—}OH$. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. $R\text{—}(OCH_2CH_2)_n\text{—}OR'$; Where $n = 1$, 2, or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; $R' + H$, or alkyl C7 or less; or OR' consisting of carboxylic ester, sulfate, phosphate, nitrate, or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: None assigned; Risk phrases: 10; Safety phrases: S2; S24 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propylene glycol monomethyl ether is a colorless liquid with an ethereal odor. The odor threshold is 10 ppm. Molecular weight = 90.14; Specific gravity (H_2O:1) = 0.96 at 25°C; Boiling point = 120°C; Freezing/Melting point = (sets to glass) −96°C; Vapor pressure = 12 mmHg at 25°C; Flash point = 36.1°C; Autoignition temperature = 272°C. Explosive limits: LEL = 1.6%; UEL = 13.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data; Primary Irritant. Propylene glycol monomethyl ether is used as a solvent for coatings; cellulose esters and acrylics; acrylics dyes; inks; and stains. It may also be used as a heat-transfer fluid.

Incompatibilities: Reacts with oxidizers, strong acids, acid chlorides, acid anhydrides, isocyanates, aluminum, and copper. Hygroscopic (i.e., absorbs moisture from the air). May slowly form reactive peroxides during prolonged storage.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.69 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 100 ppm/360 mg/m^3 TWA: 150 ppm/540 mg/m^3 STEL.

ACGIH TLV®[1]: 100 ppm TWA; 150 ppm STEL.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 150 ppm

PAC-2: 150 ppm

PAC-3: 1250 ppm

DFG MAK: 100 ppm/370 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Austria: MAK 100 ppm (375 mg/m^3), 1999; Belgium: TWA 100 ppm (369 mg/m^3); STEL 150 ppm (553 mg/m^3), 1993; Denmark: TWA 50 ppm (185 mg/m^3), 1999; Finland: TWA 100 ppm (360 mg/m^3); STEL 150 ppm, [skin], 1999; France: VME 100 ppm (360 mg/m^3), 1999; Norway: TWA 50 ppm (180 mg/m^3), 1999; the Netherlands: MAC-TGG 375 mg/m^3, 2003; Switzerland: MAK-W 100 ppm (360 mg/m^3), KZG-W 200 ppm (720 mg/m^3), 1999; United Kingdom: TWA 100 ppm (375 mg/m^3); STEL 300 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 150 ppm. Several states have set guidelines or standards for PGME in ambient air[60] ranging from 3.6—5.4 mg/m^3 (North Dakota) to 6.0 mg/m^3 (Virginia) to 7.2 mg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method #2554; OSHA Analytical Method 99.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Propylene glycol monomethyl ether can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. Exposure can irritate the nose and throat. Very high levels may cause lung, liver, and kidney damage. Very high levels of propylene glycol monomethyl ether may cause central nervous system depression, dizziness and lightheadedness, and unconsciousness.

Long Term Exposure: Causes skin dryness, dermatitis. May cause liver and kidney damage. Can irritate the lungs; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 100 ppm, use a NIOSH/MSHA- or European Standard EN 149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full-facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN 149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: 1-Methoxy-2-propanol requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3. Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

Reference

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Propylene Glycol Monomethyl Ether*. Trenton, NJ

Propyleneimine P:1280

Molecular Formula: C_3H_7N

Synonyms: Aziridina, 2-metil (Spanish); Aziridine, 2-methyl-; 2-Methylazacyclopropane; 2-Methylaziridine; 2-Methylethylenimine; 2-Methylethylen imine; Propilenimina (Spanish); Propylene imine; 1,2-Propyleneimine

CAS Registry Number: 75-55-8

RTECS® Number: CM8050000

UN/NA & ERG Number: UN1921 (stabilized)/131

EC Number: 200-878-7 [*Annex I Index No.:* 613-033-00-6]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human No Adequate Data, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—RLV F344 rat embryo; Host-mediated assay; Positive: *E. coli* polA without S9; Histidine reversion—Ames test; Positive: *In vitro* UDS—human fibroblast; *S. cerevisiae*—homozygosis; Positive: *S. pombe*—reversion; Positive/dose response: Cell transform.—BALB/c-3T3.

Banned or Severely Restricted (Belgium, Sweden) (UN).[13]

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): P067.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: F, T + , N; Risk phrases: R45; R11; R26/27/28; R41; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propyleneimine is a fuming, colorless, oily liquid with a strong ammonia-like odor. Molecular weight = 57.11; Specific gravity (H_2O:1) = 0.81 at 25°C; Boiling point = 66.7°C; Freezing/Melting point = −63°C; Vapor pressure = 112 mmHg at 25°C; Flash point = − 10°C (cc). Explosive limits: LEL = 2.3%; UEL = 15.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Propyleneimine is used in the modification of latex surface coating resins; in the production of polymers for use in the paper and textile industries as coatings and adhesives.

Incompatibilities: Reacts with acids, strong oxidizers, water, carbonyl compounds, quinones, sulfonyl halides. May explode in heat. Subject to violent polymerization in contact with acids. Hydrolyzes in water to form methylethanolamine.

Permissible Exposure Limits in Air

OSHA PEL: 2 ppm/5 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/5 mg/m^3 TWA [skin]; A potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/5 mg/m^3 TWA; 0.4 ppm/1 mg/m^3 STEL [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: (potential occupational carcinogen) 100 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: 0.4 ppm

PAC-2: **12** ppm

PAC-3: **23** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 3B.

Australia: TWA 2 ppm (5 mg/m^3), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 2 ppm (5 mg/m^3), [skin], 1999; Finland: STEL 2 ppm (5 mg/m^3), [skin], carcinogen, 1999; France: carcinogen, 1993; Japan: 2 ppm (4.7 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 0.6 μg/m^3, 2003; the Philippines: TWA 2 ppm (5 mg/m^3), [skin], 1993; Russia: TWA 2 ppm, 1993; Switzerland: MAK-W 2 ppm (5 mg/m^3), [skin], carcinogen, 1999; Turkey: TWA 2 ppm (5 mg/m^3), [skin], 1993; United

Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propyleneimine in ambient air[60] ranging from zero (North Dakota) to 12 μg/m^3 (Pennsylvania) to 50 μg/m^3 (Connecticut and Virginia) to 119 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Contact may cause skin burns and permanent eye damage. Symptoms of exposure include inflammation and blistering of the skin, eye, and upper respiratory tract; irritation, nausea, itching, and periodic vomiting. Headache, dizziness, and pain in the temple. Shortness of breath; and increased nasal and laryngeal secretion are seen. It is toxic after acute exposure. LD_{50} = (oral-rat) 19 mg/kg (highly toxic).

Long Term Exposure: Caused skin drying and dermatitis. A potential occupational carcinogen. May affect the kidneys.

Points of Attack: Eyes, skin. Cancer site in animals: nasal cavity, breast, brain, blood or bone marrow.

Medical Surveillance: NIOSH lists the following tests: complete blood count; granulocytic leukemia. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Propyleneimine must be stored to avoid contact with acids and strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where propyleneimine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of Propyleneimine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propyleneimine. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid breathing vapors; avoid bodily contact with the material. Toxic gases, including oxides of nitrogen and carbon monoxide, are released in a fire. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap with water. Use water spray to disperse vapors and dilute standing pools of liquid. Keep sparks and flames away. Attempt to stop leak if it can be done without hazard. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive

concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

Dermer, O. C., & Ham, G. E. (1969). *Ethyleneimine and Other Aziridines*. New York: Academic Press

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propyleneimine*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Propylene Imine*. Trenton, NJ

Propylene oxide P:1290

Molecular Formula: C_3H_6O

Synonyms: AD 6; Epoxypropane; 1,2-Epoxypropane; 2,3-Epoxypropane; Methyl ethylene oxide; Methyl oxirane; NCI-C50099; Oxido de propileno (Spanish); Oxyde de propylene (French); Oxirane, methyl-; Propane, 1,2-epoxy-; Propene oxide; Propylene epoxide; 1,2-Propylene oxide

CAS Registry Number: 75-56-9

RTECS® Number: TZ2975000

UN/NA & ERG Number: UN1280/127

EC Number: 200-879-2 [*Annex I Index No.:* 603-055-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence, Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1997; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; some evidence: rat; equivocal evidence: rat

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE EPA; Positive: *N. crassa*—reversion; *D. melanogaster* sex-linked lethal EPA; Positive: *S. pombe*—reversion EPA; Negative: Rodent dominant lethal EPA; Positive: CHO gene mutation.

Highly Reactive Substance and Explosive (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, T; R45; R46; R12; R20/21/22; R36/37/38; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Propylene oxide is a colorless liquid with an ether-like odor. Molecular weight = 58.09; Boiling point = 34.4°C; Specific gravity (H_2O:1) = 0.83 at 25°C; Freezing/Melting point = −112.2°C; Vapor pressure = 445 mmHg at 25°C; Flash point = −37.2°C; Autoignition temperature = 450°C. Explosive limits: LEL = 2.3%; UEL = 36−38.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2. Soluble in water; solubility = 41%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector;

Human Data; Hormone, Primary Irritant. Propylene oxide is used as an intermediate in the production of polyether polyols and propylene glycol; as a fumigant; in the production of adducts as urethane foam ingredients; in detergent manufacture; as a component in brake fluids.

Incompatibilities: Reacts with strong oxidizers, anhydrous metal chlorides, chlorine, iron, strong acids, caustics and peroxides. Polymerization may occur due to high temperatures or contamination with alkalis, aqueous acids, amines, metal chlorides, and acidic alcohols. Attacks some plastics, coatings, and rubber.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.38 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm/240 mg/m^3 TWA.

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/4.8 mg/m^3 TWA, sensitizer; confirmed animal carcinogen with unknown relevance to humans. (2000)

NIOSH IDLH: 400 ppm (potential occupational carcinogen).

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **73** ppm

PAC-2: **290** ppm

PAC-3: **870** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 20 ppm (50 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 20 ppm (48 mg/m^3), 1993; Denmark: TWA 5 ppm (12 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (12 mg/m^3), carcinogen, 1999; France: VME 20 ppm (50 mg/m^3), carcinogen, 1999; the Netherlands: MAC-TGG 6 mg/m^3, 2003; the Philippines: TWA 100 ppm (240 mg/m^3), 1993; Russia: STEL 1 mg/m^3, [skin], 1993; Sweden: NGV 5 ppm (12 mg/m^3), KTV 10 ppm (25 mg/m^3), 1999; Switzerland: MAK-W 2.5 ppm (6 mg/m^3), carcinogen, 1999; Turkey: TWA 100 ppm (240 mg/m^3), 1993; United Kingdom: TWA 5 ppm (12 mg/m^3), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC of 0.08 mg/m^3 for ambient air in residential areas. Several states have set guidelines or standards for propylene oxide in ambient air[60] ranging from 0.0833 μg/m^3 (Kansas) to 1.0 μg/m^3 (Connecticut) to 15.0 μg/m^3 (Massachusetts) to 167.0 μg/m^3 (New York) to 250.0 μg/m^3 (South Carolina) to 500.0 μg/m^3 (North Dakota) to 625.0 μg/m^3 (Pennsylvania) to 850.0 μg/m^3 (Virginia) to 1190.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1612. Propylene oxide; OSHA Analytical Method 88.

Permissible Concentration in Water: Russia has set[35] a MAC value of 0.01 mg/L in water bodies used for domestic purposes and 0.005 mg/L in water bodies used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <0.02.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Propylene oxide may irritate or burn the skin, eyes, and respiratory tract. Contact with the liquid can cause blindness and death. This material is moderately toxic by inhalation and ingestion. It may cause irreversible and reversible changes. Skin contact with the material or solutions of the material cause irritation; diluted solutions are more irritating than undiluted materials. Dermatitis (red, inflamed skin) is common. Exposure may cause mild depression of the central nervous system, and eye, nasal, and lung irritation. Other signs and symptoms of acute exposure may include headache, nausea, vomiting, and unconsciousness. Victims may appear as if they are in a drunken stupor. Pulmonary edema may occur.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. This substance is possibly carcinogenic to humans. May decrease fertility in males and females. May cause lung damage; pneumonia may develop.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: nasal cavity, stomach.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Examination of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and butyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylene oxide must be stored to avoid contact with anhydrous metal chlorides, iron, strong acids (such as hydrochloric, sulfuric, and nitric), strong bases and peroxides, copper or copper alloys since violent reactions occur. Propylene oxide will attack some forms of plastics, rubber, and coatings. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where propylene oxide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propylene oxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propylene oxide. Wherever propylene oxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Firefighting should be done from a safe distance or from a protected location. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Move container from area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides—discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.[22]

References

Bogyo, D. A., Lande, S. S., Meylan, W. M., Howard, P. H., & Santodonato, J. (March 1980). Syracuse Research Corp. Center for Chemical Hazard Assessment, *Investigation of*

Selected Potential Environmental Contaminants: Epoxides, Report EPA-560/11-08-005. Washington, DC: US Environmental Protection Agency
US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Propylene Oxide*. Washington, DC: Chemical Emergency Preparedness Program
New York State Department of Health. (April 1986). *Chemical Fact Sheet: Propylene Oxide*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment
New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Propylene Oxide*. Trenton, NJ

Propyl isocyanate P:1300

Molecular Formula: C_4H_7NO
Common Formula: C_3H_7NCO
Synonyms: 1-Isocyanatopropane; Isocyanic acid, propyl ester; *m*-Propyl isocyanate; 1-Propyl isocyanate
CAS Registry Number: 110-78-1
RTECS® Number: NR190000
UN/NA & ERG Number: UN2482/155
EC Number: 203-803-6
Regulatory Authority and Advisory Bodies
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Propyl isocyanate is a colorless to light yellow liquid with a sharp odor. Molecular weight = 85.12; Flash point = 23°C. Insoluble; reacts with water.

Potential Exposure: This material is used in making other chemicals and insecticides.

Incompatibilities: Violent reactions with strong oxidizers, water, amines, strong bases, and alcohols.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC) Isocyanate-bearing waste (as CNs, n.o.s.).
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 25 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. May be absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Propyl isocyanate can affect you when breathed in and possibly by passing through your skin. Irritates the eyes, skin, nose, throat, and lungs. Prolonged contact may cause severe irritation and permanent eye damage. Very high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Very irritating substances may affect the lungs. Many isocyanates cause an asthma-like lung allergy. It is not known for certain if propyl isocyanate does.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests. These may be normal if the person is not having an attack at the time of the test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to propyl isocyanate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Propyl isocyanate must be stored to avoid contact with strong oxidizers, water, amines, strong bases (such as sodium hydroxide or potassium hydroxide) and alcohols since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, light, and moisture. Sources of ignition, such as smoking and open flames, are prohibited where propyl isocyanate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of propyl isocyanate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propyl isocyanate.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS, FLAMMABLE LIQUID." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 1.7/2.7

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 6.0/9.6
Night 7.0+/11.0+ distance can be larger in certain atmospheric conditions

Fire Extinguishing: Propyl isocyanate is a flammable liquid. Poisonous gases are produced in fire, including hydrogen cyanide and oxides of nitrogen. Use dry chemical, CO_2, or foam extinguishers. *Do not use water*. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Propyl Isocyanate*. Trenton, NJ

n-Propyl nitrate P:1310

Molecular Formula: $C_3H_7NO_2$
Common Formula: $CH_3CH_2CH_2NO_2$
Synonyms: Nitrate de propyle *normal* (French); Nitric acid, propyl ester; Propyl nitrate; Nitric acid, *n*-propyl ester; Propyl ester of nitric acid
CAS Registry Number: 627-13-4
RTECS® Number: UK0350000
UN/NA & ERG Number: UN1865/131
EC Number: 210-985-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: *n*-Propyl nitrate is a colorless to pale yellow liquid with an ether-like odor. Molecular weight = 105.11; Specific gravity (H_2O:1) = 1.07 at 25°C; Boiling point = 110.6°C; Freezing/Melting point = −100°C; Vapor pressure = 18 mmHg at 25°C; Flash point = 20°C. Explosive limits: LEL = 2%; UEL = 100%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 3 (Oxidizer). Slightly soluble in water.

Potential Exposure: Propyl nitrate has been used as an intermediate as a rocket propellant and as an ignition improver in diesel fuels.

Incompatibilities: Reacts with strong oxidizers, combustible materials. A shock-sensitive explosive. May explode on heating. Forms explosive mixtures with combustible materials.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.30 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/110 mg/m^3 TWA.

NIOSH REL: 25 ppm/105 mg/m^3 TWA; 40 ppm/170 mg/m^3 STEL.

ACGIH TLV®[1]: 25 ppm/107 mg/m^3 TWA; 40 ppm/172 mg/m^3 STEL; BEI$_M$ issued for methemoglobin inducers.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)

TEEL-0: 25 ppm

PAC-1: 40 ppm

PAC-2: 100 ppm

PAC-3: 500 ppm

DFG MAK: 25 ppm/110 mg/m^3 TWA; Peak Limitation Category II(2).

Australia: TWA 25 ppm (110 mg/m^3); STEL 40 ppm, 1993; Austria: MAK 25 ppm (110 mg/m^3), 1999; Belgium: TWA 25 ppm (107 mg/m^3); STEL 40 ppm (172 mg/m^3), 1993; Denmark: TWA 25 ppm (110 mg/m^3), 1999; Finland: TWA 25 ppm (105 mg/m^3), 1999; Norway: TWA 20 ppm (90 mg/m^3), 1999; the Philippines: TWA 25 ppm (110 mg/m^3), 1993; the Netherlands: MAC-TGG 110 mg/m^3, 2003; Switzerland: MAK-W 25 ppm (110 mg/m^3), 1999; Turkey: TWA 25 ppm (110 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 40 ppm. Several states have set guidelines or standards for propyl nitrate in ambient air[60] ranging from 1.05−1.70 mg/m^3 (North Dakota) to 1.75 mg/m^3 (Virginia) to 2.1 mg/m^3 (Connecticut) to 2.5 mg/m^3 (Nevada).

Determination in Air: Use NIOSH II(3), Method #S-227; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: None listed for humans according to NIOSH[2] but other sources[24] state that vapor inhalation causes low blood pressure, hypotony, hemoglobin defect, anoxia, and cyanosis. In animals: irritation of the eyes, skin; methemoglobinemia, anoxia, cyanosis, dyspnea (breathing difficulty), weakness, dizziness, headache.

Points of Attack: May attack the blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; Complete blood count; urinalysis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Consider treatment for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 250 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*End-of-service life indicator (ESLI) required.

Storage: (1) Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Protect containers against physical damage. Outdoor or detached storage is preferred. Indoor storage should be in a flammable liquid storage room. Propyl nitrate should be isolated from combustible materials and oxidizing agents. Wear Neoprene™ gloves, plastic coverall, and self-contained breathing apparatus. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. After covering the spills with soda ash, mix and spray with water. Scoop into a bucket of water and let it stand for 2 h. Neutralize with 6M-HCl and pass into the drain with sufficient water. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. On fires in which containers are not exposed, use dry chemical, foam, or carbon dioxide. Water spray may be ineffective as an extinguishing agent. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Use water from unmanned monitors or householders to keep fire-exposed containers cool. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes.[22] An alternative route suggested involves pouring over soda ash, neutralizing with HCl, and flushing to the drain with water.

Reference

New Jersey Department of Health and Senior Services. (July 2001). *Hazardous Substances Fact Sheet: n-Propyl Nitrate*. Trenton, NJ

Prothoate P:1320

Molecular Formula: $C_9H_{20}NO_3PS_2$

Synonyms: AC18682; American Cyanamid 18682; *O*,*O*-Diethyldithiophosphorylacetic acid *N*-monoisopropylamide; *O*,*O*-Diethyl *S*-(*N*-isopropylcarbamoylmethyl) dithiophosphate; *O*,*O*-Diethyl *S*-(*N*-isopropylcarbamoylmethyl) phosphorodithioate; *O*,*O*-Diethyl *S*-isopropylcarbamoylmethyl phosphorodithioate; ENT 24,652; FAC; FAC20; Fostion; Isopropyl diethyldithiophosphorylacetamide; *N*-Isopropyl-2-mercaptoacetamide *S*-ester with *O*,*O*-diethyl phosphorodithioate; L 343; *N*-Monoisopropylamide of *O*,*O*-diethyldithiophosphorylacetic acid; Oleofac; Phosphorodithioic acid *O*,*O*-diethyl esters, ester with *n*-isopropyl-2-mercaptoacetamide; Phosphorodithioic acid, *O*,*O*-diethyl *S*-(2-[(1-methylethyl)amino]-2-oxoethyl) ester; Telefos; Trimethoate

CAS Registry Number: 2275-18-5

RTECS® Number: TD8225000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 218-893-2 [*Annex I Index No.:* 015-032-00-0]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Malaysia) (UN).[13]

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R52/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Prothoate is an amber to yellow crystalline solid with a camphor-like odor. Molecular weight = 285.39; Boiling point = 135°C at 0.1 mm; Freezing/Melting point = 29°C. Hazard Identification (based on NFPA-704 M

Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of the systemic acaricide and insecticide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.35 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 1.7 mg/m^3

PAC-3: 7.5 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus pesticides.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This is a highly toxic material capable of causing death or permanent injury due to exposures during normal use. Small doses at frequent intervals are additive. Similar to parathion. Symptoms may include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, headache, giddiness, dizziness, weakness, muscle twitching, difficult breathing, blurring or dimness of vision, and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all the three.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. If material has been ingested, induce vomiting with ipecac.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including nitrogen oxides, sulfur oxides, phosphorus oxides, are produced in fire. This material may burn but does not readily ignite. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. In fighting fires, stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Reference

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Prothoate*. Washington, DC: Chemical Emergency Preparedness Program

Pyrene P:1330

Molecular Formula: $C_{16}H_{10}$

Synonyms: Benzo(def)phenanthrene; Pireno (Spanish); Pyren (German); β-Pyrene

CAS Registry Number: 129-00-0

UN/NA & ERG Number: UN1325 (flammable solid)/133

RTECS® Number: UR2450000

EC Number: 204-927-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

US EPA Gene-Tox Program, Negative: Cell transform.—BALB/c-3T3; SHE—clonal assay; Negative: Cell transform.—mouse embryo; Negative: Cell transform.—RLV F344 rat embryo; Negative: *In vitro* cytogenetics—nonhuman; Host-mediated assay; Negative: Histidine reversion—Ames test; *In vivo* SCE—nonhuman; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast; Negative: V79 cell culture—gene mutation; Inconclusive: Carcinogenicity—mouse/rat; Mammalian micronucleus; Inconclusive: *In vitro* SCE—nonhuman.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.067; Nonwastewater (mg/kg), 8.2.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pyrene is a colorless crystalline solid when pure or pale yellow plates (impure). Polynuclear aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polycyclic aromatic hydrocarbons. Solids and solutions have a blue fluorescence (Merck Index). Molecular weight = 202.26; Boiling point 404°C at 760 mmHg[2]; Freezing/Melting point = 151.2°C.[2] Flash point = 199°C. Explosive limits: LEL = 0.6%; UEL = 3.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description (Toxicity evaluation)[77]: Tumorigen, Mutagen. Primary Irritant. Pyrene is used as an industrial chemical and in biochemical research.

Permissible Exposure Limits in Air
NIOSH IDLH: 80 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.75 mg/m^3
PAC-1: 2.5 mg/m^3
PAC-2: 1.7 mg/m^3
PAC-3: 15 mg/m^3
DFG MAK: [skin].
Russia set a MAC of 0.3 mg/m^3 in work-place air.

Determination in Air: Use NIOSH Analytical Method #5506 polynuclear aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polynuclear aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: Zero is recommended for maximum protection of human health.[6] Kansas[61] has set a guideline for pyrene in drinking water of 0.029 μg/L. The World Health Organization (WHO) recommends a maximum of 2 μg/L for specific PAHs, but this list does not include pyrene.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.88-5.32$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Pyrene is a skin irritant, a suspected mutagen; and an equivocal tumor-causing agent. Workers exposed to 3−5 mg/m^3 of pyrene exhibited some teratogenic effects. Pyrene is a polycyclic aromatic hydrocarbon (PAH). The acute toxicity of pure PAHs appears low when administered orally or dermally to rats or mice. Human exposure to PACs or PAHs is almost exclusively via the gastrointestinal and respiratory tracts, and approximately 99% is ingested in the diet. Despite the high concentrations of pyrene to which humans may be exposed through food, there is currently little information available to implicate diet-derived PAHs as the cause of serious health effects.

Long Term Exposure: The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, respiratory system, bladder, liver, kidneys.

Medical Surveillance: Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace. NIOSH lists: complete blood count; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria.[2]

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that this airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration over 0.1 mg/m^3:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place.

Shipping: Flammable solids, organic, n.o.s. require a shipping label of "FLAMMABLE MATERIALS." It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with toluene to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Pyrene*. Washington, DC: Chemical Emergency Preparedness Program

US EPA. (April 1975). Identification of Organic Compounds in Effluents from Industrial Sources, EPA-560/3-75-002

Eller, P. M., Cassinelli, M. E. (Eds.). (1998). *NIOSH Manual of Analytical Methods (NMAM®)* (4th ed.). 2nd Supplement. National Institute for Occupational Safety and Health, DHHS (NIOSH), Publication No. 98-119. Cincinnati, OH

Pyrethrins or pyrethrum P:1340

Molecular Formula: $C_{20-21}H_{28-30}O_{3-5}$; $C_{20}H_{28}O_3$/$C_{21}H_{28}O_5$/$C_{21}H_{30}O_3$/$C_{22}H_{30}O_5$/$C_{21}H_{28}O_3$/$C_{22}H_{28}O_5$

Synonyms: Buhach; Chrysanthemum cinerareaefolium; Cinerin I; Cinerin II; Dalmation insect flowers; Firmotox; Insect powder; Jasmolin I; Jasmolin II; Piretrina (Spanish); Pyrethrin I; Pyrethrin II; Pyrethrum; Pyrethrum insecticide; Trieste flowers

CAS Registry Number: 8003-34-7; 121-21-1 (I); 121-29-9 (II)

RTECS® Number: UR4200000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: 232-319-8; 204-455-8 [*Annex I Index No.:* 613-023-00-1] (I); 204-462-6 [*Annex I Index No.:* 613-024-00-7] (II)

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Type I:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P008.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

Type II:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1 lb (0.454 kg).

European/International Regulations (*I &II*): Hazard Symbol: Xn, N; Risk phrases: R0/21/22; R50/53; Safety phrases: S2; S13; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: The pyrethrins are a variable mixture of compounds which are found in pyrethrum flowers: cinerin, jasmolin, and pyrethrin. Pyrethrins are a brown, viscous oil or solid. Molecular weight = 316−378; 372.45; Specific gravity (H_2O:1) = 1.0 (approx.) at 25°C; Boiling point = 170°C at 0.1 mm (decomposition); Flash point = 82−88°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Human Data; Natural Product. Pyrethrins are used as an ingredient of various contact insecticides. Those engaged in the isolation, formulation, or application of these materials.

Incompatibilities: Violent reaction with strong oxidizers, alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

NIOSH IDLH: 5000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: 5 mg/m^3, inhalable fraction, danger of skin sensitization; Peak Limitation Category II(2).

Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Norway: TWA 5 mg/m^3, 1999; Thailand: TWA 5 mg/m^3, 1993; Turkey: TWA 5 mg/m^3, 1993; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for pyrethrum in ambient air[60] ranging from 16.7 μg/m^3 (New York) to 50.0 μg/m^3 (Florida and South Carolina) to 50.0–100.0 μg/m^3 (North Dakota) to 80.0 μg/m^3 (Virginia) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5008, Pyrethrum; OSHA Analytical Method 7.[18]

Determination in Water: Fish Tox: 2.38748000 ppb (HIGH).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Pyrethrum can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness and rhinorrhea (discharge of thin nasal mucus).

Long Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing, and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty, and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Skin contact can cause rash with redness, blisters, and intense itching. A severe generalized allergy can occur with weakness and collapse. Human Tox = 68.09339 ppb. Chronic Human Carcinogen Level (CHCL) (LOW).

Points of Attack: Respiratory system, skin, central nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m³:* CcrOv95 (APF = 10) [Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *125 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 mg/m³:* CcrFOv100 (APF = 50) [Any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *5000 mg/m³:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Pyrethrum must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and alkalines since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Pesticides, liquid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1. and Packing Group I to III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}): 100,000 (estimate).

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including acid fumes, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Pyrethrum*. Trenton, NJ

Pyridine P:1345

Molecular Formula: C_5H_5N

Synonyms: Azabenzene; Azine; CP 32; NCI-C55301; Pyridin (German)

CAS Registry Number: 110-86-1

RTECS® Number: UR8400000

UN/NA & ERG Number: UN1282/129

EC Number: 203-809-9 [*Annex I Index No.:* 613-002-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 2000; NCI: Carcinogenesis studies (water); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis studies (drinking water); some evidence: rat.

US EPA Gene-Tox Program, Positive/dose response: *In vitro* SCE—nonhuman.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U196, DO38.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 16.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5); 8270 (10).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 5/17/02.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; Safety phrases: S2; S26; S28 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Pyridine is a colorless liquid with a nauseating, fish-like odor. The odor threshold is 0.17 ppm. Molecular weight = 79.11; Specific gravity (H_2O:1) = 0.98 at 25°C; Boiling point = 115.6°C. Melting/Freezing point = −42.2°C; Vapor pressure = 16 mmHg at 25°C;

Flash point = 20°C; Autoignition temperature = 482°C. Explosive limits: LEL = 1.8%; UEL = 12.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Pyridine is used as a solvent in the chemical industry and as a denaturant for ethyl alcohol; as an intermediate in the production of pesticides; in pharmaceuticals; in the manufacture of paints, explosives, dyestuffs, rubber, vitamins, sulfa drugs, and disinfectants.

Incompatibilities: Violent reaction with strong oxidizers, strong acids, chlorosulfonic acid, maleic anhydride, oleum iodine.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.24 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 5 ppm/15 mg/m^3 TWA.
NIOSH REL: 5 ppm/15 mg/m^3 TWA.
ACGIH TLV®[1]: 1 ppm/3.1 mg/m^3 TWA.
NIOSH IDLH: 1000 ppm.
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 3 ppm
PAC-2: 5 ppm
PAC-3: 1000 ppm
DFG MAK: [skin] 5 ppm/16 mg/m^3 TWA; Peak Limitation Category II(2).

Arab Republic of Egypt: TWA 5 ppm (15 mg/m^3), 1993; Australia: TWA 5 ppm (15 mg/m^3), 1993; Austria: MAK 5 ppm (15 mg/m^3), 1999; Belgium: TWA 5 ppm (16 mg/m^3), 1993; Denmark: TWA 5 ppm (15 mg/m^3), 1999; Finland: TWA 5 ppm (15 mg/m^3); STEL 10 ppm (30 mg/m^3), [skin], 1999; France: VME 5 ppm (15 mg/m^3), VLE 10 ppm, 1999; the Netherlands: MAC-TGG 0.9 mg/m^3, 2003; Norway: TWA 5 ppm (15 mg/m^3), 1999; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 30 mg/m^3, 1999; Russia: STEL 5 mg/m^3, 1993; Sweden: NGV 5 ppm (16 mg/m^3), KTV 10 ppm (35 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (15 mg/m^3), KZG-W 10 ppm (30 mg/m^3), 1999; Turkey: TWA 5 ppm (15 mg/m^3), 1993; United Kingdom: TWA 5 ppm (16 mg/m^3); STEL 10 ppm (33 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm. The Czech Republic: MAC 5.0 mg/m^3.[35] Russia[35, 43] has also set a MAC of 0.08 mg/m^3 for the ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for pyridine in ambient air[60] ranging from 2.0 μg/m^3 (New York) to 150 μg/m^3 (Indiana) to 150.0−300.0 μg/m^3 (North Dakota) to 250.0 μg/m^3 (Virginia) to 300.0 μg/m^3 (Connecticut, Florida) to 357.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1613[18]; OSHA Analytical Method 7.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 207 μg/L. Russia[43] set a MAC of 200 μg/L in water bodies used for domestic purposes and 10 μg/L in water bodies used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.65$.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquids, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system; can cause stomach upset, headache, dizziness, lightheadedness, confusion, coma, and death. *Inhalation:* May cause nose and throat irritation at low levels. Above 5 ppm, the odor may no longer be detected but a characteristic taste may remain. Exposures of 6−12 ppm have caused headache, dizziness, nervousness, trouble sleeping, nausea, and vomiting. *Skin:* Contact with liquid may cause painful irritation and first-degree burns. Longer contact may cause second-degree burns. *Eyes:* Vapors may cause irritation. Contact with liquid can cause irritation, burns, and permanent eye damage. *Ingestion:* 2−3 mL (1/15−1/10 fl oz) may cause loss of appetite, nausea, fatigue, and depression. Swallowing ½ cup has resulted in vomiting, diarrhea, fever, abdominal pain, bluish tint to the skin, confusion, hallucinations, severe lung congestion, and death.

Long Term Exposure: Affects the central nervous system, brain, liver, and kidneys. Can cause skin allergy. Ingestion of about 2 mL (1/10 fl oz) three times/day for a prolonged period resulted in lever and kidney damage and death. Long-term inhalation of levels of 125 ppm in addition to the symptoms listed above may result in damage to the nervous system.

Points of Attack: Eyes, skin, central nervous system, liver, kidneys, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: Expired Air; liver function tests; urinalysis. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system; interview for brain effects, kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Pyridine must be stored to avoid contact with strong oxidizers (such as chloride, bromine, and fluorine), strong acids (such as hydrochloride, sulfuric, and nitric), chlorosulfonic acid, maleic anhydride, and oleum iodine because violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where pyridine is used, handles, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gallons or more of pyridine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of pyridine. Wherever pyridine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and cyanides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby nitrogen oxides are removed from the effluent gas by scrubber, catalytic or thermal devices.[22]

References

US Environmental Protection Agency. (April 30, 1980). *Pyridine: Health and Environmental Effects Profile No. 150*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Pyridine*. Version 2. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Pyridine*. Trenton, NJ

Pyriminil P:1350

Molecular Formula: $C_{13}H_{12}N_4O_3$

Synonyms: DLP787; DPL-87; *N*-(4-Nitrophenyl)-*N*′-(3-pyridinylmethyl)urea; 1-(4-Nitrophenyl)-3-(3-pyridinylmethyl) urea; Priminil; *N*-3-Pyridylmethyl-*N*′,*p*-nitrophenylurea; 1-(3-Pyridylmethyl)-3-(4-nitrophenyl)urea; Pyridylmethyl-*N*′, *p*-nitrophenylurea; Pyrinuron; RH-787; Urea, *N*-(4-nitrophenyl)-*N*′-(3-pyridinylmethyl)-; Vacor

CAS Registry Number: 53558-25-1

RTECS® Number: YI9690000

UN/NA & ERG Number: UN2767/151

EC Number: 258-626-7

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Pyriminil is a yellow crystalline solid resembling corn meal. Molecular weight = 272.29; Freezing/Melting point = 223°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Those involved in the manufacture, formulation, or application of this single-dose, acute rodenticide. Not registered as a pesticide in the United States.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 6.2 mg/m^3

PAC-3: 20 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This chemical may cause death by cardiovascular collapse and respiratory failure. Symptoms include nausea, vomiting, abdominal pain, chills, mental confusion, anorexia, aching, dilated pupils, dehydration, chest pain, urinary retention, irregular heartbeat, and muscular weakness. Exposure may also result in visual disturbances, central nervous system depression, and tremors.

Long Term Exposure: It may damage the pancreas, causing diabetes. Human survivors regularly develop an insulin-deficient, ketosis-prone form of diabetes mellitus. Also, it affects the central nervous system.

Points of Attack: Central nervous system.

Medical Surveillance: Blood sugar. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Phenylurea pesticide, solid, toxic, n.o.s. This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases are produced in fire, including nitrogen oxides. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Pyriminil.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2002). *Hazardous Substances Fact Sheet: Pyriminil.* Trenton, NJ

Q

Quartz

See entry under “Silica.”

Quinoline Q:0050

Molecular Formula: C_9H_7N

Synonyms: 1-Azanaphthalene; B-500; 1-Benzazine; 1-Benzine; Benzo(b)pyridine; Benzopyridine; Chinoleine; Leucol; Leucoline; Leukol; Quinoleina (Spanish); Quinolin

CAS Registry Number: 91-22-5

RTECS$^®$ Number: VA9275000

UN/NA & ERG Number: UN2656/154

EC Number: 202-051-6 [*Annex I Index No.*: 613-281-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Likely to produce cancer in humans; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: (*Quinoline and its strong acid salts*) Cancer 10/24/97.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R21/22; R36/38; R68; R51/53; Safety phrases: S1/2; S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Quinoline is a colorless liquid with a penetrating amine odor. Turns brown on exposure to light. Molecular weight = 129.17; Boiling point = 238°C; Freezing/Melting point = −15°C; Flash point = 101−107°C; Autoignition temperature = 480°C. Explosive limits: LEL = 1.2%; UEL = 7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in cold water; highly soluble in hot.

Potential Exposure: In manufacture of quinoline derivatives (dyes and pesticides); in synthetic fuel manufacture. Occurs in cigarette smoke.

Incompatibilities: Reacts, possibly violently, with strong oxidants, strong acids, perchromates, nitrogen tetroxide, and maleic anhydride. Keep away from moisture, steam, and light. Contact with hydrogen peroxide may cause explosion. Unpredictably violent, this substance has been the source of various plant accidents.

Permissible Exposure Limits in Air

AIHA WEEL: 0.001 ppm TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.001 ppm

PAC-1: 0.6 ppm

PAC-2: 5 ppm

PAC-3: 25 ppm

The state of New York has set a guideline for quinoline in ambient air[60] of 0.03 μg/m^3.

Determination in Air: No methods available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Skin or eye contact can cause burns. Vapors can irritate the eyes and respiratory tract and may cause sore throat, nosebleeds, hoarseness, cough, phlegm, and/or tightness in the chest. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. High exposure can cause nausea, vomiting, gastrointestinal cramping, fever, dizziness, fatigue, rapid and irregular pulse, troubled breathing, collapse, and even death from paralysis of muscles needed for breathing. Liver damage may also occur.

Long Term Exposure: May affect the liver and retina of the eyes. May cause liver damage. May lead to development of skin allergy with rash and itching. Very irritating substances may cause lung damage. This substance caused mutations and is possibly carcinogenic to humans.

Points of Attack: Nervous system, liver and kidneys, eyes.

Medical Surveillance: Eye examination. Liver and kidney function tests. Examination of the nervous system.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person’s airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor

Sitting’s Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00016-3

or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective butyl rubber gloves and protective clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator under an inert atmosphere and protect from exposure to light, moisture, strong oxidants, strong acids, perchromates, nitrogen tetroxide, maleic anhydride. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Quinoline requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use absorbent substance to pick up spilled material. Follow by washing surface well first with alcohol, then with soap and water. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, carbon monoxide, and carbon dioxide, are produced in fire. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (December 29, 1983). *Chemical Hazard Information Profile Draft Report: Quinoline*. Washington, DC

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Quinoline*. Trenton, NJ

Quinone Q:0100

Molecular Formula: $C_6H_4O_2$

Synonyms: Benzo-chinon (German); 1,4-Benzoquine; *p*-Benzoquinona (Spanish); *p*-Benzoquinone; 1,4-Benzoquinone; Benzoquinone; *p*-Chinon (German); Chinon

(German); Chinone; Cyclohexadeinedione; 1,4-Cyclohexadienedione; 2,5-Cyclohexadiene-1,4-dione; 1,4-Cyclohexadiene dioxide; 1,4-Dioxybenzene; 1,4-Dioxybenzol; NCI-C55845; Quinona (Spanish); *p*-Quinone

CAS Registry Number: 106-51-4

RTECS® Number: DK2625000

UN/NA & ERG Number: UN2587/153

EC Number: 203-405-2 [*Annex I Index No.:* 606-013-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

US EPA Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U197.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/25; R36/37/38; R50; Safety phrases: S1/2; S26; S28-S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Quinone is a yellow, crystalline material or large yellow, monoclinic prisms with a pungent, irritating odor. Molecular weight = 108.10; Specific gravity (H_2O:1) = 1.32 at 25°C; Boiling point = (sublimes) about 180°C; Freezing/Melting point = 115.6°C; 224°C (decomposes); Vapor pressure = 0.1 mmHg at 25°C; Flash point (depending on humidity) = 38−93°C; Autoignition temperature = 560°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. Due to this compound's ability to react with certain nitrogen compounds to form colored substances, quinone is widely used in the dye, textile, chemical, tanning, and cosmetic industries. It is used as an industrial chemical, laboratory reagent, and as an intermediate in chemical synthesis for hydroquinone and other chemicals.

Incompatibilities: Strong oxidizers, some combustible substances, reducing agents, and strong bases. Decomposes exothermically on warming above 60°C, when moist, producing carbon monoxide.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.42 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.4 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.4 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm/0.44 mg/m^3 TWA.

NIOSH IDLH: 100 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 0.35 ppm

PAC-2: 2.5 ppm

PAC-3: 22.6 ppm

DFG MAK: Danger of skin sensitization; Carcinogen Category 3B; Germ Cell Mutagen Group 3B.

Arab Republic of Egypt: TWA 0.1 ppm (0.4 mg/m^3), 1993; Australia: TWA 0.1 ppm (0.4 mg/m^3), 1993; Austria: MAK 0.1 ppm (0.4 mg/m^3), 1999; Belgium: TWA 0.1 ppm (0.44 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.4 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.4 mg/m^3); STEL 0.3 ppm, [skin], 1999; France: VME 0.1 ppm (0.4 mg/m^3), VLE 0.3 ppm (1.5 mg/m^3), 1999; the Netherlands: MAC-TGG 0.4 mg/m^3, 2003; the Philippines: TWA 5 ppm (15 mg/m^3), 1993; Poland: TWA 0.1 mg/m^3; STEL 0.4 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.1 ppm (0.4 mg/m^3), KTV 0.3 ppm (1.3 mg/m^3), 1999; Switzerland: MAK-W 0.1 ppm (0.4 mg/m^3), KZG-W 0.2 ppm (0.8 mg/m^3), 1999; Turkey: TWA 0.1 ppm (0.4 mg/m^3), 1993; United Kingdom: TWA 0.1 ppm (0.45 mg/m^3); STEL 0.3 ppm (1.3 mg/m^3), 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 ppm.

Determination in Air: Use NIOSH II(4), Method #S-181, Quinone.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.21.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: The vapor irritates the eyes, skin, and respiratory tract; can cause nosebleeds, hoarseness, cough, phlegm, and/or tightness in the chest. Skin contact can cause severe irritation. Solid quinone in contact with skin or the lining of the nose and throat may produce discoloration, severe irritation, swelling, and the formation of ulcers, papules, and vesicles. Prolonged contact with the skin may cause ulceration. Quinone vapor is highly irritating to the eyes. Following prolonged exposure to vapor, brownish conjunctival stains may appear. These may be followed by corneal opacities and structural changes in the cornea and loss of visual acuity. The early pigmentary stains are reversible, while the corneal dystrophy tends to be progressive. Further effects reported[52] include vomiting, collapse, and coma.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the skin and eyes, resulting in discoloration, inflammation and injury of the corneal epithelium, keratitis (inflammation of the cornea), reduced vision. Can cause lung irritation; bronchitis may develop. May cause kidney damage.

Points of Attack: Eyes, skin, lungs, kidneys.

Medical Surveillance: Ophthalmic examination. Careful examination of the eyes, including visual acuity and slit lamp examinations, should be done during placement and periodic examinations. Lung function tests. Kidney function tests. Also evaluate skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode). *Up to 20 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (982°C, 2.0 s minimum).

References

US Environmental Protection Agency, Quinone. (April 30, 1980). *Health and Environmental Effects Profile No. 157.* Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (June 2004). *Hazardous Substances Fact Sheet: p-Benzoquinone*. Trenton, NJ

Quintozene Q:0110

Molecular Formula: $C_6Cl_5NO_2$

Synonyms: Avicol (pesticide); Bartilex; Batrilex; Benzene, pentachloronitro-; Botrilex; Brassicol; Brassicol 75; Brassicol earthcide; Brassicol super; Chinozan; Fartox; Folosan; Fomac 2; Fungichlor; GC 3944-3-4; Kobu; Kobutol; KP2; Marisan forte; NCI-C00419; Nitropentachlorobenzene; Olipsan; Olpisan; PCNB; Pentachlornirtobenzol (German); Pentachloronitrobenzene; Pentagen; Phomasan; PKHNB; Quinosan; Quintocene; Quintoceno (Spanish); Quintozen; RTU 1010; Saniclor 30; Terrachlor; Terraclor; Terraclor 30 G; Terrafun; Tilcarex; Tri-PCNB; Tritisan

CAS Registry Number: 82-68-8; *(alt.)* 39378-26-2

RTECS® Number: DA6550000

UN/NA & ERG Number: UN2588/151

EC Number: 201-435-0 [*Annex I Index No.*: 609-043-00-5]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; NTP: Carcinogenesis Studies (feed); no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Negative: Host-mediated assay; *In vitro* UDS—human fibroblast; Negative: TRP reversion; *S. cerevisiae*—homozygosis; Negative/limited: Carcinogenicity—mouse/rat; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

US EPA Hazardous Waste Number (RCRA No.): U185.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 4.8.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R36/37/38; R40; R50/53; Safety phrases: S1/2; S22; 36/37; S45; S52; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Quintozene is a colorless to cream-colored crystalline material with a musty odor. Molecular weight = 295.32; Boiling point = 328°C; Freezing/Melting point = 142−146°C; Vapor pressure = 1×10^{-4} mbar at 25°C. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Quintozene is used as a chemical intermediate, soil and seed fungicide, slime control in industrial waters, herbicide. A rebuttal presumption against registration was issued on October 13, 1977 by EPA on the basis of oncogenicity.

Incompatibilities: Oxidizers, strong bases. Decomposition products include nitrogen oxides and hydrogen chloride.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.5 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 300 mg/m^3

PAC-3: 500 mg/m^3

Denmark: TWA 0.5 mg/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3, 2003.

Determination in Water: Fish Tox = 64.49856000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause corneal damage and permanent injury. High levels can interfere with the blood's ability to carry oxygen causing methemoglobinemia; cyanosis, with blue color to the skin and lips. Higher levels can cause trouble breathing, collapse, and even death. A chloromononitrobenzene, this chemical may have similar toxic effects as nitrobenzene.

Long Term Exposure: May cause sensitization and skin allergy. May cause damage of the liver and kidneys. Human Tox = 2.10000 ppb (HIGH).

Points of Attack: Blood, skin, liver, kidneys.

Medical Surveillance: Blood methemoglobin levels. Evaluation by a qualified allergist. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical above 0.5 mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 5000 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Chloronitrobenzenes (Mixed Isomers)*. Trenton, NJ

Quinuclidinyl benzilate (Agent BZ, WMD) Q:0120

Molecular Formula: $C_{21}H_{23}NO_3$

Synonyms: Agent 15; Agent-Buzz; 1-Azabicyclo(2,2,2) octan-3-ol, benzilate (ester); Benzeneacetic acid, α-hydroxy-α-phenyl-, 1-azabicyclo(2.2.2)oct-3-yl ester; Benzilic acid, 3-quinuclidinyl ester; BUZZ; BZ; 3-Chinuclidylbenzilate; 3-(2,2-Diphenyl-2-hydroxyethanoyloxy)-quinuclidine; Oksilidin; QNB; 3-Quinuclidinol benzilate; 3-Quinuclidinyl benzilate; Quinuclidinyl benzilate

Hydrochloride:

1-Azabicyclo(2.2.2)octan-3-ol, benzylate (ester), hydrochloride; Benzeneacetic acid, alpha-hydroxy-alpha-phenyl-, 1-azabicyclo(2.2.2)oct-3-yl ester, HCL; Benzilic acid, 3-quinuclidinyl ester, hydrochloride; CHEKB; HNB 3; 3-Quinuclidinyl benzilate hydrochloride; Quinuclidyl benzylate hydrochloride; Ro 2-3308

CAS Registry Number: 6581-06-2; 62869-69-6; 13004-56-3 (hydrochloride)
RTECS®Number: DD4639000; VD6300000 (hydrochloride)
UN/NA & ERG Number: UN 2810 (Toxic liquids, organic, n.o.s.)/153
EC Number: Not established
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Report any release of WMD to National Response Center 1-800-424-8802.
While not a mandated "Federally listed" waste, BZ is more toxic than most RCRA listed chemicals. However, BZ is a "listed" hazardous waste in some states where it may have been stockpiled by the military.
WGK (German Aquatic Class): No value assigned.
Description: Quinuclidinol benzilate (QNB) is a white crystalline solid. Odorless. Molecular weight = 337.41; Freezing/Melting point = 167.5°C; also 164−165°C; Boiling point = 320°C; Solid density = 0.51 g/cm^3 (bulk); 1.33 g/cm^3 (crystal); Vapor density = 11.6; Vapor pressure = negligible; about 0.5 mg/m^3 at 70°C; Flash point = 246°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3; Flammability 0; Reactivity 0. Slightly soluble in water.
History of the agent: QNB is an incapacitating agent and has been considered historically for use as a chemical warfare agent.[CDC] As a chemical weapon, QNB was mixed with a pyrotechnic mixture in small bombs designed for aerial delivery. Once exploded, the mixture produced a potentially dangerous aerosol of QNB. In the early 1960s at Pine Bluff Arsenal, Arkansas, the United States produced munitions containing QNB. Production ceased in the late 1960s and all stockpiles at every military installation were eventually destroyed by 1990. Iraq's "Agent 15" is believed to be identical to, or closely related to QNB. In general, the effectiveness of QNB as a WMD has proven both highly undependable and unpredictable.
Potential Exposure: Mutagen, drug; incapacitating agent. QNB is a glycolate anticholinergic compound that affects the central nervous system (CNS) and peripheral nervous system (PNS) and is related to the drugs atropine, scopolamine, and hyoscyamine. QNB is nonirritating; symptoms are delayed for several hours. QNB can be used to contaminate water, food, and agricultural products. A highly potent drug and central nervous system (CNS) depressant, QNB is a delayed-action incapacitating agent, usually dispersed as an aerosol, but it can also be used to penetrate skin when mixed with a solvent (such as DMSO), and to contaminate food and water. QNB appears to be widely used in pharmacologic research. The key to protection from QNB is prevention from entering the body with good quality aerosol filter and impermeable gloves and clothing. QMB is stable in most solvents, with a half-life of 3−4 weeks in moist air; it can be dispersed even with heat-producing munitions.
Incompatibilities: May form explosive mixture with air. Decomposes at about 170°C in air under prolonged heating. After 1 or 2 h at 200°C, it is completely decomposed. Rate of decomposition is both temperature and purity dependent. No effect on steel or stainless steel after 3 months at 71°C. Aluminum and anodized aluminum are mildly attacked after 3 months at 71°C. Contact with metals may evolve flammable and potentially explosive hydrogen gas.
Persistence of Chemical Agent: QNB is very persistent in soil and water and on surfaces.
Permissible Exposure Limits in Air:
Protective Action Criteria (PAC)*
6581-06-2
TEEL-0: 0.0075 mg/m^3
PAC-1: 0.02 mg/m^3
PAC-2: **0.037** mg/m^3
PAC-3: **0.69** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face.**
Determination in Air: No method is available for detecting QNB in environmental samples.[CDC]
Determination in Water: No method is available for detecting QNB in environmental samples.[CDC]
Routes of Entry: Respiratory system, ingestion, skin, or eye contact. Skin and eye absorption is possible, depending on liquid solvents that might be used to enhance absorption. Inhalation and ingestion of QNB are important routes of exposure for the solid.[CDC]
Harmful Effects and Symptoms
QNB is nonirritating stunning agent. The onset of incapacitation is dose dependent. Symptoms may occur as early as 1 h following exposure and continue for 48 h. The onset of incapacitation is dose dependent. It might occur as early as 1 h after exposure and continue from 48 h to 4 days depending on level of exposure. An untreated casualty may require from 3 to 4 days to achieve full recovery from the effects of QNB intoxication. QNB affects a victim's ability to remember, solve problems, make sound decisions and judgments, pay attention to assigned tasks, and understand instructions. High levels of exposure can completely destroy a victim's ability to perform any tasks, military and/or otherwise.
Short Term Exposure: A very potent drug, QNB, can cause confusion, dream-like state, hallucinations, and severe delirium; it also affects circulation, digestion, salivation, sweating, and vision. QNB causes dilation of the pupils, which is extremely uncomfortable to most people. QNB produces profound mental disturbances at a dose of 0.1−0.2 mg. Signs and symptoms of exposure include agitation, restlessness, dizziness, giddiness; failure to obey orders, confusion, erratic behavior; stumbling or staggering; vomiting; hallucinations; blurred vision; dry, flushed skin; urinary retention;

ileus; tachycardia; hypertension; and elevated temperature (>101°F/38°C). QNB may cause short-term memory loss, and variable levels of side effects are experienced in different people. Impairments caused by QNB are generally temporary and unlikely to be fatal; however, they can be severe with high exposures.[NIOSH] QNB is an anticholinergic. LCt_{50} = High; estimated to be 200,000 mg-min/m^3; ICt_{50} = 112 mg-min/m^3. LD50 = (iv-mouse) 18 mg/kg[US Army]; 25 mg/kg; TD_{Lo} (lowest published toxic dose) = (subcutaneous-human) 3 μg/kg.[NIOSH]

Delayed effects of exposure: Widespread formation of clots in the blood vessels (disseminated intravascular coagulation) is a potential complication in a victim with marked agitation and/or exceptionally high body temperature (hyperthermia).[NIOSH]

Long Term Exposure: Information is unavailable about the carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to QNB.

Points of Attack: CNS (central nervous system); PNS (peripheral nervous system).

Medical Surveillance: In a victim with marked agitation and/or exceptionally high body temperature (hyperthermia), clotting studies (e.g., prothrombin time, activated partial thromboplastin time, and international normalized ratio) are recommended. Urine tests.

Decontamination: Establish the decontamination corridor upwind and uphill of the hot zone. The warm zone should include two decontamination corridors. One decontamination corridor is used to enter the warm zone and the other for exiting the warm zone into the cold zone. The decontamination zone for exiting should be upwind and uphill from the zone used to enter. Decontamination area workers should wear appropriate PPE. A solution of detergent and water (which should have a pH value of at least 8 but should not exceed a pH value of 10.5) should be available for use in decontamination procedures. Soft brushes should be available to remove contamination from the PPE. Labeled, durable 6-mil polyethylene bags should be available for disposal of contaminated PPE.

INDIVIDUAL DECONTAMINATION: *Decontamination of First Responder:* Begin washing PPE of the first responder using soap and water solution and a soft brush. Always move in a downward motion (from head to toe). Make sure to get into all areas, especially folds in the clothing. Wash and rinse (using cold or warm water) until the contaminant is thoroughly removed. Remove PPE by rolling downward (from head to toe) and avoid pulling PPE off over the head. Remove the SCBA after other PPE has been removed. Place all PPE in labeled durable 6-mil polyethylene bags. *Decontamination of Patient/Victim:* Remove the patient/victim from the contaminated area and into the decontamination corridor. Remove all clothing (at least down to their undergarments) and place the clothing in a labeled durable 6-mil polyethylene bag. Thoroughly wash and rinse (using cold or warm water) the contaminated skin of the patient/victim using a soap and water solution. Be careful not to break the patient/victim's skin during the decontamination process, and cover all open wounds. Cover the patient/victim to prevent shock and loss of body heat. Move the patient/victim to an area where emergency medical treatment can be provided.

First Aid: *Eyes*: After removing patient/victim from the source of exposure, immediately wash eyes with large amounts of tepid water for at least 15 min. Do not allow the patient/victim to rub eyes. Monitor the patient/victim for signs of whole-body (systemic) effects; if signs appear, see the *Inhalation* section for treatment recommendations. Seek medical attention immediately.

Ingestion: After removing patient/victim from the source of exposure, immediately ensure that the patient/victim has an unobstructed airway. *Do not induce vomiting.* See the *Inhalation* section for first aid recommendations. Seek medical attention immediately.

Inhalation: After removing patient/victim from the source of exposure, immediately, evaluate respiratory function and pulse. Ensure that the patient/victim has an unobstructed airway. If shortness of breath occurs or breathing is difficult, administer oxygen. Assist ventilation as required. Always use a barrier or bag-valve-mask device. If breathing has ceased, provide artificial respiration. Monitor for exceptionally high body temperature. If body temperature is elevated above 102°F/39°C, initiate immediate and vigorous cooling (as for heatstroke), using 72° to 75°F/22° to 24°C water and air circulation (fanning), wet cloths and air circulation, or maximum exposure to air in a shaded area with maximum air circulation. Do not use ice for skin cooling. Give fluids sparingly. Manage dryness and coating of the mouth and lips using moist swabs and small amounts of petroleum jelly. Monitor for skin abrasions caused by repetitive movements. Remove potentially harmful items, including cigarettes, matches, medications, and small items that could be accidentally ingested, from the patient/victim's possession. Consider loose restraint of disoriented or agitated patient/victims. Consider separation of affected individuals into small groups to minimize potential crowd control problems. Seek medical attention immediately. *Skin:* After removing patient/victim from the source of exposure, immediately, see the *Decontamination* section (above). See the *Inhalation* section for first aid recommendations. Seek medical attention immediately.

Note to health professionals: Treatment of QNB intoxication largely consists of supportive care: use of intravenous fluids and appropriate cooling measures to address elevated core body temperature and judicious use of sedation using benzodiazepines. Severe toxicity may require the use of physostigmine in a hospital setting.*[CDC]

Antidote: *Some military references suggest the use of physostigmine to temporarily increase synaptic acetylcholine concentrations. Physostigmine poses its own risks of side effects and interactions with other drugs and should be used only by physician or other medical personnel familiar with its safe use. Suggested dosages for physostigmine in the treatment of QNB (BZ) poisoning follow: *Test dose:* If the diagnosis is in doubt, a dose of 1 mg might be given. If a slight improvement occurs, routine dosing should be given.

Routine dosing: Doses of about 45 mcg/kg for adults have been recommended. This might be modified by the response. A mental status examination should be done every hour and the dose and time interval of dosing should be modified according to whether the mental status is improved or not. As the patient improves, the dosage requirement will decrease.

Routes of administration: IM: 45 mcg/kg in adults (20 mg/kg in children); IV: 30 mcg/kg slowly (1 mg/min); PO: 60 mcg/kg if patient is cooperative (because of bitter taste, consider diluting in juice). For each route, titrate about every 60 min to mental status.[USAMRICD]

Personal Protective Methods: First Responders should use a NIOSH- or European Standard EN 149-certified Chemical, Biological, Radiological, Nuclear (CBRN) Self Contained Breathing Apparatus (SCBA) with a Level A protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level A protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience. *LEVEL A: (RED ZONE):* Used when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2 (not established). A Totally-Encapsulating Chemical Protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

Respirator Selection: Where there is potential for exposure to QNB, use a NIOSH- or European Standard EN 149-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle.

Storage: QNB is stable in most solvents, with a half-life of 3−4 weeks in moist air. Store at 2−8°C.

Shipping: Quinuclidinol benzilate (QNB) shipping name is "TOXIC, LIQUIDS, ORGANIC, N.O.S." Subsidiary Hazardous Class or Division Label "Poison (Toxic)." Hazardous Class or Division 6.1. Packing Group III.

Spill Handling: QNB aerosol is heavier than air. It will spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas (e.g., sewers, basements, and tanks). Hazardous concentrations may develop quickly in enclosed, poorly ventilated, or low-lying areas. Keep out of these areas. Stay upwind. *Environment/spillage disposal:* Do not touch or walk through the spilled agent if at all possible. However, if you must, personnel should wear the appropriate PPE during environmental decontamination. See the PPE section of this record for detailed information. Keep combustibles (e.g., wood, paper, and oil) away from the spilled agent. Use water spray to reduce aerosols or divert aerosol cloud drift. Avoid allowing water runoff to contact the spilled agent. Do not direct water at the spill or the source of the leak. Stop the leak if it is possible to do so without risk to personnel. Prevent entry into waterways, sewers, basements, or confined areas. Isolate the area until aerosol has dispersed. Ventilate the area.[NIOSH] Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt. %). Scoop up all material and place in a fully removable head drum with a high-density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10 wt. % sodium hydroxide is not available, then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate, and Supertropical Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at

(800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

QNB, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Fire Extinguishing: QNB (BZ) is combustible; it may burn but does not ignite readily. QNB (BZ) might be transported in a molten form. QNB (BZ) may decompose upon heating producing corrosive and/or toxic gases. Containers may explode when heated. In case of fire, evacuate the area, including yourself. If there is some reason that you have to put out the fire—for example, there are things nearby that cannot be allowed to burn—use unattended equipment, then evacuate everyone immediately, including yourself. When heated, aerosols may form explosive mixtures with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. QNB (BZ) aerosol is heavier than air. It will spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas (e.g., sewers, basements, and tanks). Hazardous concentrations may develop quickly in enclosed, poorly ventilated, or low-lying areas. Keep out of these areas. Stay upwind. Fire may produce irritating, corrosive, and/or toxic gases.

If you must extinguish a QNB (BZ) fire—Small fires: Use dry chemical, carbon dioxide, or water spray. *Large fires*: Use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from the fire area if it is possible to do so without risk to personnel. Dike fire control water for later disposal; do not scatter the material. For fire involving tanks or car/trailer loads, fight the fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after the fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tanks. Always stay away from tanks engulfed in fire. Run-off from fire control or dilution water may be corrosive and/or toxic, and it may cause pollution. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested:

See "Spill Handling," above.

References

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Byrd, G. D., Paule, R. C., Sander, L. C., Sniegoski, L. T., White, E. V., & Bausum, H. T. (1992). Determination of 3-Quinuclidinyl Benzilate (QNB) and its major metabolites in urine by isotope dilution gas chromatography/mass spectrometry. *Journal of Analytical Toxicology*, *16*(3), 182−187; US Army Field Manual (DA FM) 3-9 (PCN 320 008457 00); US Navy Publication No. P-467; US Air Force Manual No. 355-7; *Potential Military Chemical/Biological Agents and Compounds*; Headquarters, Department of the Army, Headquarters, Department of the Navy, Headquarters, Department of the Air Force; Washington, DC, December, 1990

CDC/NIOSH, *The Emergency Response Safety and Health Database*, <http://www.cdc.gov/NIOSH/ershdb/EmergencyResponseCard_29750015.html>

R

Radium compounds R:0050

Molecular Formula: Ra; Cl_2Ra (radium chloride); Br_2Ra (radium bromate)

Synonyms: Actinium-X (^{226}Ra); ^{224}Ra; ^{226}Ra; ^{228}Ra; Radio (Spanish); Radium-224; Radium 226; Radium 228; Radium, isotope of mass 226; Radium, isotope of mass 228; Thorium-X (^{226}Ra)

Radium bromide: Radium (II) bromide; Radium dibromide

radium chloride: Radium (II) chloride; Radium dichloride

CAS Registry Number: 7440-14-4 (Radium); 10031-23-9 (Radium bromide); 10025-66-8 (Radium chloride)

Other radium compounds:

Radium carbonate ($RaCO_3$) 7116-98-5

Radium fluoride (RaF_2) 20610-49-5

Radium hydroxide [$Ra(OH)_2$] 98966-86-0

Radium nitrate (Ra_3NO_3) 10213-12-4

Radium sulfate ($RaSO_4$) 7446-16-4

RTECS® Number: Not available

UN/NA & ERG Number: UN2915 (Radioactive material, Type A package nonspecial form, nonfissile or fissile-excepted)/163

EC Number: 231-122-4 (Radium); 233-035-7 (Radium chloride); 233-086-5 (Radium bromide)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Known carcinogen; EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation: Radium is a known human carcinogen. Radium-224; Radium-226; Radium-228; Radon-222 and their decay products Category 1.

Radionuclides and Reportable Quantities (RQ) listed under CERCLA (see 40CFR Part 302, Table 302.4, Appendix B, for more information): Radium-223 RQ = 1 curies; Radium-224 RQ = 10 curies; Radium-225 RQ = 1 curies; Radium-226 RQ = 0.1 curies; Radium-227 RQ = 1000 curies; Radium-228 RQ = 0.1 curies; Radon-220 RQ = 1 curies; Radon-222 RQ = 1 curies.

Listed in the TSCA inventory.

The Clean Air Act authorizes EPA to establish annual limits, known as National Emission Standards for Hazardous Air Pollutants (NESHAP) for the maximum amount of radium and other radionuclides that may be released to the air. Radium = 10 mRem.

The Safe Drinking Water Act authorizes EPA to limit the Maximum Contaminant Levels (MCL) of radium and other radionuclides in publicly supplied drinking water.

Description: Radium (Ra) is a radioactive element, found naturally in the environment. Ra is a silvery-white-metallic solid at 25°C; it tarnishes black when exposed to air. It is an alkaline earth metal; there are 33 isotopes, all of them are unstable. Radium is commonly available as radium bromide ($RaBr_2$) or radium chloride ($RaCl_2$). Atomic weight = 226.025; Density = 5.5 g/cm^3 at 28°C; Freezing/Melting point = 700°C; Boiling point = 1140°C; 1536°C; 1737°C [Merck]; Density = 5.3 g/cm^3 at 26.85°C; Vapor pressure = 327 Pa at 700°C. *Radium bromide* is a white to brownish crystalline solid. Radioactive. Molecular weight = 395.83; Density = 5.79 at 20°C; Specific gravity = (H_2O:1) 3.34; Freezing/Melting point = 728°C (decomposes); Boiling point = 900°C (sublimes). Soluble in cold water. *Radium chloride* is a yellowish-white or brownish crystalline solid. Radioactive. Molecular weight = 296.9 g/mol; Density = 4.91; Freezing/Melting point = 1000°C.

Potential Exposure: Radium is not available as a pure metal but is found in very small quantities in uranium and thorium ores. Uranium and thorium are found in small amounts in most rocks and soil; radium is formed when these elements break down in the environment. One ton of uranium ore yields only slightly more than 0.1 g of radium. Radium is formed from the radioactive decay; and as a by-product of refining these ores. Radium exists in several isotope forms. Two of the principal radium isotopes found in the environment are ^{226}Ra (radium-226) and ^{228}Ra (radium-228). Radium compounds, due to their geologically short half-life and intense radioactivity, are quite rare. A single gram of ^{226}Ra produces 10^{-4} mm of radon (Rn) a day. Radium-226, radium's most stable isotope has a half-life of about 1603−1620 years, and remains in the body for life. Radium, when used to produce radon gas, is used for treating various types of cancer; in radiography of metals; and combined with other metals, such as beryllium, as a neutron emitting source used in research and for calibrating radiation instruments. Until the 1960s, radium was a component in self-luminous paints used for watch, compass, and aircraft instrument dials and other aircraft and military instrumentation. A less dangerous radioactive source, ^{60}Co (cobalt-60), replaced radium in luminous paint. The greatest health risk from radium comes from exposure to its radioactive decay product, radon (Rn). Radon is common in many soils and can collect in buildings, including homes.

Incompatibilities: Metallic radium is highly chemically reactive. It forms compounds that are very similar to barium compounds, making separation of the two elements difficult.[EPA] On contact with water, radium forms flammable hydrogen gas. Radium bromate is a strong oxidizer; avoid contact with a combustible material (clothing, wood, paper, oil, etc.).

Permissible Exposure Limits:

Recommended Occupational Annual Dose Limits (NCRP and NRC):

Whole body: 5 Rem (0.05 Sv)/1 year.

Lens of eye: 15 Rem (0.15 Sv).

Skin: 50 Rem (0.5 Sv).

Hands or feet: 50 Rem (0.5 Sv).

Cumulative occupational limit: 1 Rem (0.01 Sv) × age.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00017-5

The limit for radiation exposure for a declared pregnant radiation worker is 500 mRem (0.005 Sv) for the entire gestation period. The separate limit for the fetus is 500 mRem (0.005 Sv) for the entire gestation; exposures to the fetus must be uniform and must be maintained at or below 50 mRem (0.0005 Sv)/mo.

Radiological Dispersal Device (RDD) Incidents

Particulate sampling can be performed to measure the radioactivity of dust in the air and to further characterize exposures. Based on the sampling data, the respirator protection factor needed to meet the relevant exposure limits can be determined (see Table below), and the specific type of respirator needed can be identified. According to the data, it may be possible to downgrade or remove requirements for respiratory protection. However, until exposures have been characterized, responders and support personnel should continue to utilize full-face air-purifying P100 respirators, or higher respiratory protection (e.g., SCBAs, PAPRs).

Guidance Matrix for Radiological Dispersal Device (RDD) Incidents

OSHA Occupational Exposure Limits for Ionizing Radiation 29 CFR 1910.1096	**Rem (Sv)/calendar qtr.**
Whole body, head, and trunk	—
Active blood-forming organs	—
Lens of eye, or Gonads	1.25 (0.0125 Sv)
Hands and forearms	—
Feet and ankles	18.75 (0.1875 Sv)
Skin of whole body	7.5 (0.075 Sv)
Minors (workers under age 18)	10% of above limits
Workers over age 18	3 Rem (0.3 Sv) may be permitted under conditions specified in 29CFR1910.1096(b)(2)

Note: The Department of Homeland Security is currently chairing an interagency workgroup which is in the process of assessing the protective action guidance for response to an RDD event.

EPA Limits and Advisory Levels: United States, annual radiation exposure limits are found in Title 10, Part 20 of the Code of Federal Regulations, and in equivalent state regulations.

Public dose limits due to licensed activities (NRC) 100 mRem (0.01 Sv)/year.

Air: Radium NESHAP = 10 mRem (0.1 Sv).*

Water: ^{226}Ra & ^{228}Ra (combined radium) MCL = 5 pCi/L; ^{224}Ra = 15 picocuries/liter (5 pCi/L).*

Indoor Air (advisory "action level"): 4 pCi/L radon (Rn).

*Both the air and water standards limit the increased lifetime cancer risk to about 2 in 10,000.

Permissible Concentration in Water: The US EPA has set an MCL of 5 pCi/L in drinking water for Radium-226 and Radium-228 (combined) and 15 pCi/L for Radium-224.

Permissible Concentration in Soil: The US EPA has set a soil concentration limit of 5 pCi/g for Radium-226 in uranium and thorium mill tailings in the first 15 cm of soil and 15 picocuries per gram (5 pCi/g) in deeper soil.

Routes of Entry: Inhalation, ingestion, external exposure to *alpha*-, *beta*-, and *gamma*-rays.

Harmful Effects and Symptoms

Radium is highly radioactive and its decay product, radon (Rn) gas, is also radioactive. Radium is over one million times more radioactive than the same mass of uranium. Since radium is chemically similar to calcium, it has the potential to cause great harm by replacing it in bones and teeth. The later effects include an increase in cavities and broken teeth.

Short Term Exposure: Inhalation, injection, ingestion or body exposure to radium can cause cancer and other disorders. Exposure to high levels can increase the risk of bone, liver, and breast cancer. Radium emits several kinds of radiations, in particular, *alpha* particles and *gamma* rays. *Alpha* particles are generally harmful only if emitted inside the body. However, both internal and external exposure to *gamma* radiation is harmful. *Gamma* rays can penetrate the body, so *gamma* emitters like radium can result in exposures even when the source is a distance away. *Radium bromate*: Highly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact; prolonged contact may result in skin burns, inflammation (including reddening, itching, and scaling), blistering, and ulcerations. Inhalation overexposure may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Exposure from *gamma* rays is measured in units of roentgens (Rads); 100 Rads = 1 Gray (Gy) = 1 J/kg. For example: Radiation sickness = total body exposure of 100 Rads (or 1 Gy). Radiation sickness and death in half the population = total body exposure of 400 Rads (or 4 Gy). Without medical treatment, nearly everyone who receives more than 400 Rads will die within 30 days. 100,000 Rads causes almost immediate unconsciousness and death within an hour.[NYT]

Long Term Exposure: Long-term exposure to radium increases the risk of developing several diseases. Inhaled or ingested radium increases the risk of developing lymphoma, bone cancer, and diseases that affect the formation of blood, such as leukemia and aplastic anemia. These effects usually take years to develop. External exposure to radium's gamma radiation increases the risk of cancer to varying degrees in all tissues and organs. Historically, Marie Curie's death due to aplastic anemia has been blamed on exposure and handling of radium. Patients who were injected with radium in Germany, from 1946 to 1950, for the treatment of certain diseases including tuberculosis were significantly shorter as adults than people who were not treated.[CDC]

Points of Attack: Liver, blood (anemia), eyes (cataracts) and other organs, bones and teeth.

Medical Surveillance: There are tests that are used to determine exposure to radium or other radioactive substances. For example, a whole body count can measure the total amount of radioactivity in the body, and urine and feces can be tested for the presence of radionuclides. There is no test that can detect external exposure to radium's gamma radiation, unless the doses were very high, and cellular damage is detectable. Another test measures radon (Rn) in exhaled air [radon (Rn) is a breakdown product of radium]. None of these tests are routinely performed in a doctor's office; they require specialized laboratory equipment. These tests are unable to quantify exposure, nor can they be used to predict whether a patient will develop long-term or harmful health effects.

First Aid: Unless you are dressed in appropriate protective gear to prevent self-contaminating, do not provide medical attention. Evacuate the victim from area of exposure to a safe area as soon as possible. To stop ongoing contamination, have the victim remove clothing, if possible, and place clothing in a sealed garbage bag or container. Check the victim's breathing and pulse; start CPR, if necessary.

Skin: If skin contamination has occurred, measure levels of contamination with a survey meter, record results, and begin decontamination by gentle washing with plenty of water (warm if possible) and nonabrasive and disinfecting soap, washing downwards towards extremities, not upwards. Dry body and cover the irritated skin with an emollient. If burns are obvious, do not use ointments. Wrap victim in a clean, soft blanket. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility.

Eyes: Check for and remove any contact lenses. Immediately flush eyes with cold water. Avoid the use of an eye ointment. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility. *Inhalation:* Allow the victim to rest in a well-ventilated area. If breathing is difficult, administer oxygen. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility.

Ingestion: Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility.

Personal Protective Methods: *Radium bromate:* Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Emergency responders to an explosion or the resulting fires will generally not know they are being exposed to radiation unless they utilize a radiation-detecting device. There is no practical personal protective equipment (PPE) to protect First Responders against externally penetrating *gamma* radiation. Monitoring devices are the only means to ensure that responders do not enter an area where exposures to external *gamma* radiation is excessive. Personal protective equipment (PPE) to prevent skin contamination of particulates is very effective against particulate-borne radiation hazards (i.e., *alpha* and *beta* particles). Typical firefighter "turnout" gear, including a SCBA and radiation detection device or dosimeter, may be adequate for this purpose (depending on radiation level). The use of turnout gear or any disposable protective clothing suitable for particulate exposure should be followed by appropriate decontamination of personnel and equipment. *Personal Protection in Case of a Large Spill:* Splash goggles; full suit; dust respirator; boots; gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling radioactive material.

Respirator Selection: Protection of internal organs from inhalation of radioactive particulates can be provided by wearing an appropriate particulate respirator. The SCBAs will provide the highest level of protection. Responders should utilize at least a full-face air-purifying respirator with a P-100 or HEPA filter, as appropriate. Respiratory protection specifically approved by NIOSH for CBRN exposures is desirable. However, where specific CBRN-approved respirators are not available, the incident commander may allow alternative NIOSH-approved respirators, such as SCBAs, or full-face powered or nonpowered air-purifying respirators with P-100 or HEPA filters, as appropriate. It should be noted that these recommendations for respiratory protection are designed ONLY for protection against inhalation of radioactive particulates, and do not consider protection that may be necessary for other contaminants, such as chemical or biological agents.

At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Store in a ventilated area to prevent accumulation of radon (Rn).

Shipping: Radioactive material, Type A package nonspecial form, nonfissile or fissile-excepted, requires a label of "RADIOACTIVE MATERIAL." It falls in Hazard Class 7.

A1 and A2 values for Radium-226 taken from §173.435 (see also Table A-1 in 10CFR71 (Appendix A): A1(Special Form) 0.3 TBq (8.11 Ci); A2 (Normal Form) 0.02TBq (0.541Ci))*

*Special form materials are limited to those materials which, if released from a package, would present a hazard only due to direct *external radiation*. Usually, due to the high physical integrity of a special form material, radioactive material contamination is not expected even under severe accident conditions. This high physical integrity is occasionally the result of *inherent natural* properties of the material, such as its being in nondispersible solid form. Most often, however, it is an *acquired characteristic*, resulting from being welded (encapsulated) into an extremely durable metal capsule.

The A1 and A2 quantities for each radionuclide are basically the maximum activity that can be transported in a Type A package. For many radionuclides, the regulations allow substantially larger quantities of special form material to be placed in a Type A packaging than when the material is in "normal form," i.e., "nonspecial form." Special form radioactive material is defined in 49 CFR 173.403. Special form sources must have at least one external physical dimension which exceeds 5 mm (0.197″). The minimum dimension requirement makes the capsule easier to see and recover in the event of its release from the package during an accident. *Special form encapsulations are required to be constructed in a manner that they can only be opened by destroying the capsule*. This requirement prevents the inadvertent loosening or opening of the capsule either during transport or following an accident. The testing requirements for determination of whether radioactive materials qualify as "special form" are found in 49CFR173.469, which describes tests for high temperature, impact, percussion, bending, and leakage.

Spill Handling: Notify authorities that spill has occurred. Do not touch spilled material. Cover with absorbent paper or dike with absorbent. Isolate the area to prevent unnecessary spread of the material and personnel exposures. Prevent entry into sewers, basements, or confined areas; dike if needed. Using appropriate monitoring equipment, survey the spill site; evaluate the presence of contamination on an individual's skin and clothing and on lab equipment. If skin or clothing contamination is present, assume a MAJOR spill has occurred. Do not attempt to clean it up. Confine all potentially contaminated individuals in order to prevent the further spread of contamination. If possible, shield the source, but only if it can be done without significantly increasing radiation exposure to yourself or other personnel. Leave the affected room and lock the doors in order to prevent entry. Do what you can to prevent further spreading of contamination to unrestricted areas. Contact local and state authorities and the Department of Energy (DOE) Radiological Response Team. Call for assistance on disposal.

Fire Extinguishing: If "Radioactive material, Type A package nonspecial form" is involved in a fire situation, first contact the Department of Energy (DOE) Radiological Response Team, as well as state and local authorities. Do not use water; use suitable dry powder, graphite, soda ash, powdered sodium chloride, or sand.

Disposal Method Suggested: Radioactive material considered waste and must be retained in containers for disposition by the authorizing institution. Drain disposal is prohibited. It is the responsibility of the operating institution to arrange for the proper disposal of all forms of any radioisotopes. The use, storage, transportation, labeling, and disposal of radioactive material are regulated through the Nuclear Regulatory Commission (NRC) using 10 CFR (Code of Federal Regulations) as the regulatory basis and 49 CFR (Transportation). (The CFRs are available at no cost on the internet at http://www.access.gpo.gov/nara/cfr/index.html)

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US Army Medical Research Institute of Chemical Defense (USAMRICD). Chemical Casualty Care Division (USAMRICD) MCMR-UV-ZM. (July 2000). *Field Management of Chemical Casualties* (2nd ed.). Aberdeen Proving Grounds, MD

Reserpine R:0100

Molecular Formula: $C_{33}H_{40}N_2O_9$

Synonyms: Abesta; Abicol; Adelfan; Adelphane; Adelphin; Adelphin-esidrex-K; Alkarau; Alkaserp; Alserin; Anquil; Apoplon; Apsical; Arcum R-S; Ascoserp; Ascoserpina; Austrapine; Banasil; Banisil; Benazyl; Bendigon; Bioserpine; Brinderdin; Briserine; Broserpine; Butiserpazide-25; Butiserpazide-50; Butiserpine; Cardioserpin; Carditivo; Carrserp; Crystoserpine; Daerbon; Deserpine; Diupres; Diutensen-R; Drenusil-R; Dypertane compound; Eberpine; Eberspine; Ebserpine; Elerpine; Elfanex; Enipresser; ENT 50,146; Escaspere; Eserpine; Eskaserp; Gamaserpin; Gammaserpine; Gilucard; H 520; Helfoserpin; Hexaplin; Hiposerpil; Hiserpia; Hydromox R; Hydropres; Hydropreska; Hygroton-resperine; Hypercal B; Hypertane Forte; Hypertensan; Idoserp; Idsoserp; Interpina; Key-Serpine; Kitene; Klimanosid; "L," Carpserp; Lemiserp; Loweserp; Marnitension simple; Maviserpin; Mayserpine; Mephaserpin; Methylreserpate 3,4,5,-trimethoxybenzoic acid; Methylreserpate 3,4,5,-trimethoxybenzoic acid ester; Mio-pressin; Modenol; Naquival; NCI-C50157; Nembuserpin; Neo-antitensol; Neoserfin; Rau-sed; Rauwoleaf;

Recipin; Regroton; Renese R; R-E-S; Resaltex; Resedin; Resedrex; Resedril; Reserpex; Reserpoid; Serpasil; Serpasil Apresoline; Serpine; 3,4,5-Trimethoxybenzoyl methyl reserpate; Yohimban-16-carboxylic acid derivative of benz(g)indolo(2,3-a)quinolizine; Yohimban-16-carboxylic acid, 11,17-Dimethoxy-18-(3,4,5-trimethoxybenxoyl)oxy-, methyl ester; Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-(3,4,5-trimethoxybenxoyl)oxy-, methyl ester, (3b,16b,17a,18b,20a)

CAS Registry Number: 50-55-5

RTECS® Number: ZG0350000

UN/NA & ERG Number: UN1544/151

EC Number: 200-047-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis studies (feed); clear evidence: mouse, rat, 1980.

US EPA Hazardous Waste Number (RCRA No.): U200.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Reserpine is a white to pale buff to slightly yellow crystalline substance that darkens on exposure to light. Molecular weight = 608.75; Freezing/Melting point = 264−265°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. May be combustible.

Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Human Data; Natural Product. An alkaloid. Reserpine, a pharmaceutical, is a naturally occurring substance that is isolated from the roots of the plant *Rauwolfia serpentina*. Insoluble in water. Reserpine is used as a hypertensive for humans and animals, tranquilizer, and sedative. Permitted for use as an additive in food for human consumption, and the feed and drinking water of food-producing animals.

Incompatibilities: A weak acid; keep away from bases. Incompatible with strong oxidizers and strong reducing agents.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Massive overexposure may cause decreased blood pressure, convulsions, and coma. Reserpine is highly toxic to man. In humans, 0.014 mg/kg produces psychotropic effects. Symptoms include nausea, diarrhea, excessive salivation, nasal stuffiness, drowsiness, nightmares, emotional depression and other psychotropic effects, extra systoles, angina pain, edema and weight gain sometimes associated with frank congestive heart failure, thrombocytopenia, tremor, muscular stiffness, severe hypotension in conjunction with general anesthetic administration.

Long Term Exposure: May be a human carcinogen. There is limited evidence that this chemical causes breast cancer in humans, and breast and testes cancer in animals. Reproductive activity: may also be a mutagen and teratogen. Reserpine may damage the developing fetus. People taking reserpine daily for medical purposes have developed nightmares, severe depression, cramps, diarrhea, and weight gain. It is unknown if these symptoms occur from repeated occupational exposure.

Points of Attack: Nervous system. *Cancer site:* breast in humans; breast and testes in animals.

Medical Surveillance: There is no special test for this chemical. If overexposure or illness is suspected, medical attention is recommended.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than this body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. Refer to 21CFR210, *FDA Regulation for Good Manufacturing Practices.*

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. Protect from exposure to light and acids. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Alkaloids, solid, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." Respirine falls in Hazard Class 3.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources:[52] Remove all sources of ignition and dampen spilled material with toluene to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

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New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Reserpine*. Trenton, NJ

Resorcinol R:0110

Molecular Formula: $C_6H_6O_2$

Common Formula: 1,3-$C_6H_4(OH)_2$

Synonyms: Benzene, *m*-dihydroxy-; *m*-Benzenediol; 1,3-Benzenediol; C.I. 76505; C.I. Developer 4; C.I. Oxidation base 31; Developer O; Developer R; Developer RS; *m*-Dihydroxybenzene; 1,3-Dihydroxybenzene; *m*-Dioxybenzene; Durafur developer G; Fouramine RS; Fourrine 79; Fourrine EW; *m*-Hydroquinone; 3-Hydroxycyclohexadien-1-one; *m*-Hydroxyphenol; 3-Hydroxyphenol; Nako TGG; NCI-C05970; Pelagol grey RS; Pelagol RS; Phenol, *m*-hydroxy-; Resorcin; Resorcina (Spanish); Resorcine

CAS Registry Number: 108-46-3

RTECS® Number: VG9625000

UN/NA & ERG Number: UN2876/153

EC Number: 203-585-2 [*Annex I Index No.:* 604-010-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (gavage); no evidence: mouse, rat; NTP: Carcinogenesis Studies (gavagae); no evidence: mouse, rat.

US EPA Gene-Tox Program, Negative: *N. crassa—aneuploidy*; Histidine reversion—Ames test; Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U201.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R36/38; R50; Safety phrases: S2; S26; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Resorcinol is a white crystalline solid with a characteristic odor and a sweetish taste. Turns pink on exposure to air or light, or contact with iron. Molecular weight = 110.12; Boiling point = 277.2°C; Freezing/Melting point = 108.9°C; Vapor pressure = 0.0002 mmHg at 25°C; Flash point = 127.2°C (cc); Autoignition temperature = 607°C. Explosive limits: LEL = 1.4% at 200°C. UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Highly soluble in water; solubility = 110%.

Potential Exposure: Compound Description: Drug, Tumorigen, Mutagen, Human Data; Primary Irritant. Resorcinol is weakly antiseptic; resorcinol compounds are used in the production of resorcinol−formaldehyde adhesives; or as an intermediate; in pharmaceuticals and hair dyes for human use. Major industrial uses are as adhesives in rubber products and tires, wood adhesive resins, and as ultraviolet absorbers in polyolefin plastics. Resorcinol is also a by-product of coal conversion and is a component of cigarette smoke. Thus, substantial opportunity exists for human exposure.

Incompatibilities: Reacts with oxidizers, nitric acid, oil, ferric salts, methanol, acetanilide, albumin, antipyrene, alkalies, urethane, ammonia, amino compounds. Hygroscopic; absorbs moisture from the air.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.50 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 10 ppm/45 mg/m^3 TWA; 20 ppm/90 mg/m^3 STEL.

ACGIH TLV®[1]: 10 ppm/45 mg/m^3 TWA; 20 ppm/90 mg/m^3 STEL; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 10 ppm

PAC-1: 20 ppm

PAC-2: 20 ppm

PAC-3: 20 ppm

DFG MAK: Danger of skin sensitization.

Australia: TWA 10 ppm (45 mg/m^3); STEL 20 ppm, 1993; Austria: MAK 10 ppm (45 mg/m^3), 1999; Belgium: TWA 10 ppm (45 mg/m^3); STEL 20 ppm, 1993; Denmark: TWA 10 ppm (45 mg/m^3), 1999; EU OEL: TWA 10 ppm, 45 mg/m^3; 2000; Finland: TWA 10 ppm (45 mg/m^3); STEL 20 ppm (90 mg/m^3), 1999; France: VME 10 ppm (45 mg/m^3), 1999; Hungary: TWA 45 mg/m^3; STEL 90 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 45 mg/m^3, 2003; Poland: MAC (TWA) 45 mg/m^3; MAC (STEL) 90 mg/m^3, 1999; Sweden: NGV 10 ppm (45 mg/m^3), [skin], 1999; Switzerland: MAK-W 10 ppm (45 mg/m^3), 1999; United Kingdom: TWA 10 ppm (46 mg/m^3); STEL 20 ppm (92 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 20 ppm. Several states have set guidelines or standards for resorcinol in ambient air[60] ranging from 3.1 μg/m^3 (Massachusetts) to 450.0−900.0 μg/m^3 (North Dakota) to 750.0 μg/m^3 (Virginia) to 900.0 μg/m^3 (Connecticut, Florida, New York) to 1071.0 μg/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-7; Methanol; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #5701; OSHA Analytical Method: PV-2053.

Permissible Concentration in Water: Russia[35,43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes and 0.004 mg/L in water bodies used for fishery purposes. The state of Maine has set a guideline of 140 μg/L for drinking water.[61]

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.8−0.9.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact causes a severe rash and blistering. Eye contact can cause burns and permanent damage. May affect the blood, causing formation of methemoglobin, cyanosis, convulsions, restlessness, increased heart rate, dyspnea (breathing difficulty), dizziness, drowsiness, hypothermia, hemoglobinuria. High exposure can cause kidney and/or liver damage. *Inhalation:* Humans occupationally exposed to 10 ppm showed no effects. Experiments with animals showed no toxic effects after 8-h exposure to 625 ppm. *Skin:* Itching, irritation, redness, swelling, and chemical burns have been reported from contact with solutions of 3−25% strength. Skin absorption is significant and leads to loss of oxygen-carrying capacity of blood, convulsions, and death. *Eyes:* Animal tests suggest that 10% solution may cause irritation, pain, and corneal damage. Powdered resorcinol may cause chemical burns to the cornea resulting in blindness. *Ingestion:* May cause excessive sweating, low blood pressure, slowed breathing, tremors, breakdown of blood cells and death. One teaspoonful may cause death.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated exposure can cause lung damage. May cause kidney, liver, spleen damage.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, central nervous system, blood, spleen, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: urine test for resorcinol. Tests for kidney and liver function. Methemoglobin level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine. Emergency treatment and management is similar to phenol.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, oil, ferric salts, methanol, acetanilide, albumin, antipyrine, and urethane. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Resorcinol requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Establish forced ventilation to keep levels below explosive limit. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Liquid solutions should be absorbed on sand or vermiculite and shoveled into suitable containers. Scrub spill area with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a combustible solvent and incinerate.

References

US Environmental Protection Agency. (April 30, 1980). *Resorcinol: Health and Environmental Effects Profile No. 152*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 58−59

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Resorcinol.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Resorcinol.* Trenton, NJ

Rhodium R:0120

Molecular Formula: Rh; $O_3Rh_2 \cdot xH_2O$ [Rhodium(III) oxide, hydrate]

Synonyms: Elemental rhodium; Rhodium black; Rhodium-103

CAS Registry Number: 7440-16-6; 123542-79-0 [Rhodium (III) oxide, hydrate]; 12137-27-8 (Rhodium(IV) oxide); 12036-35-0 (Rhodium oxide, solids)

RTECS® Number: VI9069000 (metal)

UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170

EC Number: 231-125-0; 234-846-9 [Rhodium(III) oxide, hydrate]

Regulatory Authority and Advisory Bodies

Listed on the TSCA inventory.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, elemental.

WGK (German Aquatic Hazard Class): Nonwater polluting agent (metal).

Description: Rhodium, together with platinum, palladium, iridium, ruthenium, and osmium, is one of the platinum-group metals in Group VIII of the Periodic Table. Rhodium metal is a white, hard, ductile, malleable solid with a bluish-gray luster. Molecular weight = 102.91; Specific gravity [metal] (H_2O:1) = 12.41 at 25°C; Boiling point = 3727°C; Freezing/Melting point = 1966°C. Insoluble in water.

Potential Exposure: Rhodium has few applications by itself, as in rhodium plating of white gold jewelry or plating of electrical parts, such as commutator slip rings, but, mainly, rhodium is used as a component of platinum alloys. Rhodium-containing catalysts have been proposed for use in automotive catalytic converters for exhaust gas cleanup.

Incompatibilities: Flammable as a dust or powder. Violent reaction with strong oxidizers, bromine pentafluoride, bromine trifluoride, chlorine trifluoride, oxygen difluoride.

Permissible Exposure Limits in Air

Metal fume and insoluble compounds

OSHA PEL: 0.1 mg[Rh]/m^3 TWA.

NIOSH REL: 0.1 mg[Rh]/m^3 TWA.

ACGIH TLV®[1] (*elemental*): 1 mg[Rh]/m^3; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

Metal

TEEL-0: 0.1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 100 mg/m^3

DFG MAK: Carcinogen Category 3B.

NIOSH IDLH: 100 mg[Rh]/m^3.

Australia: TWA 1 mg[Rh]/m^3, 1993; Belgium: TWA 1 mg [Rh]/m^3, 1993; Finland: TWA 0.1 mg[Rh]/m^3, 1999; France: VME 1 mg[Rh]/m^3, 1999; Norway: TWA 0.1 mg [Rh]/m^3, 1999; the Philippines: TWA 0.1 mg[Rh]/m^3, 1993; Switzerland: MAK-W 0.1 mg[Rh]/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg[Rh]/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Soluble compounds

OSHA PEL: 0.001 mg[Rh]/m^3 TWA.

NIOSH REL: 0.001 mg[Rh]/m^3 TWA.

ACGIH TLV®[1]: 0.01 mg[Rh]/m^3; not classifiable as a human carcinogen.

NIOSH IDLH: 2 mg[Rh]/m^3.

DFG MAK (*inorganic only*): Carcinogen Category 3B.

Several states have guidelines or standards for rhodium in ambient air[60] ranging from 0.16 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut), to 10.0 μg/m^3 (North Dakota) to 24.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II(3) Method #S-188.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: May cause metal fume fever. Rhodium(III) chloride and its hydrate are extremely toxic. May cause serious eye damage.

Long Term Exposure: Possible respiratory sensitization.

Points of Attack: Respiratory system. Ingestion [Rhodium (III) chloride].

Medical Surveillance: Examination by a qualified allergist. Lung function tests. Consider chest X-ray following acute overexposure to metal fume or dust.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If metal fume fever develops, it may last less than 36 h.

Note to physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m^3:* 95XQ

(APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red (*powder*): Flammability Hazard: Store in a flammable materials storage area. Prior to working with this material you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and sources of ignition. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Sipping: Flammable powder requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery in view of the high economic value. Recovery techniques for recycling of rhodium in plating wastes and spent catalysts have been described in the literature.

Rhodium trichloride R:0130

Molecular Formula: Cl_3Rh

Common Formula: $RhCl_3 \cdot xH_2O$ (trihydrate)

Synonyms: Hydrated rhodium trichloride; Rhodium chloride; Rhodium(III) chloride (1:3); Rhodium chloride, trihydrate

CAS Registry Number: 10049-07-7; 13569-65-8 (trihydrate)

RTECS® Number: VI9275000

UN/NA & ERG Number: UN3260 (Corrosive solid, acidic, inorganic, n.o.s.)/154

EC Number: 233-165-4 (trichloride)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: dropped from listing in 1988.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Rhodium trichloride is a red-brown or black, odorless solid or liquid. Molecular weight = 209.26; 263.32 (trihydrate); Boiling point = 775°C (sublimes); Freezing/Melting point = 400−500°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Insoluble in water.

Rhodium trichloride trihydrate, $RhCl_3 \cdot xH_2O$, is a deep-red crystalline solid. Soluble in water.
Potential Exposure: Compound Description: Mutagen. Rhodium trichloride is used in hydrosilylation, hydrogenation, carbonylation, oxidation, arylation. See also "Rhodium Metal." In plating operations and in catalyst preparation, the metal will be used as the trichloride.
Incompatibilities: Strong oxidizers.
Permissible Exposure Limits in Air
OSHA PEL: 0.001 mg[Rh]/m^3 TWA.
NIOSH REL: 0.001 mg[Rh]/m^3 TWA.
ACGIH TLV®[1]: 0.01 mg[Rh]/m^3; not classifiable as a human carcinogen.
No TEEL available.
DFG MAK: Carcinogen Category 3B.
NIOSH IDLH: 2 mg[Rh]/m^3.
Australia: TWA 1 mg[Rh]/m^3, 1993; Belgium: TWA 1 mg [Rh]/m^3, 1993; Denmark: TWA 0.001 mg[Rh]/m^3, 1999; Finland: TWA 0.001 mg[Rh]/m^3, [skin], 1999; France: VME 1 mg[Rh]/m^3, 1993; Norway: TWA 0.1 mg[Rh]/m^3, 1999; the Philippines: TWA 0.1 mg[Rh]/m^3, 1993; Switzerland: MAK-W 0.1 mg[Rh]/m^3, 1999; United Kingdom: TWA 0.001 mg[Rh]/m^3; STEL 0.003 mg[Rh]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Not classifiable as a human carcinogen. Several states have guidelines or standards for rhodium in ambient air[60] ranging from 0.16 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (North Dakota) to 24.0 μg/m^3 (Nevada).
Determination in Air: Use NIOSH II(3), Method #S-189.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: May cause eye irritation or serious damage. In animals: irritation of the eyes; central nervous system damage. LD_{50} = (oral-rat) 1302 mg/kg.
Long Term Exposure: May cause central nervous system damage. Tumorigenic and mutagenic effects have been reported in experimental lab animals.
Points of Attack: Eyes, central nervous system.
Medical Surveillance: Consider the point of attack in preplacement and periodic physical examinations.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Up to 0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Rhodium trichloride is not specifically cited in DOT regulations. However it is covered under "CORROSIVE, ACIDIC, INORGANIC, N.O.S."[19] and labeled "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and reclaiming wherever possible in view of high economic value. See "Rhodium Metal."

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Rhodium Trichloride*. Washington, DC: Chemical Emergency Preparedness Program

Riot Control Agents/Tear Gas

Highly irritating agents generally used by law enforcement for crowd control and by individuals for protection. Not designed to kill or cause serious injury, these agents are meant to weaken a victim, and render them helpless and compliant.

2-Chloroacetophenone (CN) see C:0750

o-Chlorobenzylidenemalononitrile (CS)* see C:0810

Chloropicrin (PS) see C:0980

CNB (a mixture of 10% 2-Chloroacetophenone (CN), 45% Benzene, 45% Carbon tetrachloride)

CNC (a mixture of 30% 2-Chloroacetophenone (CN) in Chloroform) see C:0810

CNS (a mixture of 23% 2-Chloroacetophenone (CN), 38% Chloropicrin (PS), 38.4% Chloroform) see C:0810 and C:0980

*CS1, CS2, CSX, all contain *o*-Chlorobenzylidenemalononitrile (CS) as agent, see C:0810

Ricin R:0135

Molecular Formula: None

Synonyms: African coffee tree; Castor; Castor bean; Castor oil; Ricine; Ricino (Spanish); Ricinus lectin; Ricinus agglutinin; Ricinus toxin; Lectin isolated from seeds of the castor bean; Ricinus communis protein/polypeptide; Steadfast

CAS Registry Number: 9009-86-3; (*alt.*) 9067-26-9; 96638-28-7 (Ricin, A chain)

RTECS Number: VJ2625000

UN/NA & ERG Number: UN3462 (Toxin, extracted from living sources, n.o.s.)/153

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Report any release of WMD to National Response Center 1-800-424-8802.

European/International Regulations: Hazard Symbol: T; Risk phrases: R26/27/28; R42/43; Safety phrases: S23; S28; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Class) No value assigned to these CAS numbers. *However, based on toxicity the following may apply*: 3—Severe hazard to waters.

Description: Ricin is a lethal, delayed-action cytotoxin; it is persistent in the environment. Ricin is a white powder. Molecular weight = (approx.) 64,000−66,000 Da; Volatility = negligible; Vapor pressure = negligible at 20°C; Boiling point = decomposes; Ricin is detoxified in 10 min at 80°C/176°F or in 1 h at 50°C/122°F at pH 7.8. Hazard Identification (based on NFPA-704 M Rating System): Health 4; Flammability 1; Reactivity 0.[CDC] Ricin is stable under ambient conditions and destroyed by heat and contact with solution household bleach. Michaelis constant (KM) = 0.1 imol/L for ribosomes; Enzymatic constant (K_{cat}) = 1500/min. The toxin is soluble in water.

Detection: Various tests for the detection of Ricin are available, including "Pro-Strips™" from Avant Technologies, the BIO-911™ test strip developed by Osborn Scientific Group, Lakeside, AZ. This one-step test is reported to detect, within minutes, the presence of minute quantities of the toxin (less than 50 ng); the freeze-dried assay kit to detect crude Ricin called Ruggedized Advanced Pathogen Identification Device (Rapid)™, Rapid LT™, and Razor™ instrument developed by Idaho Technologies, Inc. Ricin is detectable in urine, plasma, and environmental samples. *Instant Check Abrin/Ricin Detection Kit*, Catalog Number: IC-RA-003-10. Kit Contents: 10 test units each test contains 2 tests (1 Abrin and 1 Ricin) per unit, lyophilized reagent, reconstitution buffer, wash buffer, transfer pipettes, instruction booklet. EY Laboratories, Inc., 107 N. Amphlett Blvd, San Mateo, CA 94401, USA, Toll Free (North America) 1-800-821-0044; Telephone: 1-650-342-3296, Option 2 or 3 Fax: +1 (650) 342 2648. Also, in 2009, researchers at Yeshiva University's Albert Einstein College of Medicine have developed an accurate test. Polymerase Chain Reaction (PCR) can detect castor bean DNA in most Ricin preparations. See also "Water Detection," below.

History of the material: Ricin is a lectin—a plant glycoprotein that binds and agglutinates animal cells. Ricin comes from the seeds (or beans) of the castor bean plant, *Ricinus communis.* The beans are processed to form castor oil, formerly used as a laxative and now used in industry as a lubricant. Annual worldwide processing of castor beans is approximately 1 million tons to produce castor oil; waste mash from this production is 3−5% Ricin by weight. Large scale production and use of Ricin by an enemy is fairly difficult. It is estimated that a ton of Ricin would be required to produce a mass casualty biological weapon; therefore an enemy would have to produce a very large quantity in order to cover a large area of a battlefield. For centuries farmers have known the dangers to farm animals that have eaten castor beans. In fact, people found castor beans in 6000-year-old Egyptian tombs. Castor oil has been used for centuries as a medicine, and scientists have known about Ricin's effect on stopping the body from making proteins since 1800. During WWII the United States and Britain worked together on building bombs carrying Ricin, but the only reported military use was by Iraq in their war with Iran. The US Army discovered large stores of Ricin in Al Qaeda caves in Afghanistan. This relatively inexpensive, accessible, natural source allows easy preparation of large quantities of Ricin; therefore, there is little motivation to produce it synthetically. Large-scale production of Ricin by recombinant DNA techniques is probably possible. Certain governments have successfully used Ricin to murder political enemies. In 1978, Georgi Markov, a Bulgarian journalist living in London, was assassinated when a Ricin pellet was injected into his leg using a specialized gun disguised as an umbrella. In February 2004, Ricin was found in the Senate mail room on Capitol Hill in Washington, DC. No one became ill from that exposure. Since 1978, worldwide, there have been more than a dozen other known incidents involving Ricin. Although Ricin has the potential for use as a terrorist weapon, it is also being investigated as a treatment for cancer and AIDS.

Potential Exposure: Potentially Fatal. Mutagen, Teratogen. Ricin, a protein found in castor beans, is one of the most incredibly potent and lethal substances known to humankind—500 μg (an amount capable of fitting on the head of a pin)—is capable of killing an adult within a few days. The castor plant and castor beans are important industrial plants and vast amounts of castor plants and beans are grown commercially. The castor plant, originally native to Africa, is an attractive plant that can be found in people's yards as ornamentals. If the flowers are removed before they produce seeds, the risk of accidents can be averted. Ricin poisoning can occur following accidental ingestion of castor beans. In some countries castor beans are used as beads on necklaces; both children and adults have eaten just a few beans and died from the poison. This invasive 8−10 foot tall plant can be found in more than 25 US states and other places, including Australia. The plants die in freezing weather. The beans are turned into important and valuable industrial products. After the castor oil is squeezed from the castor beans, about 5% of what's left is Ricin. Although people have used weak castor oil as a laxative, purgative, and general folk-medicine "cure all," pure Ricin kills in a few days. Ricin get into the body's cells and inhibits protein synthesis. Once this essential mechanism is halted, within hours the body's system begin to shut down and the body begins to die. Ricin poisoning is not contagious and does not spread from person to person. Because Ricin is not a living thing but rather a chemical made by living things, it probably would NOT make as effective a military weapon as viruses or bacteria like the ebola virus or anthrax. Nevertheless, it would make an effective terrorist weapon because it is easy to make and easy to use. It is estimated that a ton of Ricin would be required to produce a mass casualty biological weapon. With no known antidote*, vaccine, or other effective therapy available for Ricin poisoning, the threat of this agent being released into the environment as an aerosol, or added to the food or water supply, could be catastrophic. Ricin is extremely hazardous when freeze-dried, forming a light, easily-dispersed powder. For this reason, research laboratory personnel are usually directed to avoid freeze-drying Ricin.

*Various public and private sector organizations are working on the development of antibody therapy that shows promise in neutralizing Ricin in animals. If successful, this therapy could result in a vaccine for humans and potentially reduce the threat of Ricin being used as a terrorist weapon.

Incompatibilities: Product is considered stable at ambient temperature. Ricin and other protein toxins can be destroyed by exposure to 0.1% sodium hypochlorite solution (household bleach) for 10 min. The toxic portion of Ricin is heat stable at ambient temperatures and begins to decompose at 60°C/140°F. At 80°C/176°F, most of the toxicity is lost in about 30 min. When heated to decomposition, Ricin emits toxic nitrogen oxides. Avoid contact with strong oxidizers.

Permissible Exposure Limits in Air:
Protective Action Criteria (PAC)[CDC]
TEEL-0: 0.025 mg/m^3
PAC-1: 0.075 mg/m^3
PAC-2: 0.5 mg/m^3
PAC-3: 1.5 mg/m^3
ChemWatch®: 0.00006 mg/m^3 Ceiling limit (sensitizer).[CDC]

Determination in Air: No NIOSH or OSHA methods available.

Permissible Concentration in Water: Unknown.

Determination in Water:

Detecting Ricin in Water; Summary of Results

Technology	*Contaminant Presence/ Absence*	*False Pos (+)/Neg(−) Responses*	*Consistency*	*Lowest Detectable Conc.*
BADD™ Test Strips	9/21	0/0	100%	20 mg/L
BioVerify Test Kits	15/22	0/3	97%	0.0005 mg/L
RAMP® Test	12/15	0/0	100%	5 mg/L
BioThreat Alert® Test Strips*	15/15	2/1	100%	0.035 mg/L
Enzyme Linked Immunosorbent Assay (ELISA)	12/15	0/0	100%	0.0075 mg/L
QTL Biosensor	12/15	2/2	90%	0.25 mg/L

*The most accurate results for Ricin using the Bio-Threat® Alert test strips.

Source: EPA/Homeland Security (2004−2006): see full report at http://www.epa.gov/nhsrc/tte_immtestkitpandb.html

(Tetracore, Inc.) detected 15/15 for Ricin (2004−2006).

Routes of Entry: Can be absorbed by all routes of exposure. Ricin normally enters the body by ingestion. Aerosolized Ricin would enter the body by inhalation. The toxin attaches to cell surfaces of a variety of tissues, particularly the stomach lining if ingested or the moist, upper respiratory tissues if inhaled.

Harmful Effects and Symptoms

The symptoms depend on purity of the Ricin, the level of exposure, and route of exposure (inhalation, ingestion, or injection), the dose received. The LD_{50} = (oral-ingestion) 1−20 mg/kg (the equivalent of 8 castor beans); (human-injection) 1−1.75 μg/kg; (human-inhalation) 21−42 μg/kg. As little as 500 μg of Ricin (about what might fit on the head of a pin; 1/228th of an aspirin tablet) may be enough to kill an adult. When Ricin toxins get inside the victim's body, they block protein synthesis (the body's ability to regenerate protein). Initial symptoms usually appear between 6−10 h and 3 days. Clinical signs may appear as early as 45 min after ingestion if the victim has an empty stomach. Death can occur within 36−72 h of exposure, depending on the route of exposure and upon the dose received. Death from Ricin poisoning could take place within 36−48 h of exposure, whether by injection, ingestion, or inhalation. Victims may linger for 10−12 days before death or recovery, also depending upon the level of exposure. However, if a person lives longer than 5 days after Ricin poisoning, without complications, they are less likely to die.

Short Term Exposure: The following lists do not convey prioritization or indicate specificity.

Inhalation: Within a few hours of inhaling significant amounts of Ricin, the likely symptoms would be respiratory distress, difficult or labored breathing, shortness of breath, chest tightness, hypoxemia, fever, cough, nausea, sweating, aching muscles. Heavy sweating may follow as noncardiogenic pulmonary edema develops.* This would make breathing even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by X-ray or by listening to the chest with a stethoscope. Finally, low blood pressure, blue skin, multisystem organ failure, respiratory failure may occur, and possible death.

Skin: It is uncertain if Ricin can be absorbed through the skin. It is generally believed that the risk of toxicity is low from contact with unbroken skin; however, Ricin may be absorbed through irritated, damaged, abraded, wounded, or injured skin; or through normal skin when Ricin is dissolved in a solvent carrier. If enough ricin gets through the skin, the symptoms will be similar to those described for ingestion. If Ricin is injected, the muscles and lymph nodes near the injection site would die. This could lead to liver and kidney failure and death. *Eyes:* Tearing, swelling of the eyelids, pain, redness, corneal injury. Urinary excretion of Ricin is probably slow and limited with the estimated half-life being about 8 days. LD_{50} = (humans) 1 mg/kg; a single seed can be fatal. LD_{50} = (oral-mice) about 3 μg/kg by injection or aerosol.

Ingestion: Generally within a few hours symptoms will appear, including nausea, vomiting, abdominal pain and cramping, diarrhea (possibly bloody), lowered blood pressure, hallucinations, and bloody urine, gastrointestinal bleeding, low or no urinary output, dilation of the pupils, fever, thirst, sore throat, headache, vascular collapse, and shock. Severe vomiting and diarrhea may result from severe dehydration and multisystem organ failure. In a few days, organs (liver, spleen, and kidneys) might stop working, and possible death.

*Ricin-induced pulmonary edema would be expected to occur much later (1−3 days postexposure) compared to other agents such as phosgene (about 6 h postexposure).

Late phase complications: Ricin has cell-killing (cytotoxic) effects on the liver, central nervous system, kidneys, and adrenal glands, typically 2−5 days after exposure. The patient may be asymptomatic (showing no symptoms of exposure) during the preceding 1−5 days.[CDC]

Pulmonary edema would be expected to occur much later (1−3 days postexposure) compared to that induced by other agents such as phosgene (about 6 h postexposure).

Long Term Exposure: Repeated exposures to Ricin may cause allergic/asthma-like symptoms with congestion of nose and throat; itchy, watery eyes; hives; tightness of the chest; and in acute cases, wheezing. May affect kidneys, liver, pancreas. Based on animal studies, Ricin may be capable of causing severe lung damage in humans. Information about carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to Ricin is unknown at this time.

Points of Attack: Lungs, eyes, skin (primarily through cuts and bruises). The risk of toxicity from unbroken skin exposure to Ricin is low but there is still a danger of allergic skin reactions.

Medical Surveillance: Unfortunately Ricin symptoms resemble those that are similar to other diseases, especially the common flu. Laboratory testing might include metabolic acidosis, increased liver function tests, increased renal function tests, hematuria, leukocytosis (2- to 5-fold higher than normal).

First Aid: No antidote exists for Ricin. Make all exposed people go to the nearest hospital emergency department. Make all potentially exposed people shower and change clothes. In case you have gotten Ricin on your skin or your clothing, immediately shower and change clothes. See a doctor as soon as possible: since it can take only a day and a half for symptoms to appear, all exposed persons should get to a doctor that same day. If exposure includes contact with Ricin, remove it *off or out* of the body as quickly as possible. Treatment needs to be provided in a hospital setting. Make the doctors and nurses aware of the potential for exposure so that they can protect themselves; and provide the most appropriate treatments and therapies. If you have to wait for medical assistance, make the victim comfortable. If Ricin has been ingested, the airway must be secured and stomach pumping (gastric lavage) may be considered. Vigorous gastric lavage is recommended only if it can be done shortly after ingestion (generally within 1 h). Risk of aggravating injury to the lining of the gastrointestinal (GI) tract must be considered.

To minimize the effects of the poisoning and to keep the patient stable, Ricin poisoning is treated through supportive therapy. The types of supportive medical care would depend on several factors, such as the route by which victim(s) were poisoned (i.e., whether poisoning was by inhalation, ingestion, eye, or skin exposure). Do not induce vomiting. Rinse mouth, flush stomach with activated charcoal* (if the Ricin has been very recently ingested), wash out the victim's eyes with water, especially if the eyes are red and irritated. Supportive care could include intravenous fluid input and support of circulation and respiration; giving medications to treat conditions such as seizure and low blood pressure. Fluid input is critical, as fluid losses of up to 2−1/2 L are probable. If individual is drowsy or unconscious, do not give anything by mouth. In the event of vomiting, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. Fluid and electrolyte balance should be monitored and restored if abnormal. Early and aggressive IV fluid and electrolyte replacement. If the victim's lungs fill with fluid, you administer oxygen if his breathing is difficult or labored.

*Superactivated charcoal may be of little value for large molecules such as Ricin.[USAMRICD]

Decontamination: When Ricin symptoms appear and you know the location of the attack, the area should be decontaminated with responders wearing Level A (fully encapsulated suit with SCBA). Otherwise, stay away. Move as fast as possible; extra minutes before decontamination might make a big difference. If the Ricin attack was aerosolized (by small particles floating in the air), and you have the equipment (*this is very important*), then you have to decontaminate as soon as possible. If you do not have the equipment and training, do not enter the hot zone to rescue and decontaminate victims. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. If possible, place all clothing in a labeled durable 6-mil polyethylene bag. If the victim cannot move, decontaminate, if possible, without touching and without entering the hot zone. To prevent spreading the agent, be certain that victims are decontaminated as much as possible before allowing them to leave the area. During the decontamination process, be careful not to break the patient's/victim's skin, and take care to cover all open wounds. The CDC recommends a decontamination procedure solution of detergent and water (with a pH value in the alkaline range of more than 8 but less than 10.5). Soft brushes should be available to remove contamination from the personal protective equipment. Also, recommended for cleanup of people and surfaces is household bleach. Use a fresh (made daily) solution of 0.5% sodium hypochlorite [diluted household bleach (10%, or one part bleach to nine parts water)]. Contact time: 15 min. Do not get bleach solution in the victim's eyes, open wounds (especially of the abdomen, spinal cord, or brain), or mouth. Wash off the diluted bleach solution after 15 min. Labeled, durable 6-mil polyethylene bags should be available for disposal of clothing and contaminated personal protective equipment. In the absence of pH adjusted solutions, wash the victim with lots of warm water with soap. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you would not have to touch the victim; do not even wait for soap or for the victim to remove clothing (at least down to undergarments), begin washing immediately. Immediate flush the eyes with water for at least 15 min. Wash−strip−wash−evacuate upwind and uphill: the idea is to immediately wash with water, then have the victim (not the responder) remove all the victim's clothing, then wash again (with soap if available), and then move away from the hot zone in an upwind and uphill direction.

Personal Protective Methods: Level A (Fully encapsulated suit with SCBA) protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level A (Fully encapsulated suit with SCBA) protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. Recommended protective clothing and materials include Tychem® BR or Responder® CSM. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

Respirator Selection: Pressure demand, self-contained breathing apparatus [SCBA; Chemical, Biological, Radiological, Nuclear (CBRN), if available] is recommended in response to nonroutine emergency situations.

Storage: Color Code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked poison location. Store in a cool, dry, well-ventilated area and away from food stuff containers.

Shipping: Toxin, extracted from living sources, n.o.s. requires a label of "POISON (TOXIC)." This falls in Hazard Class: 6.1(a) Packing Group: III,[NIOSH] but you may want to treat it as Packing Group I.

Spill Handling: You must be careful! Avoid generating dust. Since a Ricin attack may be by small particles of Ricin floating in the air (aerosol), do not breathe it or get it on you. Remember that the victim's clothes or body may have Ricin; touch them and you can become a victim. If you think Ricin particles might be in the area, stay out until you are equipped with Level A (Fully encapsulated suit with SCBA), proper personal protective equipment (PPE), including protective clothing and respiratory protection. Shut off heating, ventilation, and air conditioning (HVAC) systems to prevent the tiny aerosolized (floating in the air) Ricin droplets from spreading throughout the building. Keep the public away. Immediately call for medical assistance. For those contaminated by Ricin, do not allow anyone to leave the hot zone. The Ricin chemical does not dissipate quickly, and "survives" in clothing and bedding for long periods of time. Consequently, people as well as "things" must be quarantined and decontaminated. Do not allow anyone to leave until medical people examine them. Do not breathe, touch, or eat anything that might be contaminated with Ricin. Notify the federal authorities, local health, and pollution/environmental agencies. See Decontamination.

Fire Extinguishing: Foam, dry chemical powder, BCF [bromochlorodifluoromethane (Halon 1211)] (where regulations permit), carbon dioxide, water spray or fog—large fires only. When heated to decomposition, Ricin emits toxic nitrogen oxides.

Disposal Method Suggested: Do not clean up or dispose of Ricin, except under supervision of a specialist.

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Ronnel R:0140

Molecular Formula: $C_8H_8Cl_3O_3PS$

Common Formula: $Cl_3C_6H_2OP(S)(OCH_3)_2$

Synonyms: Dermaphos; *O*,*O*-Dimethyl *O*-2,4,5-trichlorophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-(2,4,5-trichlorophenyl) thiophosphate; Dimethyl trichlorophenyl thiophosphate; *O*,*O*-Dimethyl-*O*-(2,4,5-trichlorphenyl)-thionophosphat (German); Dow ET 14; Dow ET 57; Ectoral; ENT 23,284; ET 14; ET 57; Etrolene; Fenchlorfos; Fenchlorophos; Fenchlorphos; Karlan; Korlan; Korlane; Nanchor; Nanker; Nankor; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(2,4,5-trichlorophenyl) ester; Thiophosphate de *O*,*O*-dimethyle et de *O*-(2,4,5-trichlorophenyle) (French); Trichlorometafos; 2,4,5-Trichlorophenol, *O*-ester with *O*, *O*-dimethyl phosphorothioate; *O*-(2,4,5-Trichlor-phenyl)-*O*, *O*-dimethyl-monothiophosphat (German); Trolen; Trolene; Viozene

CAS Registry Number: 299-84-3

RTECS® Number: TG0525000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 206-082-6 [*Annex I Index No.:* 015-052-00-X]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: 21/22; R50/53; Safety phrases: S2; S25; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Ronnel is a white to light tan crystalline solid. Molecular weight = 321.54; Specific gravity (H_2O:1) = 1.48 at 25°C; Boiling point = (decomposes); Freezing/Melting point = 41°C. Practically insoluble in water; solubility = 0.004% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. Those involved in manufacture, formulation, and application of this insecticide for farm (livestock) and household uses.

Incompatibilities: Strong oxidizers. Store at temperatures not exceeding 25−30°C.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA.

NIOSH REL: 10 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA measured as inhalable fraction and vapor; not classifiable as a human carcinogen; BEI$_A$ issued for Acetylcholinesterase-inhibiting pesticides.

NIOSH IDLH: 300 mg/m^3.
No TEEL available.
Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 10 mg/m^3, 1993; Russia: STEL 0.3 mg/m^3, 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; United Kingdom: TWA 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for ronnel in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2054.

Permissible Concentration in Water: Mexico[35] has set maximum permissible concentration of 50 μg/L in estuaries and 5 μg/L in coastal waters.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.9$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. There is limited evidence that ronnel may damage the developing fetus. May cause personality changes, such as depression, anxiety, irritability. High or repeated exposure may cause nerve damage causing weakness, a feeling of "pins and needles" in the arms and legs; and poor coordination.

Points of Attack: Skin, central nervous system, blood plasma.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 100 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 250 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 300 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, solid, toxic, require a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including oxides of phosphorus, sulfur dioxide, dimethyl sulfide, and trichlorophenol. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added flammable solvent in furnace equipped with afterburner and alkali scrubber.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Ronnel.* Trenton, NJ

Rotenone R:0150

Molecular Formula: $C_{23}H_{22}O_6$

Synonyms: Arol gordon dust; Barbasco; (1)Benzopyrano (3,4-b)furo(2,3-H)(1)benzopyran-6(6aH)-one, 1,2,12,12a-tetrahydro-8,9-dimethoxy-2-(1-methylethenyl), [2R-(2a, 6 (a)a,12(a)a)]; Cenol garden dust; Chem fish; Chem-mite; Cube; Cube extract; Cube-pulver; Cube root; Cubor; Curex flea duster; Dactinol; Deril; Derrin; Derris; Dri-kil; ENT 133; Extrax; Fish-tox; Green cross warble powder; Haiari; Liquid derris; Mexide; NCI-C55210; Nicouline; Noxfish; Paraderil; Powder and root; Prentox; Pro-nox fish; Ro-Ko; Ronone; Rotefive; Rotefour; Rotenon; Rotenona (Spanish); Rotessenol; Rotocide; [2R-(2a,6aa,12aa)]-1,2,12,12a-Tetrahydro-8,9-dimethoxy-2-(1-methylethenyl) (1)-benzopyrano(3,4-b)furo(2,3-H) (1)-benzopyran-6(6aH)one; Tubatoxin

CAS Registry Number: 83-79-4; *(alt.)* 12679-58-2

RTECS® Number: DJ2800000

UN/NA & ERG Number: UN2588/151

EC Number: 201-501-9 [*Annex I Index No.:* 650-005-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); equivocal evidence: rat; no evidence: mouse.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R25; R36/37/38; R50/53; Safety phrases: S1/2; S22; S24/25; S36; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Rotenone is a colorless to red odorless crystalline solid. Molecular weight = 394.45; Boiling point =

(decomposes below BP); 210−220°C at 0.5 mm; Freezing/Melting point = 165.6°C; Vapor pressure = 1×10^{-6} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Those involved in extraction from derris root, formulation, or application of this insecticide. Rotenone is used as a pharmaceutical and veterinary drug.

Incompatibilities: Strong oxidizers, alkalies.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.
NIOSH REL: 5 mg/m^3 TWA.
ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 2500 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 125 mg/m^3
DFG MAK: [skin].

Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3; STEL 10 mg/m^3, 1993; the Philippines: TWA 5 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Turkey: TWA 5 mg/m^3, 1993; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for rotenone in ambient air[60] ranging from 1.67 μg/m^3 (New York) to 50.0 μg/m^3 (Florida and South Carolina) to 50.0−100.0 μg/m^3 (North Dakota) to 80.0 μg/m^3 (Virginia) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5007, Rotenone.

Permissible Concentration in Water: The state of Maine has set a guideline of 4.0 μg/L for rotenone in drinking water.[61]

Determination in Water: Fish Tox = 1.49403000 ppb (HIGH); Octanol−water coefficient: Log $K_{ow} = 4.1$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause severe irritation and permanent damage. Exposure can cause numbness of the mucous membrane, nausea, vomiting, abdominal pain, muscular tremors, incoherence, colonic convulsions, stupor. May cause a severe drop in blood sugar. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May affect the liver and kidneys. There is limited evidence that rotenone causes cancer of the liver and breast in animals, and damage to the developing fetus. There is limited evidence that this chemical is stored in breast milk and passed on to nursing infants. Repeated skin contact can cause severe rash. Human Tox = 28.00000 ppb (INTERMEDIATE).

Points of Attack: Central nervous system, eyes, respiratory system, liver, and kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Blood sugar. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter]. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 250 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from prolonged exposure to light. Keep away from oxidizers and alkalis. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Rotenone requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10,000 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Rotenone is decomposed by light and alkali to less insecticidal products. It is readily detoxified by the action of light and air. It is also detoxified by heating; 2 h at 100°C results in 76% decomposition. Oxidation products are probably nontoxic. Incineration has been recommended as a disposal procedure. Burial with lime would also present minimal danger to the environment.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (October 2000). *Hazardous Substances Fact Sheet: Rotenone*. Trenton, NJ

S

Saccharin S:0100

Molecular Formula: $C_7H_5NO_3S$
Synonyms: 550 Saccharine; Anhydro-*o*-sulfaminebenzoic acid; 3-Benzisothiazolinone 1,1-dioxide; 1,2-Benzisothiazolin-3-one, 1,1-dioxide, and salts; 1,2-Benzisothiazol-3(2H)-one 1,1-dioxide; *o*-Benzoic acid sulfimide; *o*-Benzoic sulfimide; Benzoic sulfimide; *o*-Benzoic sulphimide; Benzoicsulphimide; Benzoic sulphinide; *o*-Benzosulfimide; Benzo-2-sulphimide; Benzosulphimide; Benzo-sulphimide; *o*-Benzoyl sulfimide; 1,2-Dihydro-2-ketobenzisosulfonazole; 1,2-Dihydro-2-ketobenzisosulphonazole; 2,3-Dihydro-3-oxobenzisosulfonazole; 2,3-Dihydro-3-oxobenzisosulphonazole; 1,1-Dioxide-1,2-benzoisothiazol-3(2H)-one; Garantose; Glucid; Gluside; Glycophenol; Glycosin; Hermesetas; 3-Hydroxybenzisothiazole-*S,S*-dioxide; Kandiset; Natreen; Neosaccarin; Sacarina (Spanish); Saccharimide; Saccharina; Saccharin acid; Saccharinol; Saccharinose; Saccharol; Saccharose; Saxin; Sucre Edulcor; Sucrette; *o*-Sulfobenzimide; *o*-Sulfobenzoic acid imide; 2-Sulphobenzoic imide; Sweeta; Sycorin; Sykose; Syncal; Zaharina
CAS Registry Number: 81-07-2
RTECS® Number: DE4200000
EC Number: 201-321-0 [1,2-benzisothiazol-3(2H)-one 1,1-dioxide]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3.
US EPA Hazardous Waste Number (RCRA No.): U202.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 100 lb (45.4 kg).
California Proposition 65 Chemical: Delisted 4/6/01.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: Saccharin is a crystalline solid with a sweet taste (500 times sweeter than sugar). Molecular weight = 183.19; Freezing/Melting point = 229°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.
Potential Exposure: The information provided has to do, primarily, with the manufacturing of saccharin. Saccharin has been used as a nonnutritive sweetening agent. At one point the US consumption pattern for all forms of saccharin has been estimated as 45% in soft drinks; 18% in tabletop sweeteners; 14% in fruits, juices, sweets, chewing gum, and jellies; 10% in cosmetics and oral hygiene products; 7% in drugs, such as coating on pills; 2% in tobacco; 2% in electroplating; and 2% for miscellaneous uses. Human exposure to saccharin occurs primarily through ingestion because of its use in many dietetic foods and drinks and some personal hygiene products, including toothpastes and mouthwashes. The general public is exposed to saccharin, especially by persons required to reduce sugar intake.
Incompatibilities: Keep away from strong oxidizers.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: May cause skin irritation. Exposure to very high levels can cause loss of appetite, nausea, vomiting, and diarrhea.
Long Term Exposure: Saccharin in very high doses has been shown to cause bladder cancer in male rats. Other animal species have not shown this effect. High exposures in certain susceptible individuals may cause skin allergy.
Points of Attack: Bladder, skin.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Urine cytology (a special test for abnormal cells in the urine). Evaluation by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: At any exposure level, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00018-7

breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use extinguishers suitable for surrounding fires. Poisonous gases are produced in fire, including oxides of nitrogen and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 18−21

New Jersey Department of Health and Senior Services. (June 2006). *Hazardous Substances Fact Sheet: Saccharin*. Trenton, NJ

Safrole S:0110

Molecular Formula: $C_{10}H_{10}O_2$

Synonyms: 5-Allyl-1,3-benzodioxole; Allylcatechol methylene ether; Allyldioxybenzene methylene ether; 1-Allyl-3,4-methylenedioxybenzene; 4-Allyl-1,2-(methylenedioxy)benzene; *m*-Allylpyrocatechinmethylene ether; Allylpyrocatechol methylene ether; Benzene, 4-allyl-1,2-(methylenedioxy)-; 1,3-Benzodioxole, 5-(2-propenyl)-; 3,4-Methylenedioxy-allylbenzene; 3-(3,4-Methylenedioxyphenyl) prop-1-ene; Methylene ester of allyl-pyrocatechol; 5-(2-Propenyl)-1,3-benzodioxole; Rhyuno oil; Safrene; Safrol (Spanish); Safrole MF; Shikimole; Shikomol

CAS Registry Number: 94-59-7

RTECS® Number: CY2800000

UN/NA & ERG Number: UN3077/171

EC Number: 202-345-4 [*Annex I Index No.:* 605-020-00-9]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: Reasonably anticipated to be a human carcinogen.

Banned or Severely Restricted (US).[13]

US EPA Hazardous Waste Number (RCRA No.): U203.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 22.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R22; R68; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Safrole is a colorless to yellow liquid with an odor of camphor or sassafras. Molecular weight = 162.20; Boiling point = 232−234°C; Freezing/Melting point = 11°C; Flash point = 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This compound has been used to flavor beverages and foods. It is also reported to be used in soap manufacture, perfumery, sleep aids, sedatives, and pesticides. The FDA estimated exposure to safrole of the general public through food consumption was extremely low since the Agency prohibited its use in food. Derived from oil of sassafras or camphor. Minimal exposure may occur through the use of edible spices, including nutmeg and mace, which contain low levels of naturally occurring safrole.

Incompatibilities: Oxidizing agents.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 100 mg/m^3
PAC-3: 500 mg/m^3

Permissible Concentration in Water: The compound does not pose a hazard to the general population through consumption of drinking water because safrole is insoluble in water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact can cause severe skin and eye irritation. Ingestion may cause abdominal burning, nausea, and vomiting; diarrhea, dysuria, hematuria, unconsciousness, shallow respiration, and convulsions. Inhalation may cause dizziness, rapid and shallow breathing, tachycardia, bronchial irritation, and unconsciousness or convulsions. Other effects may include cyanosis, delirium, and circulatory collapse.

Long Term Exposure: May be a carcinogen in humans.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Environmentally hazardous substances, solid, n.o.s. require a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources[52]: Remove all sources of ignition, ventilate the spill area, and use absorbent to pick up spilled material. Follow by washing surfaces well, first with 60−70% ethanol and water, then with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

Salicylic acid S:0120

Molecular Formula: $C_7H_6O_3$
Common Formula: $C_6H_4(OH)COOH$
Synonyms: *o*-Hydroxybenzoic acid; 2-Hydroxybenzoic acid; Keralyt; Orthohydroxybenzoic acid; Retarder W; SA; SAx
CAS Registry Number: 69-72-7
RTECS® Number: VO0525000
UN/NA & ERG Number: Not regulated.
EC Number: 200-712-3
Regulatory Authority and Advisory Bodies
US EPA Gene-Tox Program, Positive: *S. cerevisiae*—reversion; Negative: Histidine reversion—Ames test.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
FDA—over-the-counter drug.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Salicylic acid is a white crystalline solid. Molecular weight = 138.13; Boiling point = 76°C (sublimes); Freezing/Melting point = 157°C; Flash point = 157°C; Autoignition temperature = 540°C. Explosive limits: LEL = 1.1% at 200°C; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Insoluble in water.
Potential Exposure: Compound Description: Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as a topical keratolytic agent; in the manufacture of aspirin, salicylates, resins, as a dyestuff intermediate; prevulcanization inhibitor; analytical reagent; fungicide, antiseptic, and food preservative.
Incompatibilities: Iron salts; lead acetate; iodine. Forms an explosive mixture in air.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.3 mg/m^3
PAC-1: 0.75 mg/m^3
PAC-2: 6 mg/m^3
PAC-3: 400 mg/m^3

Routes of Entry: Ingestion, inhalation, eyes and/or skin contact. Absorbed through the skin.
Harmful Effects and Symptoms
Short Term Exposure: Overexposure may affect the central nervous system and the body's acid−base balance, causing delirium and tremors. *Inhalation:* May cause ringing in the ears, confusion, rapid pulse and breathing; headache, dizziness, nausea, and vomiting. *Skin:* May be very irritating and cause skin sores. May act as a systemic poison if applied to large areas of the skin. *Eyes:* Causes irritation; may be severe. *Ingestion:* 10 g may cause headache, dizziness, nausea, and vomiting. Ingestion of about 1 oz may be fatal.
Long Term Exposure: Repeated large doses may cause, in addition to the symptoms listed above, abdominal pain; loss of appetite; heartburn, poor digestion; stomach ulcers; bleeding of the stomach; iron-deficiency anemia; restlessness, incoherent speech; tremor, kidney damage; coma, convulsions, and death. Repeated or prolonged contact with skin may cause acne-like skin sores.
Points of Attack: Skin, blood, kidneys.
Medical Surveillance: Complete blood count (CBC). Kidney function tests. Evaluation by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately.
Skin contact: remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to physician: Induced emesis—gastric lavage, activated charcoal, or a combination of these—may be necessary to clear the gastrointestinal tract. Sodium bicarbonate (IV) with added potassium may be necessary for blood acidosis.
Personal Protective Methods: Wear protective gloves and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a

full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained in its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from light. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Salicylic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

Sarin (Agent GB, WMD) S:0130

Molecular Formula: $C_4H_{10}FO_2P$
Common Formula: $(CH_3)_2CHOP(CH_3)OF$

Synonyms: Fluoroisopropoxymethyl oxide; GB (military designation); IMPF; Isopropoxymethylphoryl, fluoride; Isopropyhyl methylphosphonofluoridate; Isopropyl methylfluorophosphate; *O*-Isopropyl methylphosphonofluoridate; Isopropyl methylphosphonofluoridate; Isopropyl-methylphosphoryl fluoride; Methylfluorophosphoric acid isopropyl ester; Methylfluorphosphorsaeureisopropylester (German); Methylphosphonofluoridic acid isopropyl ester; Methylphosphonofluoridic acid 1-methylethyl ester; MFI; Sarina (Spanish); Sarin II; T-144; T-2106; Tl 1618; Trilone 46

CAS Registry Number: 107-44-8; 50642-23-4

RTECS® Number: TA84000000

UN/NA & ERG Number: UN2810/153

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g (*107-44-8; 1445-76-7 Chlorosarin, a precursor*).

Carcinogenicity: GB is not listed by the International Agency for Research on Cancer (IARC); American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical.

Note: Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sarin (GB), a nerve agent, is one of the most toxic of the known chemical warfare agents. Exposure to sarin can cause death in minutes. A fraction of an ounce (1−10 mL) of GB on the skin can be fatal. GB is an odorless, colorless, tasteless, nonflammable liquid at 15°C and 1 atm. *GB has no warning properties, especially when pure, and it can take away your sense of smell.* Molecular weight = 140.09; Specific gravity (H_2O:1) = 1.080 at 25°C; Boiling point = 147°C; Freezing/Melting point = −57°C; Vapor pressure = 2.9 mmHg at 25°C; 2.1 mmHg at 20°C; Liquid density = 1.10 g/mL at 20°C; Relative vapor density (air = 1) = 4.86; Vapor density = 4.9; Volatility = 22,000 mg/m^3 at 25°C. Flash point = >280°C; 78°C (cc).[NIOSH] Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Sinks in water; soluble in water and hydrolyzes. The hydrolysis products are considerably less toxic than the material itself. *Note:* If it is used as a weapon, notify US Department of Defense: Army. If a means of detection is available, use M-8 paper (detection: yellow) or M256-A1 Detector Kit (detection limit: 0.005 mg/m^3). *Warning: A single drop on* *the skin can be fatal*. Damage and/or death may occur before chemical detection can take place.

Potential Exposure: GB is used as a quick-acting chemical warfare nerve agent; nerve gas. Both the liquid and the vapor can kill you. Very small amounts can hurt you in 1 min or less, and can quickly lead to death. A single drop, if vaporized, can kill everyone in a room![USCG] Sarin is 26 times more deadly than cyanide gas and 20 times more deadly than potassium cyanide.

Persistence of Chemical Agent: Sarin (GB): Summer: 10 min to 24 h; Winter: 2 h to 3 days.

Incompatibilities: Attacks tin, magnesium, cadmium-plated steel, and some aluminums. GB decomposes tin, magnesium, cadmium-plated steel, and aluminum. Slightly corrosive to brass, copper, and lead. No attack on 1020 steel, Inconel®, and K-Monel®. Hydrolyzed by water. In acid conditions, GB hydrolyzes, forming hydrofluoric acid (HF). Rapidly hydrolyzed by dilute aqueous sodium hydroxide, or sodium carbonate, forming relatively nontoxic products of polymers and isopropyl alcohol. Contact with metals may evolve flammable hydrogen gas.

STEL: 0.0001 mg/m^3

IDLH: 0.1 mg/m^3

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) GB*

TEEL-0: 0.00015 ppm

PAC-1: **0.00048** ppm

PAC-2: **0.006** ppm

PAC-3: **0.022** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

WPL (Worker population limit): 0.00003 mg/m^3.

The suggested permissible airborne exposure concentration of sarin (GB) for an 8-h workday or a 40-h workweek is an 8-h time-weighted average (TWA) of 0.00003 mg/m^3 (2×10^{-5} ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX.*

GPL (General population limit): 0.000001 mg/m^3.

Also, the general population limits (as recommended by the Surgeon General's Working Group, US Department of Health): 0.000003 mg/m^3. *Human Toxicity:* The human lethal dose (man) is approximately 0.01 mg/kg. LCt_{50} = 100 mg-min/m^3. LD_{50} [skin] = 1.7 g/70 kg [man] (*Medical Aspects of Chemical and Biological Warfare, Part I*, Walter Reed Medical Center, 1997).

Determination in Air: Available monitoring equipment for agent GB is the M8/M9 detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS); Automatic Continuous Air Monitoring System (ACAMS); Real Time Monitoring (RTM); Demilitarization Chemical Agent Concentrator (DCAC); M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYPED); CAM-M1, Miniature Chemical Agent Monitor (MINICAM); and the Real Time Analytical Platform (RTAP). Real-time, low-level monitors (with alarm) are required for GB operations. In their absence, an IDLH atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

Determination in Water: Use M-272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Also, for cyanides, distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). *Food chain concentration potential:* sarin is soluble in water; bioconcentration in aquatic organisms is not expected to be an important fate process [US Army Corps of Engineers. Special Report 86−38, Britton, K. B., *Low Temperature Effects on Sorption, Hydrolysis, and Photolysis of Organophosphates: A Literature Review, p. 23.* Washington DC, 1986]. Octanol−water coefficient: Log K_{ow} = (estimated) −1.4.

Water pollution: If used as a weapon, utilize an M272 Water Detection Kit (Detection limit: 0.02 mg/L). Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes. This material will be broken down in water quickly, but small amounts may evaporate. This material will be broken down in moist soil quickly. Small amounts may evaporate into the air or travel below the soil surface and contaminated groundwater.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Extremely toxic; vapor LCt_{50} = 100 mg-min/m^3. Extremely active cholinesterase inhibitor. The toxic effects of this chemical are similar to parathion, but more severe and dangerous. Liquid, LD_{50} (skin) = 1.7 g/70 kg man; sarin: (mice) (200 μg/kg). A single drop on the skin can cause death. Death may occur within 15 min after fatal dose is absorbed. Symptoms of overexposure may occur within minutes or hours—depending upon dose. They include miosis (constriction of pupils) and visual effects; headache and pressure sensation; runny nose and nasal congestion; salivation, tightness in the chest; nausea, vomiting, giddiness, anxiety, difficulty in thinking; difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps; diarrhea, involuntary urination, and defecation.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions and respiratory failure. Limited data suggest that chronic or repeated exposure to GB may result in a delayed postural sway and/or impaired psychomotor performance (neuropathy).

Points of Attack: Respiratory system; central nervous system; skin, eyes, plasma and red blood cell cholinesterase. Liver and kidney damage.

Medical Surveillance: Patients/victims who have severe exposure should be evaluated for persistent central nervous system (CNS) effects. Consider the points of attack in preplacement and periodic physical examinations. Complete blood count (CBC). Evaluation of thyroid function. Lung function tests. Central nervous system tests. Liver and kidney function tests.

First Aid: Administration of antidotes is a critical step in managing a patient/victim. However, this may be difficult to achieve in the Red Zone, because the antidotes may not be readily available, and procedures or policies for their administration in the Red Zone may be lacking. Do not administer antidotes preventatively; there is no benefit to doing so. Diazepam (or other benzodiazepines) should be administered when there is evidence of seizures, usually seen in cases of moderate to severe exposure to a nerve agent. Remember, physical findings of localized exposure often precede systemic exposure and physical findings.[NIOSH]

Inhalation: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, a lack of coordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5−20 min intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. *Seek medical attention immediately*.

Eye contact: Immediately flush eyes with water for 10−15 min, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken *immediately* to the medical treatment facility for observation.

Skin contact: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer an intramuscular injection with the *Mark I* Kit injectors only if local sweating and muscular twitching symptoms are observed. *Seek medical attention immediately*.

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. Immediately administer an intramuscular injection of the *Mark I* kit autoinjectors.

Medical Treatment: Electrocardiogram (ECG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5−10 mg in adults and 0.2−0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6−12 h to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.[NIOSH]

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Nerve gases stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate upwind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Remember that the water you use to decontaminate the victims is dangerous. Be sure you have decontaminated the victims as much as you can before they are released from the area, so they do not spread the nerve gas. Rinse the eyes, mucous membranes, or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

*The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach ($NaOCl$ or $Ca(OCl)_2$); (2) DS2 (2% $NaOH$, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

Note: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: Wear protective "A-Level" PPE: rubber gloves, protective clothing; goggles, respirators, butyl rubber gloves M3 and M4, Norton chemical protective glove set; and Tyvek® "F" decontamination suit provides barrier protection against chemical warfare agents. Airtight, impermeable clothing was developed for personnel who must enter heavily contaminated areas. This clothing is made of butyl rubber or a coated fabric, such as Tyvek "F," and provides barrier protection against liquid chemical warfare agents. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. If the proper equipment is not available, or if the rescuers have not been trained in its use, call for assistance from the US Soldier and Biological Chemical Command—Edgewood Research Development and Engineering Center (from 0700-1630 EST call 410-671-4411, and from 1630-0700 EST call 410-278-5201; ask for the Staff Duty Officer). All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Swatch Test Results for Level A Suits and Chemical Protective Gloves for GB (Sarin)

Item	**Breakthrough**
25-mil Chemical protective gloves	>480 min
Kappler Suit Model 42483	350 min
TYCHEM 10,000 Pkg Style No. 12645	>480 min
Trellchem HPS suit	>480 min
Ready 1 Limited Use Suit: Model 91	>480 min
First Team XE HazMat suit	>480 min
Commander Ultrapro Suit, Style 79102	>480 min
Kappler Suit Model 50660	>480 min
TYCHEM Style No. 11645	>480 min
Trellchem TLU suit	>480 min
Chemturion Suit: Model 13	>480 min
Chempruf II BETEX Suit	225 min
Commander Brigade: F91	>480 min

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvHie [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister having a high-efficiency particulate filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus). The US Army standard M40 Series (which replaced the M17A1 protective mask) provides complete respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen-deficient environment and it does not afford protection against industrial toxics, such as ammonia and carbon monoxide. *It is not approved for civilian use.*

The following is taken from the Riegle Report:

Less than 0.0001 mg/m^3: A full face-piece, chemical canister, air-purifying protective mask will be on hand for escape. (The M9- or M40-series masks are acceptable for this purpose). *0.0001–0.2 mg/m^3:* A NIOSH/MSHA- or European Standard EN149-approved pressure demand full face-piece SCBA or supplied-air respirator with escape air cylinder may be used. Alternatively, a full face-piece, chemical canister air-purifying protective mask is acceptable for this purpose (for example, M9-, M17-, or M40-series mask or other mask certified as equivalent) is acceptable. *Greater than 0.2 mg/m^3 or unknown concentration:* NIOSH/MSHA- or European Standard EN 149-approved pressure demand full face-piece SCBA suitable for use in high agent concentrations with protective ensemble.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone A] requires a shipping label of "POISONOUS/TOXIC MATERIALS." Inhalation Hazard. It falls in Hazard Class 6.1 and Packing Group III.[NIOSH]

Storage: In handling, the buddy system will be incorporated. No smoking, eating, and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.

Spill Handling: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt. %). Scoop up all material and place in a fully removable head drum with a high-density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of material used to decontaminate exterior of drum. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

If 10 wt. % aqueous sodium hydroxide solution is not available, then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate, and Super-tropical Bleach Slurry (STB).

GB when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.8/1.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (½ mile) in all directions; also, consider initial evacuation for 800 m (½ mile) in all directions. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Rapidly hydrolyzed by dilute aqueous sodium hydroxide or sodium carbonate forming relatively nontoxic products. Water alone removes the fluorine atom producing a nontoxic acid. Decontaminants include bleach slurry, dilute alkali, hot soapy water, steam, and ammonia. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. See also above "Determination in Water." Soil: 2−24 h at 5°−25°C.

Fire Extinguishing: Highly volatile poison! (organophosphate). Breathing the vapor, skin [a single drop on the skin can be fatal] or eye contact, or swallowing the material can kill you; symptoms may be delayed for several hours. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Storage containers and parts of containers may rocket great distances, in many directions. Vapors are heavier than air and will collect and stay in low areas. *Combustion products are less deadly than the material itself.* Toxic products of combustion may include carbon monoxide, fluorine, and phosphorus oxide. GB will react with steam or water to produce toxic and corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face-piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing. Complete protection required; have available decontaminants (bleach, alkali) and atropine. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Open pit burning or burying of GB or items containing or contaminated with GB in any quantity is prohibited. The detoxified GB using procedures above can be thermally destroyed by incineration in an EPA-approved incinerator in accordance with appropriate provisions of federal, state, and local RCRA regulations.

A minimum of 56 g of decon solution is required for each gram of GB. Decontaminant/agent solution is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour. At the end of 1 h, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, sodium hydroxide (NaOH) should be added until a pH above 11.5 can be maintained for 60 min. An alternate solution for the decontamination of GB is 10 wt. % sodium carbonate in place of the 10% sodium hydroxide solution above. Continue with 56 g of decon to 1 g of agent. Agitate for 1 h but allow 3 h for the reaction. The final pH should be adjusted to above 10. It is also permitted to substitute 5.25% sodium hypochlorite or 25 wt. % monoethylamine (MEA) for the 10% sodium hydroxide solution above. MEA must be completely dissolved in water prior to addition of the agent. Continue with 56 g of decon for each gram of GB and provide agitation for 1 h. Continue with same ratios and time stipulations. Scoop up all material and place in a fully removable head drum with a high-density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum in accordance with IAW, federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

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Selenium S:0140

Molecular Formula: Se

Synonyms: C.I. 77805; Colloidal selenium; Elemental selenium; Selenate; Selenio (Spanish); Selenium (colloidal); Selenium alloy; Selenium base; Selenium dust; Selenium element; Selenium homopolymer; Selenium powder

CAS Registry Number: 7782-49-2

RTECS® Number: VS7700000

UN/NA & ERG Number: UN2658 (powder)/152

EC Number: 231-957-4 [*Annex I Index No.:* 034-001-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not classifiable as to human carcinogenicity.

Banned or Severely Restricted (in agriculture) (Germany, UK) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): D010.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 1.0 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.82; Nonwastewater (mg/L), 0.16 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L), total dust 6010 (750); 7740 (20); 7741 (20).

Safe Drinking Water Act: MCL, 0.05 mg/L; MCLG, 0.05 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/25-33; Safety phrases: S1/2; S20/21; S28; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Selenium exists in three forms: a red amorphous powder, a gray form, and red crystals. Occurs as an impurity in most sulfide ores. Selenium, along with tellurium, is found in the sludges and sediments from electrolytic copper refining. It may also be recovered in flue dust from burning pyrites in sulfuric acid manufacture. Molecular weight = 78.96; Specific gravity (H_2O:1) = 4.28 at 25°C; Boiling point = 685°C; Freezing/Melting point = 144°C (red crystalline form); 217°C (gray crystalline form). Hazard Identification (based on NFPA-704 M Rating System): (powder) Health 3, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Human Data. Most of the selenium produced is used in the manufacture of selenium rectifiers. It is also utilized as a pigment for ruby glass, paints, and dyes; as a vulcanizing agent for rubber; a decolorizing agent for green glass; a chemical catalyst in the Kjeldahl test; as an insecticide; in the manufacture of electrodes, selenium photocells, selenium cells, and semiconductor fusion mixtures; in photographic toning bathes; and for dehydrogenation of organic compounds. It is also used in veterinary medicine and in antidandruff shampoos. Se is used in radioactive scanning for the pancreas and for photostatic and X-ray xerography. It may be alloyed with stainless steel, copper, and cast steel. Selenium is a contaminant in most sulfide ores of copper, gold, nickel, and silver; and exposure may occur while removing selenium from these ores.

Incompatibilities: Reacts violently with strong acids and strong oxidizers, chromium trioxide, potassium bromate, cadmium. Reacts with incandescence on gentle heating with phosphorous and metals, such as nickel, zinc, sodium, potassium, platinum. Reacts with water at 50°C forming flammable hydrogen and selenious acids.

Permissible Exposure Limits in Air

The PEL and REL also apply to other selenium compounds (as Se) except selenium hexafluoride; the MAK applies to Se and its inorganic compounds.

OSHA PEL: 0.2 mg[Se]/m^3 TWA.

NIOSH REL (*except selenium hexafluoride*): 0.2 mg[Se]/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.

NIOSH IDLH: 1 mg[Se]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.6 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

DFG MAK (*metal and inorganic compounds*): 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II (4); Carcinogen Category 3B; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3; STEL 0.3 mg/m^3, 1999; Hungary: STEL 0.1 mg/m^3, 1993; the Netherlands: MAC-TGG 0.1 mg[Se]/m^3, 2003; the Philippines: TWA 0.2 mg/m^3, 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.3 mg/m^3, 1999; Sweden: NGV 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, 1999; Turkey: TWA 0.2 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg [Se]/m^3. Russia[43] set a MAC of 2.0 mg/m^3 in work-place air. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μg/m^3 (Montana) to 0.27 μg/m^3 (Massachusetts) to 0.66 μg/m^3 (New York) to 2.0 μg/m^3 (Florida and North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μm filtration prior to the above analysis.

Routes of Entry: Inhalation of dust or vapor, percutaneous absorption of liquid, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

The normal dietary intake of selenium, about 50−150 μg/day, is sufficient to meet the daily nutritional requirement for this essential nutrient. Selenium compounds can be toxic. However, at levels of daily intake that are only moderately higher than the nutritional requirement. The severity of the toxic effects of selenium would depend upon how much selenium was eaten and how often. Swallowing a quantity of concentrated sodium selenate or sodium selenite (for example, part of a bottle of sodium selenate designed to be administered to a flock of sheep, or large numbers of selenium supplement pills) would be life threatening without immediate treatment. If amounts of selenium that were moderately higher than the daily nutritional requirement were eaten over long periods of time, several health effects could occur, including brittle hair, deformed nails; and in extreme cases, numbness and a lack of coordination in arms and legs. These health effects have been observed in people living in several villages in the People's Republic of China who were exposed to foods that were high in selenium for months to years. There have been no reports of populations in the United States exhibiting these symptoms of extreme chronic selenium poisoning.

Short Term Exposure: Selenium can affect you when breathed in. Fumes can irritate the eyes and the respiratory tract. Contact can burn the eyes and skin. Inhalation of fume may cause symptoms of asphyxiation, chills and fever, and bronchitis. High levels can cause troubled breathing, lung irritation (pneumonitis), and headaches. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms of exposure can cause visual disturbance, headache, chills, fever, dyspnea (breathing difficulty), bronchitis, metallic taste, garlic breath, gastrointestinal disturbance.

Long Term Exposure: Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, blood, spleen. In animals: anemia, liver necrosis, cirrhosis, kidney, spleen damage.

Medical Surveillance: NIOSH lists the following tests: Body Hair/Nail; whole blood (chemical/metabolite); blood plasma; blood serum; liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), 24-h collection; urinalysis; white blood cell count/differential. Urine test for selenium (normal is less than 100 μg/L of urine). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator) or 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Selenium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water.

Shipping: Selenium requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including selenium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Powdered selenium: dispose in a chemical waste landfill. When possible, recover selenium and return to suppliers.[22]

References

National Academy of Sciences. (1976). *Selenium*. Washington, DC (Also issued by EPA Health Effects Res. Lab. as Report EPA-600/1-76-014, Research Triangle Park, NC)

US Environmental Protection Agency. (1980). *Selenium: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Selenium: Health and Environmental Effects Profile No. 153*. Washington, DC: Office of Solid Waste

US Public Health Service. (December 1988). *Toxicological Profile for Selenium*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (September 2002). *Hazardous Substances Fact Sheet: Selenium*. Trenton, NJ

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 75−78

Selenium dioxide S:0150

Molecular Formula: O_2Se

Common Formula: SeO_2

Synonyms: Dioxido de selenio (Spanish); Selenious acid anhydride; Selenious anhydride; Selenium(IV) dioxide; Selenium oxide; Selenium(IV) oxide

CAS Registry Number: 7446-08-4

RTECS® Number: VS8575000

UN/NA & ERG Number: UN3283/151; UN2811/154 (selenium oxide)

EC Number: 231-194-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ same as CERCLA; Section 313 Water Priority Chemicals (57FR41331, 9/9/92) as selenium oxide; 40CFR 401.15 Section 307 Toxic Pollutants as selenium and compounds.

US EPA Hazardous Waste Number (RCRA No.): U204.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Selenium dioxide is a white to slightly reddish crystalline solid or yellow liquid which forms a yellow-green vapor that has a sour and pungent odor. Odor threshold in air = 0.0002 mg/m^3. Molecular weight = 110.96; Sublimation point = 315°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water; solubility = 40%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector. Selenium dioxide is used in the manufacture of selenium compounds, a reagent for alkaloids; an oxidizing agent; in paint and ink pigments; in metal "blueing" and etching; as a chemical catalyst; in photographic toners; in electric and photoelectric components; and others.

Incompatibilities: Strong acids may cause release of toxic hydrogen selenide gas. Water solution is a medium strong acid (selenious acid). Reacts with many substances producing toxic selenium vapors. Attacks many metals in the presence of water.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg[Se]/m^3 TWA.

NIOSH REL: 0.2 mg[Se]/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.

NIOSH IDLH: 1 mg [Se]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.281 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 6 mg/m^3

PAC-3: 6 mg/m^3

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Japan: 0.1 mg[Se]/m^3, 1999; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3; MAC (STEL) 0.3 mg[Se]/m^3, 1999; Sweden: NGV 0.1 mg[Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Se]/m^3. Russia[43] set a MAC of 0.1 μg/m^3 in ambient air in residential areas on a momentary basis and 0.05 μg/m^3 on a daily average basis.

Determination in Air: Use NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μm filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion, skin, and/or eyes. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. *Inhalation:* Low-level exposures may cause garlic breath and metallic taste in the mouth. Tiredness, pallor, and indigestion have been reported. Unknown high levels have caused intense irritation of nose, throat, and lungs, with coughing, sneezing, congestion, dizziness, and headache. Inhalation may cause chemical pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* May cause dermatitis with itchy red bumps forming. Chemical burns may also occur. Intense pain will occur if selenium oxide penetrates under the fingernail. *Eyes:* May cause pain and irritation. Eyelids may become puffy, an allergic reaction known as “rose eye.” *Ingestion:* No information specific to selenium oxide. Based on other selenium compounds, may cause nausea, vomiting, abdominal pain, diarrhea, metallic taste, and garlic odor on breath. Animal studies suggest that the lethal dose for an adult may be as low as 1/200 oz.

Long Term Exposure: Allergic sensitization may occur resulting in onset of skin rash and rose eye at very low levels. Discoloration of hair and nails may also affect many organ systems. Animal feeding studies suggest that liver, spleen, and kidney damage is possible. Nasopharyngeal irritation, gastrointestinal distress, and persistent garlic breath may also occur. Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Skin, eyes, liver, kidneys, spleen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to physician: 10% sodium thiosulfate solutions, creams, and eye ointments will rapidly convert selenium oxide to less harmful red selenium. Urinary selenium may be useful indicator of degree of exposure. Liver function tests are suggested.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator) or 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store away from acids and water. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. For liquids, absorb on sand or vermiculite and shovel slurry into sealed container. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including selenium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Selenium Oxide* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

Selenium hexafluoride S:0160

Molecular Formula: F_6Se

Common Formula: SeF_6

Synonyms: Selenium fluoride

CAS Registry Number: 7783-79-1

RTECS® Number: VS9450000

UN/NA & ERG Number: UN2194/125

EC Number: None assigned

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥1.67% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Selenium hexafluoride is a nonflammable, colorless gas. Repulsive odor. Molecular weight = 192.96; Boiling point = −34.4°C (Sublimation point = −46°C); Freezing/Melting point = −50.6°C (also −39°C); Relative vapor density (air = 1) = 6.66. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Insoluble in water; slow reaction.

Potential Exposure: Selenium hexafluoride, a gas, is utilized as a gaseous electric insulator.

Incompatibilities: Hydrolyzes very slowly in cold water. Decomposes on heating, producing hydrogen fluoride, fluoride, and selenium. Contact with metal or acid will produce toxic gaseous hydrogen selenide.

Permissible Exposure Limits in Air

OSHA PEL: 0.05 ppm/0.4 mg[Se]/m^3 TWA.

NIOSH REL: 0.05 ppm TWA.

ACGIH TLV®[1]: 0.05 ppm/0.4 mg[Se]/m^3 TWA.

NIOSH IDLH: 2 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.053 ppm

PAC-1: **0.053** ppm

PAC-2: **0.087** ppm

PAC-3: **0.26** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 0.05 ppm (0.2 mg/m^3), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.05 ppm (0.16 mg/m^3), 1993; Denmark: TWA 0.05 ppm (0.4 mg/m^3), 1999; Finland: TWA 0.05 ppm (0.4 mg/m^3); STEL 0.15 ppm (1.2 mg/m^3), 1999; France: VME 0.05 ppm (0.2 mg/m^3), 1999; Japan 0.1 mg [Se]/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg[Se]/m^3, 2003; Norway: TWA 0.05 ppm (0.4 mg/m^3), 1999; the Philippines: TWA 0.05 ppm (0.4 mg/m^3), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 0.05 ppm (0.4 mg/m^3), 1999; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; TWA 2.5 mg[F]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 ppm. Several states have set guidelines or standards for SeF_6 in ambient air[60] ranging from 2 μg/m^3 (North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: Collection by impinger or fritted bubbler, analysis by atomic absorption spectrometry.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Contact with the liquid can cause frostbite.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. May affect the central nervous system, liver, and kidneys.

Points of Attack: Respiratory system, liver, kidneys, skin. In animals: pulmonary irritation, edema.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine). Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests. Examination by a qualified allergist. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 2 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Selenium hexafluoride requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.2/1.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 1.8/2.9
Night 4.0/6.5

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire. The material itself does not burn or burns with difficulty. Poisonous gases are produced in fire, including hydrogen fluoride, fluoride, and selenium. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: If possible, convert selenium compounds to an insoluble form with SO_2 before landfill or solidification.

References

New Jersey Department of Health and Senior Services. (September 2001). *Hazardous Substances Fact Sheet: Selenium Hexafluoride*. Trenton, NJ

Selenium oxychloride S:0170

Molecular Formula: Cl_2OSe
Common Formula: $SeOCl_2$
Synonyms: Seleninyl chloride; Selenium chloride oxide; 9Seleninyl dichloride
CAS Registry Number: 7791-23-3
RTECS® Number: VS7000000
UN/NA & ERG Number: UN2879/157
EC Number: 232-244-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as selenium compounds, n.o.s., waste number not listed.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Selenium oxychloride is a colorless to yellowish liquid. Fumes in air. Molecular weight = 165.86; Boiling point = 176.3°C; Specific gravity (H_2O:1) = 2.42 at 25°C; Freezing/Melting point = 8.5−11°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1₩. Reacts with water.

Potential Exposure: Compound Description: Human Data. This material is used as a solvent for many substances, including metals and as a chlorinating agent; and resin plasticizer; as an ionizing solvent; for monochlorination of ketones.

Incompatibilities: Water and air reactive. The aqueous solution is a strong acid and oxidizer. Reacts violently with bases, reducing agents, powdered antimony, red and white phosphorus, disilver oxide, lead oxide, and potassium.

Note: Never pour water into this substance; when dissolving or diluting always add it slowly to the water.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg[Se]/m^3 TWA.
NIOSH REL: 0.2 mg[Se]/m^3 TWA.
ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.
NIOSH IDLH: 1 mg [Se]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.42 mg/m^3
PAC-1: 1.26 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 10 mg/m^3

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C. Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg[Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg [Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Se]/m^3. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μg/m^3 (Montana) to 0.27 μg/m^3 (Massachusetts) to 0.66 μg/m^3 (New York) to 2.0 μg/m^3 (Florida and North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μm filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is very toxic and may cause death or permanent injury after very short exposures to small quantities. Inhalation of small quantities may be corrosive and irritating to the respiratory tract. It can burn and severely irritate the skin and eyes and cause burns to the mouth, esophagus, and stomach when ingested. Inhalation of this material may cause garlic breath, odor, nausea, vomiting, indigestion, fever, headache, lassitude, irritability, and unstable blood pressure.

Long Term Exposure: Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Skin, lungs, liver.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 mg/m³:* DM if not present as a fume (any dust and mist respirator) or any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Selenium oxychloride requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including selenium and chloride, are produced in fire. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Selenium Oxychloride*. Washington, DC: Chemical Emergency Preparedness Program

Selenium sulfides S:0180

Molecular Formula: SSe; Se_4S_4; SeS_2; Se_2S_6

Common Formula: SeS; Se_4S_4; SeS_2; Se_2S_6

Synonyms: 7446-34-6 *(monosulfide):* NCI-C50033; Selenium monosulfide; Selenium sulfide; Selenium sulphide; Selensulfid (German); Sulfur selenide

7788-56-4 *(disulfide):* Exsel; Selenium(IV) disulfide (1:2); Selenium disulphide; Selenium sulfide; Sulfuro de selenio; Selsun

CAS Registry Number: 7446-34-6 (SeS); 7488-56-4 (SeS_2)

RTECS® Number: VT0525000 (SeS); VS8925000 (SeS_2)

UN/NA & ERG Number: UN2657 (SeS_2)/153

EC Number: 231-303-8 (selenium disulphide)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: rat, mouse; NCI: Carcinogenesis Bioassay (dermal); no evidence: mouse.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds.

US EPA Hazardous Waste Number (RCRA No.): U205.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 10/1/89.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (SeS_2).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: There are various selenium sulfides: Selenium monosulfide, SeS, is orange-yellow powder or tablets, Molecular weight = 111.02; Boiling point = (decomposes) 118−119°C; Freezing/Melting point = 111°C. Selenium disulfide, SeS_2 which is a bright red to yellow material; Freezing/Melting point ≤100°C. Se_2S_6 which is a light orange crystalline solid. Freezing/Melting point = 121.5°C. Se_4S_4 is a red crystalline solid. Molecular weight = 143.08; Freezing/Melting point = 113°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Selenium sulfide is used for the treatment of seborrhea, especially in shampoos. The chemical is available over the counter as Selsun®, a stabilized buffered suspension. FDA reports that selenium sulfide is an active ingredient in some drug products used for the treatment of dandruff and certain types of dermatitis. A dandruff shampoo containing 1% selenium sulfide is available without a prescription and is recommended for use once or twice a week. By prescription, selenium sulfide is available in a 2.5% shampoo or lotion, with the recommended application limited to 10 min for 7 days to avoid the possibility of acute toxic effects. Selenium sulfide is also used topically in veterinary medicine for eczemas and dermatomycoses.

Incompatibilities: Oxidizers, strong acids. Violent reaction with silver oxide.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg[Se]/m^3 TWA.

NIOSH REL: 0.2 mg[Se]/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.

Protective Action Criteria (PAC)

NIOSH IDLH: 1 mg [Se]/m^3.

Monosulfide

TEEL-0: 0.281 mg/m^3

PAC-1: 0.844 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 15 mg/m^3

Disulfide

TEEL-0: 0.362 mg/m^3

PAC-1: 1.09 mg/m^3

PAC-2: 1.81 mg/m^3

PAC-3: 60 mg/m^3

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C.

Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μg/m^3 (Montana) to 0.27 μg/m^3 (Massachusetts) to 0.66 μg/m^3 (New York) to 2.0 μg/m^3 (Florida and North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μm filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Eye contact can cause irritation. The dust irritates the respiratory tract. Higher exposure can cause headaches, troubled breathing, and pneumonitis. Symptoms of exposure include irritation of the skin (dermatitis), eyes, and mucous membranes; eye injury; hair loss; discoloration of hair; garlic odor of the breath; depression, languor, giddiness, emotional instability; excess dental caries; pallor, nervousness; digestive disturbances; and nausea.[52]

Long Term Exposure: A probable carcinogen in humans, it has been shown to cause liver and lung cancer in animals. Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Liver.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine).

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Selenium disulfide requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides and selenium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Selenium Sulfide*. Trenton, NJ

Selenous acid S:0190

Molecular Formula: H_2O_3Se
Common Formula: H_2SeO_3
Synonyms*:* Acide selenieux (French); Acido selenioso (Spanish); Hydrogen selenite; Monohydrated selenium dioxide; Selenious acid; Selenium dioxide
CAS Registry Number: 7783-00-8; *(alt.)* 11140-60-6
RTECS® Number: VS7175000
UN/NA & ERG Number: UN3283/151; UN2811/154
EC Number: 231-974-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds.
US EPA Hazardous Waste Number (RCRA No.): U204.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as selenium compounds, n.o.s., waste number not listed.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Selenious acid is a colorless, crystalline solid. Molecular weight = 128.98; Freezing/Melting point = 70°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 1 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. It is used as a reagent for alkaloids and as an oxidizing agent. Isotope is used in labeling radiopharmaceuticals.

Incompatibilities: A strong oxidizer. Incompatible with reducing agents, combustibles, acids. Contact with acids produce toxic and gaseous hydrogen selenide. Attacks metals.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg[Se]/m^3 TWA.
NIOSH REL: 0.2 mg[Se]/m^3 TWA.
ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.
NIOSH IDLH: 1 mg [Se]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.327 mg/m^3
PAC-1: 0.98 mg/m^3
PAC-2: 250 mg/m^3
PAC-3: 250 mg/m^3
DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C.
Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg [Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg [Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg [Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg[Se]/m^3, 1999; Switzerland: MAK week 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom:

TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Se]/m^3. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μg/m^3 (Montana) to 0.27 μg/m^3 (Massachusetts) to 0.66 μg/m^3 (New York) to 2.0 μg/m^3 (Florida and North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μm filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Selenous acid and its salts are capable of penetrating the skin and can produce acute poisonings. Corrosive to the eyes, skin, and respiratory tract. May affect the eyes, resulting in "rose-eye," an allergic-type reaction of the eyelids. It is highly toxic orally. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inorganic selenium compounds may cause dermatitis. Toxic effects are similar to those of selenium and other selenium compounds. Garlic odor of breath is a common symptom. Pallor, nervousness, depression, and digestive disturbances have been reported in cases of chronic exposure. The most common industrial injuries are irritations and burns of the skin.

Long Term Exposure: Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Skin, eyes, liver, kidneys, nervous system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine). Examination of the nervous system. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained in its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from reducing agents, acids, combustibles. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Liquid containing selenium inorganic compounds should be absorbed in vermiculite, dry sand, earth, or similar material. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including selenium oxides and selenium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Selenious Acid*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Selenious Acid*. Trenton, NJ

Semicarbazide hydrochloride S:0200

Molecular Formula: CH_6ClN_3O

Common Formula: $H_2NNHCONH_2 \cdot HCl$

Synonyms: Amidourea hydrochloride; Aminourea hydrochloride; Carbamylhydrazine hydrochloride; CH; Clorhidrato de semicarbazide (Spanish); Hydrazinecarboxamide monohydrochloride

CAS Registry Number: 563-41-7; 18396-65-1

RTECS® Number: VT3500000

UN/NA & ERG Number: Not regulated.

EC Number: 209-247-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Semicarbazide hydrochloride is a white crystalline solid. Molecular weight = 111.55; Freezing/Melting point = 172−175°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as a reagent for ketones and aldehydes with which it affords crystalline compounds having characteristic freezing/melting points. Also used in isolation of hormones and certain fractions from essential oils.

Incompatibilities: Oxidizers. May ignite combustible materials (wood, oil, paper).

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 20 mg/m^3

PAC-1: 60 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 100 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can irritate the eyes and skin. Toxic by ingestion. Symptoms of exposure include convulsions; irritation of skin, eyes, and mucous membranes; gastroenteric disturbances; and anemia. High level of exposure may affect the nervous system.

Long Term Exposure: There is limited evidence that this chemical causes lung cancer in animals. High or repeated exposure may cause nerve damage with weakness, a feeling of “pins and needles,” and loss of coordination in the limbs.

Points of Attack: Nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained in its proper handling and storage. Store in a refrigerator and protect from oxidizers, combustible materials, moisture. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. For small fires, use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam. For large fires, use water spray, fog, or foam. Poisonous gases are produced in fire, including nitrogen oxides and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Semicarbazide Hydrochloride*. Washington, DC: Chemical Emergency Preparedness Program

Silane S:0210

Molecular Formula: H_4Si

Common Formula: SiH_4

Synonyms: Monosilane; Silano (Spanish); Silicane; Silicon tetrahydride

CAS Registry Number: 7803-62-5

RTECS® Number: VV1400000

UN/NA & ERG Number: UN2203/116

EC Number: 232-263-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Silane is a colorless, pyrophoric gas with a repulsive odor. Molecular weight = 32.13; Boiling point = −169°C; Specific gravity (H_2O:1) = 1.31 at 25°C; Specific gravity (H_2O:1) = 1.31 at 25°C; Freezing/Melting point = −111.7°C; Flash point = −236°C. Relative vapor density (air = 1) = 1.11. Explosive limits: LEL = 1.37%; UEL = 100%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 3₩. Slight solubility in water; slowly decomposes.

Potential Exposure: Compound Description: Mutagen. Silane is used as a doping agent for solid-state devices, as a source of silicon for semiconductors, and in the production of amorphous silicon.

Incompatibilities: An extremely flammable gas; may spontaneously ignite in air. A strong reducing agent. Reacts slowly with water. Reacts with oxidizing agents, halogens [bromine, chlorine, carbonyl chloride, antimony pentachloride, tin(IV) chloride], potassium hydroxide solution. Explodes in oxygen. Decomposes on heating or on burning producing silicon and hydrogen.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 ppm/7 mg/m^3 TWA.

ACGIH TLV®[1]: 5 ppm/6.6 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 5 ppm

PAC-1: **100** ppm

PAC-2: **130** ppm

PAC-3: **270** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 5 ppm (7 mg/m^3), 1993; Belgium: TWA 5 ppm (6.6 mg/m^3), 1993; Denmark: TWA 0.5 ppm (0.7 mg/m^3), 1999; Finland: TWA 0.5 ppm (0.7 mg/m^3); STEL 1.5 ppm (2.0 mg/m^3), 1999; France: VME 5 ppm (7 mg/m^3), 1999; Japan: 100 ppm (130 mg/m^3), 1999; Norway: TWA 0.5 ppm (0.7 mg/m^3), 1999; the Netherlands: MAC-TGG 0.7 mg/m^3, 2003; United Kingdom: TWA 0.5 ppm (0.67 mg/m^3); STEL 1 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 ppm. Several states have set guidelines or standards for silane in ambient air[60] ranging from 70 μg/m^3 (North Dakota) to 140 μg/m^3 (Connecticut) to 167 μg/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Silicon tetrahydride can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Skin or eye contact with the liquid may cause frostbite. Not much is known about the effects of exposure to high levels, but somewhat similar chemicals cause severe irritation of the eyes, skin, and lungs.

Long Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Silicon tetrahydride must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Silicon tetrahydride should be stored and used under a blanket of inert gas as it explodes on contact with air. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where silicon tetrahydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of silicon tetrahydride.

Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Silane, compressed, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. For small fires, use dry chemical or CO_2 extinguishers. Avoid halons. Dolomite powder or graphite are recommended dry chemical agents.[24] Poisonous gases are produced in fire, including silicon and explosive hydrogen. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose by controlled burning or seal cylinders and return to suppliers.[24]

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Silicon and its Compounds*, Report PB-270,073. Cincinnati, OH, pp. 55−61

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Silicon Tetrahydride*. Trenton, NJ

Silica, amorphous S:0220

Molecular Formula: O_2Si

Common Formula: SiO_2

Synonyms: *Diatomaceous earth:* Amorphous silica; Celite; Chromosorb; D.E.; Diatomaceous earth, natural; Diatomaceous silica; Diatomite; Infusorial earth; Kieselguhr; Silica, amorphous-diatomaceous earth (uncalcined); Snowfloss

Silica, amorphous hydrated: Amorphous fumed silica; Silica aerogel; Silica gel; Silica xerogel; Silicic acid; Silicid anhydride

CAS Registry Number: 7631-86-9 (amorphous hydrated); *(alt.)* 50926-93-7; *(alt.)* 67256-35-3; 112945-52-5 (fumed); 60676-86-0 (fused); 61790-53-2 (diatomaceous earth, uncalcined); *(alt.)*12750-99-1; *(alt.)* 29847-98-1; *(alt.)* 37337-67-0; *(alt.)* 54511-18-1; *(alt.)* 56748-40-4; *(alt.)* 67016-73-3; 68855-54-9 (diatomaceous earth); 112926-00-8 (precipitated silica and silica gel); 69012-64-2 (silica fume); 7699-41-4

RTECS® Number: VV73100000 (fumed); VV7311000 (diatomaceous earth)

EC Number: 231-545-4

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; NIOSH (*Silica, amorphous silica, fused*): Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex I (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Amorphous silica, the noncrystalline form of SiO_2, is a transparent to gray, odorless, amorphous powder. Molecular weight = 60.09; Specific gravity (H_2O:1) = 2.20 at 25°C; Boiling point = 2230°C; Freezing/Melting point = 1710°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Amorphous fumed silica is used as a mineral, natural or synthetic fiber. Those involved in the production and handling of fumed silica for paint pigments or catalysts. Diatomaceous earth is used in clarifying liquids, in manufacture of fire brick and heat insulators; used as a filtering agent; as a filler in construction materials; pesticides, paints, and varnishes. Those involved in mining of diatomaceous earth or fabrication of products therefrom.

Incompatibilities: Fluorine, oxygen difluoride, chlorine trifluoride.

Permissible Exposure Limits in Air

Silica, amorphous silica, fused

OSHA PEL: 30 mg/m^3 total dust/divided by the value "%$SiO_2 + 2$" TWA; *either one* of the following methods: 250 mppcf respirable dust/divided by the value "%$SiO_2 + 5$" *or* 10 mg/m^3 respirable dust/divided by the value "%$SiO_2 + 2$."

NIOSH REL: 0.05 mg/m^3, respirable dust TWA; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: withdrawn.

DFG MAK (*CAS: 60676-86-0 & 7699-41-4*): 0.3 mg/m^3 respirable fraction; Pregnancy Risk Group C.

Silica, amorphous precipitated and gel and diatomaceous earth, uncalcined

OSHA PEL: *either one of the methods:* 20 mppcf [millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques] *or* 80 mg/m^3 divided by the value "%SiO_2," TWA.

NIOSH REL: 6 mg/m^3 TWA.

ACGIH TLV®[1]: withdrawn for the following: silica amorphous, precipitated and gel; silica fume; silica fused; diatomaceous earth, calcined.

NIOSH IDLH: 3000 mg/m^3.

Protective Action Criteria (PAC)

Amorphous hydrated

TEEL-0: 6 mg/m^3
PAC-1: 18 mg/m^3
PAC-2: 100 mg/m^3
PAC-3: 500 mg/m^3

Amorphous fumed

TEEL-0: 6 mg/m^3
PAC-1: 18 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 500 mg/m^3

DFG MAK (*diatomaceous earth, uncalcined)*: 4 mg/m^3, inhalable fraction; Pregnancy Risk Group C.

Austria: MAK 4 mg/m^3, 1999; Norway: TWA 1.5 mg/m^3 (respirable dust), 1999; Switzerland: MAK-W 4 mg/m^3, 1999; Thailand: TWA 80 mg/m^3, 1993; United Kingdom: TWA 6 mg/m^3, total dust, 2000; United Kingdom: TWA 1.2 mg/m^3 (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 3 mg/m^3 (respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica). Russia[43] set a MAC of 2 mg/m^3 in work-place air.

Determination in Air: Use NIOSH(IV) Method #7501 (any form); OSHA Analytical method ID-125G (fumed).

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Amorphous fused silica can affect you when breathed in. Exposure can cause a very serious lung disease called silicosis, with cough and shortness of breath. Very high exposures can cause this problem to develop in a few weeks, or with lower exposures it may occur over many years. Silicosis can cause death. If silicosis develops, chances of getting tuberculosis are increased. The disease may progress, with or without continued exposure. If it does, this can be crippling or even fatal.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Chest X-ray every 1−3 years. If abnormal chest X-ray develops, the following should be done periodically: skin test for TB.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 60 mg/m^3:* 95XQ (APF = 10) [Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 150 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 300 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 3000 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Amorphous fused silica must be stored to avoid contact with powerful oxidizers including fluorine, oxygen difluoride, chrome trifluoride, and manganese trioxide, since violent reactions occur.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Amorphous fused silica itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 94

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: Silica, Amorphous-Dimataceous Earth.* Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2003). *Hazardous Substances Fact Sheet: Silica, Amorphous (Fume).* Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Silica, Amorphous Fused.* Trenton, NJ

Silica, crystalline S:0230

Molecular Formula: O_2Si

Common Formula: SiO_2

Synonyms: *Cristobalite:* Calcined diatomite; Silica, cristobalite; Silica, crystalline-cristobalite

Silica, quartz: Agate; Amethyst; Chalcedony; Cherts; Flint; Onyx; Pure quartz; Quartz; Rose quartz; Sand; Silica flour (powdered crystalline silica); Silicic anhydride

Tridymite: Christensenite; Silica, crystalline-tridymite; Tridimite (French); α-Tridymite; Tridymite; Tridymite 118

Tripoli: Finely ground silica; Silica flour

CAS Registry Number: 14808-60-7 (crystalline quartz); 14464-46-1 (cristobalite); *(alt.)* 1317-48-2; 105269-70-3 (cristobalite); 15468-32-3; *(alt.)* 1317-94-8; 12414-70-9 (tridymite); 1317-95-9 (tripoli)

RTECS® Number: VV7325000 (cristobalite); VV7330000 (quartz); VV7335000 (tridymite); VV7336000 (tripoli)

EC Number: 238-878-4; 238-455-4 (cristobalite); 239-487-1 (tridymite)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC (*cristobalite, tridymite, tripoli, and quartz*): Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP (*respirable cristobalite, tridymite, tripoli, and quartz*): 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NIOSH (*cristobalite, tridymite, tripoli, and quartz*): Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer [Silica, crystalline (airborne particles of respirable size)] 10/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, all forms.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Crystalline silica is a component of many mineral dusts and materials which melts to a glass at very high temperature. Molecular weight = 60.09; Specific gravity (H_2O:1) = 2.66 at 25°C; Boiling point (quartz) = 2230°C; Freezing/Melting point (quartz) = 1610°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description (cristobalite): Tumorigen, Human Data; (quartz): Tumorigen, Mutagen, Organometallic, Human Data; (tridymite): Tumorigen, Mutagen; Human Data. Cristobalite is used in the manufacture of water glass, refractories, abrasives, ceramics, and enamels. Quartz is used as a mineral, natural or synthetic fiber. Tridymite is used as a filtering and insulating media and as a refractory material for furnace linings. Workers are potentially exposed to crystalline silica in industries such as granite quarrying and cutting, foundry operations; metal, coal, dentistry, painting, and nonmetallic mining; and manufacture of clay and glass products.

Incompatibilities: Violent reactions with powerful oxidizers: fluorine, chlorine trifluoride; manganese trioxide; oxygen difluoride, hydrogen peroxide, etc.; acetylene; ammonia.

Permissible Exposure Limits in Air

OSHA PEL: (*silica, crystalline α-quartz, CAS: 14808-60-7 & Silica, crystalline tripoli CAS: 1317-95-9*): 30 mg/m^3 total dust/divided by the value "%$SiO_2 + 2$" TWA; *either one* of the following methods: 250 mppcf respirable dust/divided by the value "%$SiO_2 + 5$" *or* 10 mg/m^3 respirable dust/divided by the value "%$SiO_2 + 2$"; For Silica crystalline, tridymite, CAS: 15468-32-3 and Silica, crystalline cristobalite, CAS 14464-46-1 use ½ the values calculated above using the count or mass formula for quartz. See also Table Z-3 of 29 CFR 1910.1000.

NIOSH REL (*silica, crystalline, all forms*): 0.05 mg/m^3, respirable dust TWA; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1] (*Silica, crystalline α-quartz, CAS: 14808-60-7 & Crystalline cristobalite, CAS 14464-46-1*): 0.025 mg/m^3 TWA, Respirable fraction of dust; Suspected Human Carcinogen.

NIOSH IDLH: (*cristobalite and tridymite*) 25 mg/m^3; (*quartz and tripoli*) 50 mg/m^3.

Protective Action Criteria (PAC)

14808-60-7 Silica, crystalline-quartz; (Silicon dioxide)

TEEL-0: 0.025 mg/m^3

PAC-1: 0.075 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 50 mg/m^3

14464-46-1 (cristobalite)

TEEL-0: 0.025 mg/m^3

PAC-1: 0.075 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK (s*ilica, crystalline, all forms*): respirable; Carcinogen Category 1.

Austria: MAK 0.15 mg/m^3, 1999; Belgium: TWA 0.05 mg/m^3, 1993; Finland: TWA 0.1 mg/m^3, 1999; France: VME 10/(2X + 2), 1999; Norway: TWA 0.05 mg/m^3 (respirable dust), 1999; Russia: STEL 1 mg/m^3 (total dust), 1993; the Netherlands: MAC-TGG 0.075 mg/m^3, 2003; Switzerland: MAK-W 0.15 mg/m^3, 1999; Thailand: TWA 10 mg/m^3, 1993; United Kingdom: TWA0.3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 mg/m^3 (respirable dust).

Determination in Air: Use: Use NIOSH Analytical Method (cristobalite), #7500, Silica, crystalline, by XRD; #7601, by VIS; #7602, by IR; #7603, Silica, crystalline in coal mine dust, by IR; OSHA Analytical Method ID-142; 125-G.

Routes of Entry: Inhalation of dust, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. Inhalation can cause cough, dyspnea (breathing difficulty), wheezing.

Long Term Exposure: Can cause decreased pulmonary function, progressive respiratory symptoms, fibrosis (silicosis). A potential occupational carcinogen. Silicosis is a very serious lung disease that can cause cough and shortness of breath. Silicosis can develop in a few weeks at very high exposures, or it may occur over many years with lower exposures. Silicosis can cause death. If silicosis develops, risk of developing tuberculosis is increased. The disease may progress with or without continued exposure. If it does, this can be crippling or even fatal. Very fine silica or "silica flour" is even more hazardous.

Points of Attack: Eyes, respiratory system. Cancer site in animals: lungs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Chest X-ray every 1−3 years. Chest X-rays should be read by a "B-reader," a doctor with special training for reading X-rays of the lungs. If abnormal chest X-ray develops, the following should be done periodically, skin test for tuberculosis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in the NIOSH document CT-112-23b, *Control Technology for Bag Filling Operations at Manville Products Corporation, Lompoc, CA.* NIOSH recommends that *silica sand* or materials containing *more than 1% free silica* be prohibited as abrasive substances in abrasive blasting and cleaning operations. The New Jersey Department of Health and Senior Services document *Stop Silicosis in Sandblasters; Use Silica Substitutes* recommends the substitution of less toxic *alumina* in pottery, and *quartz free grit* in abrasive blasting for silica, cristobalite. Follow OSHA regulations (OSHA Standard 1910.94) for abrasive blasting operations.

Respirator Selection: NIOSH: *Up to 0.5 mg/m^3:* 95XQ (APF = 10) (any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100). *Up to 1.25 mg/m³:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 2.5 mg/m³:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter). *Up to 25 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Silica must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Silica itself does not burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

References

National Institute for Occupational Safety and Health. (1974). *Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica*, NIOSH Document No. 75-120. Washington, DC

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Silica, Quartz*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Silica, Tripoli*. Trenton, NJ

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Silica Cristobalite*. Trenton, NJ

Silicon S:0240

Molecular Formula: Si

Synonyms: Defoamer S-10; Elemental silicon; Silicon, amorphous powder

CAS Registry Number: 7440-21-3

RTECS® Number: VW0400000

UN/NA & ERG Number: UN1346 (powder, amorphous)/170

EC Number: 231-130-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Silicon is a nonmetallic element which is known as silicon metal. Does not occur free in nature, but is found in silicon dioxide (silica) and in various silicates.[NIOSH] It is a steel-gray crystalline solid or a black-brown amorphous material. Molecular weight = 28.09; Specific gravity (H_2O:1) = 2.33 at 25°C; Boiling point = 2345°C; Freezing/Melting point = 1410°C. Minimum Explosive Concentration = 160 g/m³. Ignition temperature of dust cloud = Unknown; Minimum Explosive concentration = 0.11 oz/ft³.[USBM] Relative explosion hazard of dust: Strong. Hazard Identification (based on NFPA-704 M Rating System): [powder] Health 1, Flammability 2, Reactivity 1. Nearly insoluble in water.

Potential Exposure: Compound Description: Primary Irritant. Silicon may be used in the manufacture of silanes, silicon tetrachloride, ferrosilicon, silicones. It is used in purified elemental form in transistors and photovoltaic cells.

Incompatibilities: The powder is highly flammable. Keep this material away from calcium, carbonates, chlorine, fluorine, oxidizers, cesium carbide, alkaline carbonates.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m³ TWA, total dust; 5 mg/m³ TWA, respirable fraction.

NIOSH REL: 10 mg/m³ TWA, total dust; 5 mg/m³ TWA, respirable fraction.

ACGIH TLV®[1]: withdrawn.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m³

PAC-1: 45 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 500 mg/m^3
Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 10 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 10 mg/m^3, 1999; Switzerland: MAK-W 4 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^2, total inhalable dust, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3.

Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust; Method #0600 (respirable dust).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Causes irritation of the eyes, skin, and upper respiratory system; cough. Silicon dust does not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Unpleasant deposits may be caused in eyes, ears, and nasal passages, and injury to the skin and mucous membranes may be caused by the dust itself or by cleansing procedures used for its removal.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function test. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard (*amorphous powder*): Store in a flammable materials storage area. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and other incompatible materials.

Shipping: Silicon powder, amorphous requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Silicon carbide S:0250

Molecular Formula: CSi

Common Formula: SiC

Synonyms: Carbon silicide; Carborundum®, Crystolon®, Carbonite®, Electrolon®; Silicon monocarbide

CAS Registry Number: 409-21-2; *(alt.)* 12504-67-5; *(alt.)* 66039-27-8

RTECS® Number: VW0450000

EC Number: 206-991-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Silicon carbide is a yellow to green to bluish-black, iridescent crystalline substance. Colorless when pure. Molecular weight = 40.10; Specific gravity (H_2O:1) = 3.23 at 25°C; Boiling point = (sublimes); Freezing/Melting point = (sublimes with decomposition) 2700°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen. Those involved in the manufacture of silicon carbide abrasives, refractories, and semiconductors. Silicon carbide fibers are also produced in fibrous form as reinforcing fibers for composite materials.

Incompatibilities: None listed. Sublimes with decomposition at 2700°C.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.

NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA, respirable fraction.

ACGIH TLV®[1]: *Nonfibrous:* 10 mg/m^3 TWA, inhalable fraction; particulate matter containing no asbestos and $<1\%$ crystalline silica; 3 mg/m^3 TWA, respirable fraction, for particulate matter containing no asbestos and $<1\%$ crystalline silica; *fibrous (including whiskers):* 0.1 f/cc, TWA, respirable fibers; length >5 μm; aspect ratio $\geq 3:1$, as determined by the membrane filter method at 400−450× magnification (4-mm objective), using phase-contrast illumination; Suspected Human Carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 45 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1.5 mg/m^3, respirable fraction (previously "fine dust"); 4 mg/m^3, inhalable fraction; Pregnancy Risk Group C.

Australia: TWA 10 mg/m^3, 1993; Austria: MAK 4 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; France: VME 10 mg/m^3, 1999; Switzerland: MAK-W 4 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; United Kingdom: TWA 4 mg/m^3 (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen.

Determination in Air: Use NIOSH IV Method #0500, total dust, Method #0600 (respirable dust), Particulates NOR.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, upper respiratory system; cough.

Long Term Exposure: Silicon carbide can alter the course of inhalation tuberculosis leading to extensive fibrosis and progressive disease.

Points of Attack: Respiratory system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill.

References

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Silicon Carbide.* Trenton, NJ

Silver S:0260

Molecular Formula: Ag

Synonyms: Argentum; C.I. 77820; Elemental silver; Shell silver; Silber (German); Silver metal

Soluble compounds: Silver acetate; Silver bromate; Silver bromide; Silver carbonate; Silver chloride; Silver chromate; Silver cyanide; Silver cichromate; Silver hydroxide; Silver iodate; Silver iodide; Silver nitrite; Silver oxalate; Silver sulfate; Silver sulfide; Silver thiocyanate

CAS Registry Number: 7440-22-4

RTECS® Number: VW3500000

EC Number: 231-131-3

Regulatory Authority and Advisory Bodies

Carcinogenicity (*metal*): EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants as *silver and compounds.*

US EPA Hazardous Waste Number (RCRA No.): D011.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 5.0 mg/L.

Land Ban chemical.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.43; Nonwastewater (mg/L), 0.30 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (70); 7760 (100).

Safe Drinking Water Act: SMCL, 0.1 mg/L.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (includes any unique chemical substance that contains silver as part of that chemical's infrastructure).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*metal*); 3—Highly water polluting (*colloidal*).

Description: Silver is a white lustrous metal that is extremely ductile and malleable. Molecular weight = 107.87; Specific gravity (H_2O:1) = 10.49 at 25°C (metal); Boiling point = 2212°C; Freezing/Melting point = 961°C. Hazard Identification (based on NFPA-704 M Rating System) (*powder*): Health 0, Flammability 0, Reactivity 1. Insoluble in water but soluble in hot sulfuric and nitric acids. Perhaps the most common soluble silver compounds are silver nitrate ($AgNO_3$) and silver cyanide (AgCN).

Potential Exposure: Silver may be alloyed with copper, aluminum, cadmium, lead, or antimony. The alloys are used in the manufacture of silverware, jewelry, coins, ornaments, plates, commutators, scientific instruments, automobile bearing, and grids in storage batteries. Silver is used in chrome-nickel steels, in solders and brazing alloys; in the application of metallic films on glass and ceramics, to increase corrosion resistance to sulfuric acid, in photographic films, plates, and paper; as an electroplated undercoating for nickel and chrome; as a bactericide for sterilizing water; fruit juices; vinegar, etc.; in bus bars and windings in electrical plants; in dental amalgams; and as a chemical catalyst in the synthesis of aldehydes. Because of its resistance to acetic and other food acids, it is utilized in the manufacture of pipes, valves, vats, pasteurizing coils and nozzles for the milk, vinegar, cider, brewing, and acetate rayon silk industries.

Incompatibilities: Acetylene, ammonia, hydrogen peroxide, bromoazide, chlorine trifluoride, ethyleneimine, oxalic acid, tartaric acid.

Permissible Exposure Limits in Air

Silver metal dust and fume

OSHA PEL: 0.01 mg[Ag]/m^3 TWA.

NIOSH REL: 0.01 mg[Ag]/m^3 TWA.

ACGIH TLV®[1]: *silver metal dust and fume*: 0.1 mg[Ag]/m^3 TWA; *silver salts*: 0.01 mg[Ag]/m^3 TWA.

NIOSH IDLH: 10 mg[Ag]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.01 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 0.5 mg/m^3

PAC-3: 10 mg/m^3

DFG MAK: *silver metal dust and fume*: 0.1 mg[Ag]/m^3, inhalable fraction TWA; Peak Limitation Category II(8); Pregnancy Risk Group D. *Silver salts:* 0.01 mg[Ag]/m^3, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 0.1 mg/m^3, 1993; Austria: MAK 0.01 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.01 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1999; Japan: 0.01 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Norway: TWA 0.01 mg/m^3, 1999; Russia: STEL 1 mg/m^3, 1993; Sweden: NGV 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.01 mg/m^3, 1999; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3 *silver metal dust*. Several states have set guidelines or standards for silver in ambient air[60] ranging from 0.01−0.08 $\mu g/m^3$ (Montana) to 0.2 $\mu g/m^3$ (Connecticut and Nevada) to 1.0 $\mu g/m^3$ (North Dakota) to 16,000 $\mu g/m^3$ (Virginia).

As silver soluble compounds
OSHA PEL: 0.01 mg/m^3 TWA.
NIOSH REL: 0.01 mg/m^3 TWA.
ACGIH TLV®[1]: 0.01 mg/m^3 TWA.

Determination in Air: NIOSH Analytical Method #7300 Elements by ICP; #8005, Elements in blood or tissue, #8310 Metals in urine; OSHA Analytical Method ID-121.

Permissible Concentration in Water: *To protect freshwater aquatic life:* should not exceed e[1.72 in(hardness)—6.52] μg/L at any time. *To protect saltwater aquatic life:* never to exceed 2.3 μg/L. To protect human health: 50 μg/L.[6] The state of Maine recommends that silver in drinking water should not exceed 50 μg/L.[61]

Determination in Water: Digestion followed by atomic absorption or colorimetric determination (with Dithizone) or by inductively coupled plasma (ICP) optical emission spectrometry. This gives total silver. Dissolved silver may be determined by these same methods preceded by 0.45 μm filtration.

Routes of Entry: Inhalation of fumes or dust, ingestion of solutions or dust, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Causes irritation of the eyes, skin, and respiratory tract. Ingestion of dust can cause gastrointestinal disturbance.

Long Term Exposure: Silver can affect you when breathed in. Repeated exposure to fine silver dust or fumes can cause blue-gray staining of the eyes, mouth, throat, internal organs, and skin. This occurs slowly and may take years to develop. Once present, it does not go away. It can be very disfiguring. Skin contact can cause silver to become imbedded in small cuts in the skin, forming a permanent tattoo. Can cause sores on the inner lining of the nose and may cause perforation of the nasal septum.

Points of Attack: Nasal septum, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; biologic tissue/biopsy; Pigmentation Evidence; urine (chemical/metabolite). Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Slit lamp examination by an eye doctor. Examination of the skin, nose, and throat. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Silver must be stored to avoid contact with acetylene, ammonia, hydrogen peroxide, or ethyleneimine, since violent reactions occur.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical

as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, but flammable in the form of dust or powder. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery, wherever possible, in view of economic value of silver. Techniques for silver recovery from photoprocessing and electroplating wastewaters have been developed and patented.

References

US Environmental Protection Agency. (1980). *Silver: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *Silver: Health and Environmental Effects Profile No. 154*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 52−55

New Jersey Department of Health and Senior Services. (October 2002). *Hazardous Substances Fact Sheet: Silver*. Trenton, NJ

Silver cyanide S:0270

Molecular Formula: CAgN

Synonyms: Cianuro de plata (Spanish); Cyanure d'argent (French)

CAS Registry Number: 506-64-9

RTECS® Number: VW3850000

UN/NA & ERG Number: UN1684/151

EC Number: 208-048-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as silver and compounds.

US EPA Hazardous Waste Number (RCRA No.): P104.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cyanides.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Silver cyanide is a white or grayish odorless powder which darkens when exposed to light. Molecular weight = 133.89; Freezing/Melting point = 320°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: It is primarily used in silver plating.

Incompatibilities: Acetylene, ammonia, and hydrogen peroxide (H_2O_2). Acid and acid fumes produce hydrogen cyanide. Contact with fluorine is violently explosive at normal temperatures. Incompatible with phosphorus cyanide.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA.

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

Protective Action Criteria (PAC)

TEEL-0: 0.0124 mg/m^3

PAC-1: 0.35 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 12.4 mg/m^3

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

NIOSH IDLH: 25 mg[CN]/m^3.

Silver salts: 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

NIOSH IDLH: 10 mg[Ag]/m^3

Determination in Air: Use NIOSH Analytical Method #7904, Cyanides. See also entry for Silver.

Permissible Concentration in Water: Again, both silver and cyanide can be considered. The EPA limit for silver in drinking water is 50 μg/L and that for cyanides is 154 μg/L.[61]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Silver cyanide can affect you when breathed in and by passing through your skin. Heating releases deadly cyanide gas. Skin or eye contact can cause irritation. A deadly poison if ingested.

Long Term Exposure: Repeated exposure can slowly cause the eyes, inner nose, throat, skin, and body organs to turn a blue-gray color. This may take years to develop but is permanent. High or repeated exposure may cause kidney damage.

Points of Attack: Kidneys, skin.

Medical Surveillance: To detect early changes in body color, careful periodic examinations of the eyes, inner nose, throat, and skin are useful. Persons with high or frequent exposure should consider periodic tests for kidney function. If cyanide exposure is suspected, immediate medical attention is recommended. Consider urine test for thiocyanates to detect cyanide exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene, ammonia, and hydrogen peroxide. Protect from light. Silver cyanide and fluorine are violently explosive at normal temperatures.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including cyanide and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Silver Cyanide*. Trenton, NJ

Silver nitrate S:0280

Molecular Formula: $AgNO_3$

Synonyms: Lunar caustic; Nitrate d'argent (French); Nitrato de plata (Spanish); Nitric acid, silver(1+) salt; Nitric acid, silver(I) salt; Silbernitrat (German); Silver(1+) nitrate; Silver(I) nitrate

CAS Registry Number: 7761-88-8

RTECS® Number: VW4725000

UN/NA & ERG Number: UN1493/140

EC Number: 231-853-9 [*Annex I Index No.:* 047-001-00-2]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Negative: *E. coli* polA without S9.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR 41331, 9/9/92).

40CFR401.15 Section 307 Toxic Pollutants as silver and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed.

Land Ban chemical.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: O, C, N; Risk phrases: R8; R34; R50/53; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Silver nitrate is a colorless to dark gray, odorless, crystalline solid. Molecular weight = 169.88; Boiling point = 444°C (decomposes); Freezing/Melting point = 212°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Silver nitrate is used in photography, silver plating; as an antiseptic; in chemical reactions; and mirror manufacturing; as starting material in production of other silver compounds.

Incompatibilities: A strong oxidizer. Reacts violently with combustible and reducing materials. Reacts with acetylene forming a shock-sensitive explosive. Reacts with alkalis, antimony salts, ammonia, arsenites, bromides, carbonates, chlorides, iodides, hydrogen peroxide, thiocyanates, ferrous salts, oils, hypophosphites, morphine salts, creosote, phosphates, tannic acid, tartarates, halides, vegetable extracts, and others. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

As silver soluble compounds

OSHA PEL: 0.01 mg/m^3 TWA.

NIOSH REL: 0.01 mg/m^3 TWA.

ACGIH TLV®[1]: 0.01 mg/m^3 TWA.

NIOSH IDLH: 10 mg[Ag]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0157 mg/m^3

PAC-1: 15.7 mg/m^3

PAC-2: 15.7 mg/m^3

PAC-3: 15.7 mg/m^3

DFG MAK: *Silver salts:* 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Arab Republic of Egypt: TWA 0.01 mg[Ag]/m^3, 1993; Australia: TWA 0.01 mg[Ag]/m^3, 1993; Belgium: TWA 0.01 mg[Ag]/m^3, 1993; Denmark: TWA 0.01 mg[Ag]/m^3, 1999; Finland: TWA 0.01 mg[Ag]/m^3; STEL 0.03 mg[Ag]/m^3, [skin], 1999; France: VME 0.01 mg[Ag]/m^3, 1999; Japan: 0.01 mg[Ag]/m^3, 1999; Norway: TWA 0.01 mg[Ag]/m^3, 1999; the Philippines: TWA 0.01 mg[Ag]/m^3, 1993; Poland: MAC (TWA) 0.01 mg[Ag]/m^3, 1999; Sweden: NGV 0.01 mg[Ag]/m^3, 1999; Switzerland: TWA 0.01 mg [Ag]/m^3, 1999; United Kingdom: TWA 0.01 mg[Ag]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.01 mg[Ag]/m^3.

Determination in Air: See entry for Silver.

Permissible Concentration in Water: EPA[6] and the state of Maine[61] have set guidelines of 50 μg/L for silver in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. May affect the blood, causing formation of methemoglobin. *Inhalation:* May cause irritation of the nose, throat, and lungs. *Skin:* May cause irritation. Concentrated solutions may cause burns, sores, and discoloration of skin. Solid materials will cause chemical burns especially if skin is wet. *Eyes:* May cause irritation which can be severe. Solid material may cause chemical burns and permanent damage.

Ingestion: May cause burns to mouth and throat, abdominal pain, diarrhea, and dizziness. Shock and convulsions may develop. Estimated lethal dose is 2 g or 1/14 oz for a 150-lb adult.

Long Term Exposure: All forms of silver accumulate and are excreted very slowly. Blue-gray discoloration (argyreia) of eyes, nose, throat, and skin may occur. This discoloration is likely to be permanent. May affect the blood causing formation of methemoglobin. Very irritating substances can cause lung effects. High or repeated exposure may cause kidney damage.

Points of Attack: Skin, kidneys, blood.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Examination of the eyes, nose, throat, and skin for changes in color. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Test for blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: If swallowed, perform gastric lavage, using 1−2% sodium chloride water every 15 min, followed by saline catharsis. Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with solutions containing silver nitrate. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Silver nitrate must be stored to avoid contact with oils and fuels, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and alkalis. Silver nitrate should not be stored in plastic containers. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Solid material: evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable but is a strong oxidizer capable of increasing the intensity of an existing fire and the flammability of combustible, organic, or other oxidizable materials. Use type of extinguisher appropriate to other burning materials. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 52−53

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Silver Nitrate* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Silver Nitrate*. Trenton, NJ

Silver picrate S:0290

Molecular Formula: $C_6H_2AgN_3O_7$

Common Formula: $C_6H_2(NO_2)_3OAg$

Synonyms: Picragol; Picrotol; 2,4,6-Trinitro-phenol silver (1+) salt

CAS Registry Number: 146-84-9

RTECS® Number: TJ7891000

UN/NA & ERG Number: UN1347 (wetted with not <30% water, by mass)/113

EC Number: 205-682-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Silver compounds

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as silver and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed. Land Ban chemical.

EPCRA Section 313: Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as silver, soluble compounds.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Silver picrate is a yellow powder or crystalline material which turns brown when heated or exposed to light. Molecular weight = 335.98. Soluble in water.

Potential Exposure: Used in antibacterial medicines.

Incompatibilities: Organics or other oxidizable materials. Dried out material is unstable and a severe explosion risk; protect from shock, light, and vibration.

Permissible Exposure Limits in Air

As silver soluble compounds

OSHA PEL: 0.01 mg/m^3 TWA.

NIOSH REL: 0.01 mg/m^3 TWA.

ACGIH TLV®[1]: 0.01 mg/m^3 TWA.

No TEEL available.

DFG MAK: *silver salts:* 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

NIOSH IDLH: 10 mg[Ag]/m^3.

Determination in Air: See entry for Silver.

Permissible Concentration in Water: The EPA[6] and the state of Maine[61] have set limits of 50 μg/L for silver in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Silver picrate can affect you when breathed in and by passing through your skin. Eye contact can cause burns with possible damage. Skin contact can cause severe irritation or burns.

Long Term Exposure: Repeated exposure can slowly cause the eyes, inner nose, throat, skin, and body organs to turn a blue-gray color. This usually takes years to develop but is permanent. High or repeated exposure can cause kidney damage.

Points of Attack: Skin, eyes, kidneys.

Medical Surveillance: To detect early changes in body color, careful periodic examinations of the eyes, inner nose, throat, and skin are useful. Persons with high or frequent exposure should consider periodic tests for kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *10 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Treat as an explosive material. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organics or other readily oxidizable materials. Protect from shock, light, and vibration. Sources of ignition, such as smoking and open flames, are prohibited where silver picrate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever silver picrate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Silver picrate (dry) is FORBIDDEN. Silver picrate, wetted with not $<$30% water, by mass, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep silver picrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Silver picrate is a flammable material which may be ignited by heat, sparks, or flames. Containers may explode if exposed to heat, flame, or shock. Cover with sand, earth, or water spray, and keep it wet. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Silver Picrate*. Trenton, NJ

Silvex S:0300

Molecular Formula: $C_9H_7Cl_3O_3$

Common Formula: $Cl_3C_6H_2OCH(CH_3)COOH$

Synonyms: Acide, 2-(2,4,5-trichloro-phenoxy) propionique (French); Amchen 2,4,5-TP; Aqua-Vex; Color-set; Dedweed; Double strength; Fenomore; Fenoprop; Fruitone T; Fruit-O-Net; Kuran; Kuron; Kurosal; Kurosalg; Miller NU set; Propon; Silvex herbicide; Silvi-RHAP; STA-fast; 2,4,5-TC; 2,4,5-TCPPA; 2,4,5-TP; 2,4,5-Trichlorophenoxy-α-; α-(2,4,5-Trichlorophenoxy)propanoic acid; 2-(2,4,5-Trichlorophenoxy)propanoic acid; 2-(2,4,5-Trichlorphenoxy)propionsaeure (German)

CAS Registry Number: 93-72-1

RTECS® Number: UF8225000

UN/NA & ERG Number: UN2765 (Phenoxy pesticides, solid, toxic)/152

EC Number: 202-271-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Banned or Severely Restricted (several countries) (UN).[13]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below) as 2,4,5-tp acid.

US EPA Hazardous Waste Number (RCRA No.): U233.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (2).

Safe Drinking Water Act: MCL, 0.05 mg/L; MCLG, 0.05 mg/L; Regulated chemical (47 FR 9352) as 2,4,5-TP.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.72; Nonwastewater (mg/kg), 7.9.

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Silvex is a colorless powder; Freezing/Melting point = 179−181°C; Vapor pressure = 1×10^{-7} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly water soluble.

Potential Exposure: Those engaged in the manufacture, formulation, and application of this herbicide.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 35 mg/m^3

PAC-3: 250 mg/m^3

Permissible Concentration in Water: Surface water levels should never exceed 2.5 ppb silvex (butoxyethyl ester); 2.0 ppb (propyleneglycolbutylether ester) (EPA).

Determination in Water: Fish Tox = 1515.29908000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May cause skin and eye irritation. Poisonous by ingestion. Approximate lethal dose = 2.4 tablespoonful/150 lb man.

Long Term Exposure: Silvex has caused liver and kidney damage in experimental animals. Human Tox = 56.00000 ppb (LOW).

Points of Attack: Liver, kidneys, skin, eyes.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Phenoxy pesticides, solid, toxic and "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 300.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.[1] Mix with excess sodium carbonate, add water and let stand for 24 h before flushing down the drain with excess water; or[2] pour onto vermiculite and incinerate with wood, paper, and waste alcohol. EPA compared disposal procedures. They concluded that incineration was difficult and unreasonably expensive. They concluded that land-spreading permitted exposure to silvex and the contaminant TCDD. The preferred method was disposal in a secure hazardous waste landfill.

Simazine S:0310

Molecular Formula: $C_7H_{12}ClN_5$

Synonyms: A 2079; AI3-51142; Aktinit S; Aquazine; Batazina; 2,4-Bis(aethylamino)-6-chlor-1,3,5-triazin (German); 2,4-Bis(ethylamino)-6-chloro-*s*-triazine; Bitemol; Bitemol S-50; Cat (Japan); CDT; Cekusan; Cekuzina-S; Cet; 1-Chloro-3,5-bis(ethylamino)-2,4,6-triazine; 2-Chloro-4,6-bis (ethylamino)-*s*-triazine; 2-Chloro-4,6-bis(ethylamino)-1,3,5-triazine; 6-Chloro-*N*,*N*′-diethyl-1,3,5-triazine-2,4-diamine; 6-Chloro-N^2,N^4-diethyl-1,3,5-triazine-2,4-diamine; 6-Chloro-*N*, *N*′-diethyl-1,3,5-triazine-2,4-diyldiamine; Framed; G 27692; Geigy 27692; Gesaran; Gesatop; Gesatop-50; H 1803; Herbazin 50; Herbex; Herboxy; Hungazin DT; NSC 25999; Premazine; Primatel S; Primatol S; Princep 80W; Simadex; Simanex; Simazina (Spanish); Simazine 80W; Tafazine; Tafazine 50-W; Taphazine; Triazine A 384; *s*-Triazine, 2-chloro-4,6-bis(ethylamino)-; 1,3,5-Triazine-2,4-diamine, 6-chloro-*N*,*N*′-diethyl-; W 6658; Weedex; Zeapur

CAS Registry Number: 122-34-9

RTECS® Number: XY5250000

UN/NA & ERG Number: UN2753/151

EC Number: 204-535-2 [*Annex I Index No.*: 612-088-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Safe Drinking Water Act: MCL, 0.004 mg/L; MCLG, 0.004 mg/L; Regulated chemical (47 FR 9352).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R40; R50/53; Safety phrases: S2; S36/37; S46; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Simazine is a combustible, white crystalline solid with little or no odor; Freezing/Melting point = (decomposes) 225°C; Vapor pressure = 2.2×10^{-8} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this preemergence herbicide.

Incompatibilities: Powder forms explosive mixture with air. Incompatible with strong oxidizers.

Permissible Exposure Limits in Air: Russia set a MAC of 2.0 mg/m^3 for simazine in work-place air[35] and a MAC of 0.02 mg/m^3 for ambient air in residential areas both on a momentary and a daily average basis.

Permissible Concentration in Water: Russia set a MAC of 2.4 μg/L in water bodies used for fishery purposes and a limit of zero in water bodies used for domestic purposes. A lifetime health advisory of 35 μg/L has been developed by EPA (see "References" below). Various states have developed guidelines for simazine in drinking water[61] ranging from 150 μg/L (California) to 430 μg/L (Maine) to 2150 μg/L (Wisconsin).

Determination in Water: Analysis of simazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen−phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen−phosphorus detector. The method detection limit has not been determined for this compound but it is estimated that the detection limits for the method analytes are in the range of 0.1−2 μg/L. Fish Tox = 1732.04831000 ppb (VERY LOW). Octanol−water coefficient: Log K_{ow} = 2.08.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May cause skin or eye irritation. Moderately poisonous if ingested. Approximate lethal dose = 1.5 cupful/150 lb man. No case of poisoning in humans from simazine has been reported, although exposure to simazine has caused acute and subacute dermatitis in Russia, characterized by erythema, slight edema, moderate pruritus, and burning lasting 4−5 days.

Long Term Exposure: Repeated exposure may cause weight loss and reduced red blood cell count. *Chronic*

Toxicity—simazine fed to rats for 2 years at 1.0, 10, and 100 ppm produced no difference between treated and control animals in gross appearance or behavior. The rats fed 100 ppm had approximately twice as many thyroid and mammary tumors as the control animals, but it was stated that these were not attributable to simazine. A 2-year chronic-feeding study of simazine in dogs with simazine 80W fed at 15, 150, and 1500 ppm showed only a slight thyroid hyperplasia at 1500 ppm and slight increases in serum alkaline phosphatase and serum glutamic oxaloacetic transaminase in several of the dogs fed 1500 ppm. Human Tox = 4.00000 ppb (HIGH).

Points of Attack: Blood.

Medical Surveillance: Complete blood count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Triazine pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I to III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 130.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Strong acid or alkaline hydrolysis leads to complete degradation of simazine. However, large quantities of simazine should be incinerated in a unit operating at 850°C equipped with off-gas scrubbing equipment.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 109−113

US Environmental Protection Agency. (August 1987). *Health Advisory: Simazine*. Washington, DC: Office of Drinking Water

Soapstone S:0320

Molecular Formula: $H_2Mg_3O_{12}Si_4$

Common Formula: $3MgO \cdot 4SiO_2 \cdot H_2O$

Synonyms: Massive talc; Silicate soapstone; Soapstone silicate; Steatite; Talc

CAS Registry Number: None listed.

RTECS® Number: VV8780000

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence (talc not containing asbestiform fibers); Sufficient (for talc containing asbestiform fibers).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Description: Soapstone is an odorless gray-white crystalline solid. Molecular weight = 351.31; Specific gravity (H_2O:1) = 2.7−2.8 at 25°C; Freezing/Melting point = 900−1000°C. Negligible solubility in water.

Potential Exposure: Soapstone is used as a pigment in paints, varnishes, rubber, and soap. It is used in lubricating molds and machinery. In massive form, it is used as a heat insulator.

Incompatibilities: Silicates can react violently with lithium.

Permissible Exposure Limits in Air

OSHA PEL: 20 mppcf TWA.

NIOSH REL: 6 mg/m^3, total dust TWA; 3 mg/m^3 (respirable dust) TWA.

ACGIH TLV®[1]: 6 mg/m^3 (for particulate matter containing no asbestos and <1% crystalline silica) TWA; 3 mg/m^3 (respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica) TWA.

NIOSH IDLH: 3000 mg/m^3.

Protective Action Criteria (PAC)

Talc

TEEL-0: 2 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: *for talcum* suspended 2004; Carcinogen Category 3B.

The Netherlands: MAC-TGG 5 mg/m^3 (total dust); 2.5 mg/m^3 (respirable dust), 2003.

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract causing coughing, wheezing.

Long Term Exposure: Pneumoconiosis: cough, dyspnea (breathing difficulty); digital clubbing; cyanosis, basal crackles; or pulmonale.

Points of Attack: Respiratory system, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 60 mg/m^3*: 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 150 mg/m^3:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 300 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50)* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 3000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust, then transfer material to a suitable container for disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

Sodium S:0330

Molecular Formula: Na

Synonyms: Elemental sodium; Natrium; Sodio (Spanish); Sodium element; Sodium, metal liquid alloy; Sodium metal

CAS Registry Number: 7440-23-5

RTECS® Number: VY0686000

UN/NA & ERG Number: UN1428/138

EC Number: 231-132-9 [*Annex I Index No.:* 011-001-00-0]

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 10 lb (4.54 kg).

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R14/15; R34; Safety phrases: S1/2; S5 (If appropriate); S8; S43; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium is a soft silvery white metallic element. Pyrophoric solid or molten liquid. Odorless. Molecular weight = 22.99; Boiling point = 881.4°C; Freezing/Melting point = 98°C; Autoignition temperature ≥115°C (in dry air). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 3₩. Violent reaction with water.

Potential Exposure: Those involved in tetra-alkyl lead manufacture using lead-sodium alloy as a reactant; those using sodium as a liquid metal coolant, as a catalyst, or in the manufacture of sodium hydride, borohydride, or peroxide.

Incompatibilities: A strong reducing agent. A dangerous fire hazard when exposed to heat and moisture. Violent reaction with water, forming sodium hydroxide. Violent reaction with oxidizers, acids, halogenated hydrocarbons, phosphorus and phosphorus compounds, sulfur and sulfur compounds, and many other chemicals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: The metal reacts with water. Sodium ion limit is 10 mg/L as desirable in drinking water; 200 mg/L may be injurious to humans. Russia[43] set a MAC of 120 mg/L in water bodies used for domestic purposes. Several states have set guidelines for sodium in drinking water[61] ranging from 20 mg/L (Massachusetts) to 100 mg/L (Kansas).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Contact with water, including perspiration, causes the formation of sodium hydroxide fumes which are highly irritating to skin, eyes, nose, and throat. May cause sneezing and coughing. Very severe exposures may result in difficult breathing, coughing, and chemical bronchitis. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Contact may cause itching, tingling, thermal and caustic burns, and may cause permanent damage. *Eyes:* May cause tearing, very painful irritation, and burns. Contact with eyes may result in permanent damage and loss of sight. *Ingestion:* Causes immediate intense burning sensation in mouth, throat, and stomach, followed by salivation, vomiting, rapid breathing, symptoms of shock, diarrhea, loss of consciousness, and death.

Long Term Exposure: Very irritating substances may affect the lungs. It is not known, however, if sodium causes lung damage.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure to sodium metal, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek

medical attention immediately. Wipe the chemical off the skin with a dry cloth. Then quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to sodium, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—Red Stripe (*lump*): Flammability Hazard: Do not store in the same area as other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium must be stored to avoid contact with water, halogenated hydrocarbons, phosphorus and phosphorus compounds, and sulfur and sulfur compounds, since violent reactions occur. Protect storage containers from physical damage. Keep in an inert atmosphere or under oil. Requires special precautions to avoid contact with moisture, including condensation from other objects and perspiration. Store in a dry, fire resistive room exclusively for sodium storage. Sprinkler systems should not be used, so keep combustibles away. Remove only the amount of sodium needed for immediate use and place dry in a friction top metal can under a layer of oil. Transport in a special container with a tight-fitting cover. Where sodium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Sodium metal requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group I. *Note:* Finely divided sodium is pyrophoric.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Put on proper protective equipment. Blanket with appropriate inert material. Scoop up and place in a suitable, sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. A severe fire risk on contact with water or moisture. Blanket with dry soda ash, graphite, salt, dry limestone, or other approved dry powder. *Do not use water*, carbon dioxide, or halogenated extinguishers. Poisonous gases are produced in fire, including sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with absorption of oxide fumes.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 85−88

Sittig, M. (1956). *Sodium, Its Manufacture, Properties and Uses*. American Chemical Monograph No. 133. New York: Reinhold Publishing Corp.

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Sodium*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Sodium*. Trenton, NJ

Sodium aluminate S:0340

Molecular Formula: $AlNaO_2$
Common Formula: $NaAlO_2$ ($Na_2O \cdot Al_2O_3$)
Synonyms: β-Alumina; *beta*-Alumina; Aluminum sodium oxide; J 242; Maxifloc 8010; Monofrax H; Nalco 680; Sodium aluminum oxide; Sodium polyaluminate; VSA 45
CAS Registry Number: 11138-49-1
RTECS® Number: BD1600000
EC Number: 234-391-6
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
UN/NA & ERG Number: UN2812 (solid)/154; UN1819 (solution)/154.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Sodium aluminate is a white crystalline solid or solution. Molecular weight = 82.12; Freezing/Melting point = 1650°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.
Potential Exposure: Used in water and waste treatment; papermaking industry; in printing on fabrics; in the manufacture of pigments, milk glass, and soap; hardening building stone; sizing paper; as a water softener.
Incompatibilities: The aqueous solution is a strong base. Reacts violently with acid. Incompatible with organic anhydrides, isocyanates, alkylene oxides, epichlorohydrin, aldehydes, alcohols, glycols, caprolactum, chlorocarbons. Attacks copper, tin, aluminum, and zinc.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 2 mg[Al]/m^3 TWA.
ACGIH TLV®[1]: 2 mg[Al]/m^3 TWA as soluble salts and alkyls, n.o.s.
Protective Action Criteria (PAC)
TEEL-0: 6.08 mg/m^3
PAC-1: 18.2 mg/m^3
PAC-2: 30.4 mg/m^3
PAC-3: 150 mg/m^3
Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 10 mg/m^3, total dust inhalable dust; TWA 4 mg/m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg[Al]/m^3.
Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Sodium aluminate can affect you when breathed in. Sodium aluminate solution is a corrosive chemical. Skin or eye contact can cause severe irritation or burns, with possible damage. Breathing sodium aluminate dust can irritate the air passages. This may cause cough with phlegm and/or shortness of breath. Inhalation of dust may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Corrosive on ingestion.
Long Term Exposure: Irritating substances may affect the lungs. It is not known whether sodium aluminate causes lung damage.
Points of Attack: Lungs.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.
Respirator Selection: Where there is potential for exposure to solid sodium aluminate, use a NIOSH/MSHA- or

European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. Where there is potential for high exposures or liquid sodium aluminate, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Sodium aluminate, solid, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III. Sodium aluminate, solution, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (October 1986). *Hazardous Substances Fact Sheet: Sodium Aluminate*. Trenton, NJ

New York State Department of Health. (April 2000). *Chemical Fact Sheet: Sodium Aluminate*. Albany, NY: Bureau of Toxic Substance Assessment

Sodium aluminum fluoride S:0350

Molecular Formula: AlF_6Na_3

Common Formula: Na_3AlF_6

Synonyms: Aluminum sodium fluoride; Cryolite; ENT 24,984; Kryolith (German); Natriumaluminumfluorid (German); Natriumhexafluoroaluminate (German); Sodium aluminofluoride; Sodium fluoaluminate; Sodium hexafluoroaluminate; Trisodium hexafluoroaluminate; Villiaumite

CAS Registry Number: 15096-52-3; 13775-53-6 (synthetic)

RTECS® Number: WA9625000

UN/NA & ERG Number: UN3077/171

EC Number: 239-148-8 [*Annex I Index No.:* 009-016-00-2]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol (*natural and synthetic*): T, N; Risk phrases: R20/22; R48/23/25; R51/53; Safety phrases: S1/2; S22; S37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium aluminum fluoride is a colorless to dark red or black, crystalline solid. Odorless. Loses color on heating. Molecular weight = 209.95; Boiling point = (decomposes); Freezing/Melting point = 1000°C. Very slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Sodium aluminum fluoride is used in making pesticides, ceramics, glass, and polishes; in refining reduction of aluminum, flux, glass, and enamel.

Incompatibilities: Strong acids, strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL

0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

As aluminum, soluble salts

OSHA PEL: None.

NIOSH REL: 2 mg[Al]/m^3 TWA.

No TEEL available.

Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1993; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: LTEL 2 mg [Al]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg[Al]/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluoride; for aluminum, soluble salts, use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Permissible Concentration in Water: Drinking water, *aluminum* guidelines[61] are 1.43 mg/L in Massachusetts and 5.0 mg/L in Kansas. *Fluoride* guidelines are 1.8 mg/L in Arizona, 2.4 mg/L in Maine, and 4.0 mg/L according to EPA. Toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sodium aluminum fluoride can affect you when breathed in. Eye contact can cause severe irritation, burns with possible loss of vision. Skin contact can cause irritation and even burns, especially if prolonged. Breathing can irritate the nose, throat, and air passages. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause nausea, abdominal pain, diarrhea, salivation, thirst, sweating.

Long Term Exposure: Repeated exposure can cause stiff spine; calcification of ligaments of ribs, pelvis. Repeated or high exposures may cause permanent lung damage.

Points of Attack: Eyes, skin, lungs, skeletal system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. Urine fluoride test (levels above 3−4 mg/L at the end of exposure represent increased exposure).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic fluorides*.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium aluminum fluoride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Environmentally hazardous substances, solid, n.o.s. require a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Use dry chemicals appropriate for metal fires. Poisonous gases are produced in fire, including sodium oxides and fluorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Sodium Aluminum Fluoride*. Trenton, NJ

Sodium aluminum hydride S:0360

Molecular Formula: AlH_4Na

Common Formula: $NaAlH_4$

Synonyms: Aluminate(1-), tetrahydro-, sodium, (*t*-4)-; Aluminum sodium hydride; Sah 22; Sodium aluminum tetrahydride; Sodium tetrahydroaluminate(1-)

CAS Registry Number: 13770-96-2

RTECS® Number: BD01800000

UN/NA & ERG Number: UN2835/138

EC Number: 237-400-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium aluminum hydride is a white crystalline solid. Molecular weight = 54.01; Freezing/Melting point = 183°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity ₩. Reaction with water may be dangerous.

Potential Exposure: Used in chemical synthesis.

Incompatibilities: A strong reducing agent. Violent reaction with water, air, oxidizers, acids, alcohols, and ethers. Reaction with water may cause fire or explosion. May ignite spontaneously in moist air.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 300 mg/m^3

The limits for "aluminum pyro powders" may be applicable (NJ).

OSHA PEL: None.

NIOSH REL: 5 mg[Al]/m^3 TWA.

ACGIH TLV®[1]: 5 mg[Al]/m^3 TWA.

The limits for aluminum soluble salts, for reference

OSHA PEL: None.

NIOSH REL: 2 mg[Al]/m^3 TWA.

ACGIH TLV®[1]: 2 mg[Al]/m^3 TWA as soluble salts and alkyls, n.o.s.

Determination in Air: Use NIOSH #7300; #7301; #7303.

Permissible Concentration in Water: This material reacts vigorously with water so this category is not pertinent.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sodium aluminum hydride can affect you when breathed in. Exposure can irritate the eyes, skin, and respiratory tract. If wet, sodium aluminum hydride may cause burns and permanent damage.

Long Term Exposure: May cause lung injury, pulmonary fibrosis.

Points of Attack: Skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Dangerous if any form of moisture is present. Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium aluminum hydride must be stored to avoid contact with water, air, oxidizers, acids, alcohols, and ethers, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where sodium aluminum hydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of sodium aluminum hydride. Wherever sodium aluminum hydride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "DANGEROUS WHEN WET." It falls in Hazard Class 4.3 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium aluminum hydride is a flammable solid. It can ignite spontaneously in moist air. The flame may be invisible. *Do not use water*. Use dry chemical, soda ash, or lime extinguishers. Fires may restart after it has been extinguished. Poisonous and explosive gases are produced in fire, including sodium oxides and hydrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 2002). *Hazardous Substances Fact Sheet: Sodium Aluminum Hydride*. Trenton, NJ

Sodium arsenate S:0370

Molecular Formula: $AsH_3Na_xO_4$; $AsHNa_2O_4$
Common Formula: $Na_xH_3AsO_4$; HNa_2AsO_4
Synonyms: Arsenite de sodium (French); Arsenito sodico (Spanish); Arsenous acid, sodium salt; Atlas A; Chem Pels C; Chem-Sen 56; Disodium arsenate heptahydrate; Kill-All; Penite; Prodalumnol; Sodanit; Sodium metaarsenite
Dibasic: Arsenic acid disodium salt; Disodium arsenate; Disodium hydrogen arsenate; Sodium arsenate, dibasic
Heptahydrate: Dibasic sodium arsenate heptahydrate; Disodium arsenate, heptahydrate; Sodium acid arsenate, heptahydrate; Sodium arsenate, dibasic, heptahydrate; Sodium arsenate heptahydrate; Sodium arseniate heptahydrate
CAS Registry Number: 7631-89-2; 7778-43-0 (dibasic; disodium hydrogenarsenate); *(alt.)* 55957-14-7; 10048-95-0 (heptahydrate)
RTECS® Number: CG1225000; CG0875000 (dibasic); CG0900000 (heptahydrate)
UN/NA & ERG Number: UN1685/151
EC Number: 231-547-5; 231-902-4 [*Annex I Index No.:* 033-005-00-1] (*dibasic; disodium hydrogenarsenate*)
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).
Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
California Proposition 65 Chemical: Cancer 2/27/87.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; 1% [disodium hydrogen arsenate (dibasic)].
Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) arsenic compounds.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23/25; R53; Safety phrases: S1/2; S20/21; S28; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Sodium arsenate and sodium arsenate, dibasic are both white crystalline, odorless solids. Molecular weight = 202.94; 185.91 (dibasic); 427.00 (heptahydrate); Boiling point = 180°C (decomposition); Freezing/Melting point = 85°C; 57°C (dibasic). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description (dibasic): Mutagen, (heptahydrate) Tumorigen, Mutagen; Reproductive Effector. Sodium arsenate is used in dyeing and printing; making other arsenates; as a germicide; in dyeing with turkey-red oil.
Incompatibilities: Acids, chemically active metals. Arsine, a very deadly gas, can be released in the presence of acid, acid mists, or hydrogen gas. Attacks many metals (such as aluminum, iron, and zinc) in the presence of moisture producing arsenic and arsine fumes.
Permissible Exposure Limits in Air
Inorganic arsenic compounds
OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018].
NIOSH REL: 0.002 mg[As]/m^3 15 min Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.
ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 0.0271 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 13.5 mg/m^3
PAC-3: 13.5 mg/m^3
DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1.
NIOSH IDLH: potential occupational carcinogen 5 mg[As]/m^3.
Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).
Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of

Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: EPA[61] has set 50 μg/L of arsenic as a standard for drinking water. This standard has been in effect for 50 years. The Clinton administration reduced this level to 10 μg/L, and the G.W. Bush administration rescinded this change in 2001.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system, digestive tract, circulatory system, causing loss of fluids and electrolytes, collapse, shock, and death. Exposure at low level may result in death. Death can occur due to a severe decrease in blood pressure. Thickening of skin on palms and soles following chronic low-level exposures. Symptoms of exposure include a feeling of constriction of throat, difficulty in swallowing; abdominal discomfort with pain, vomiting, watery diarrhea; sweetish metallic taste; garlicky odor of breath and stools; and dizziness with frontal headaches. Symptoms usually appear one-half to 1 h after ingestion but may be delayed many hours.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and dermatitis. May affect the peripheral nervous system, skin, mucous membranes, causing neuropathy, skin thickening and pigmentation disorders, ulcers and perforation of nasal septum, and liver cirrhosis. Nerve damage may include "pins and needles," burning, numbness, and later weakness in the limbs. This substance is carcinogenic to humans. A probable teratogen in humans.

Points of Attack: Skin, nervous system, liver.

Medical Surveillance: Before first exposure and every 6−12 months thereafter, a medical history and examination are recommended, including: examination of the nose, skin eyes, nails, and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a workday). At NIOSH recommended exposure levels, urine arsenic should not be greater than 100 μg/g creatinine in the urine. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures: For severe poisoning BAL have been used. For milder poisoning, penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, *Inorganic Arsenic.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium arsenate must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Sodium arsenate must be stored to avoid contact with acids. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Sodium arsenate itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in minimum quantity of concentrated, reagent hydrochloric acid. Filter if necessary. Dilute with water until white precipitate forms. Add just enough 6 M HCl to redissolve. Saturate with hydrogen sulfide. Filter, wash the precipitate; dry, package, and ship to the supplier. (Sax, DPIMR see below).

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 71−73

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Arsenate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Sodium Arsenate*. Trenton, NJ

Sodium arsenite S:0380

Molecular Formula: AsO_2Na

Common Formula: $NaAsO_2$

Synonyms: Arsenite de sodium (French); Arsenito sodico (Spanish); Arsenous acid, sodium salt; Atlas A; Chem Pels C; Chem-Sen 56; Disodium arsenate heptahydrate; Kill-All; Penite; Prodalumnol; Sodanit; Sodium metaarsenite

CAS Registry Number: 7784-46-5

RTECS® Number: CG3675000

UN/NA & ERG Number: UN2027 (solid)/151; UN1686 (solution)/154

EC Number: 232-070-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; EPA: Human Carcinogen; NTP: Known to be a human carcinogen; Known to be a human carcinogen; NIOSH: Potential occupational carcinogen; OSHA: Potential human carcinogen.

Banned or Severely Restricted (several countries) (UN).[13]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 2/27/87.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium arsenite is a white or grayish-white powder or flakes. Molecular weight = 129.91; Freezing/Melting point = 615°C; Boiling point = decomposes. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Highly soluble in water.

Potential Exposure: This material is used in manufacturing of arsenical soap for use on skin, treating vines against certain scale diseases, wood preservation, as a reagent in preparation of methylene iodide, corrosion inhibitor, and for herbicidal and pesticidal purposes.

Incompatibilities: Chemically active metals. Arsine, a very deadly gas, can be released in the presence of acid, acid mists, or hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018].

NIOSH REL: 0.002 mg[As]/m^3 [15 min] Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen.

NIOSH IDLH: potential occupational carcinogen 5 mg[As]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0173 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 8.67 mg/m^3

PAC-3: 8.67 mg/m^3

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1.

Arab Republic of Egypt: TWA 0.2 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg/m^3, 1993; Denmark: TWA 0.05 mg/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 mg/m^3, 1993; Hungary: STEL 0.5 mg/m^3, carcinogen, 1993; India: TWA 0.2 mg/m^3, 1993; Norway: TWA 0.02 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3, 1999; Sweden: NGV 0.03 mg/m^3, carcinogen, 1999; Switzerland: TWA 0.1 mg/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg (As)/m^3, 1993; Turkey: TWA 0.5 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 mg/m^3 on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 mg/m^3 (California Prop. 65), 0.0002 μg/m^3 (Rhode Island), 0.00023 μg/m^3 (North Carolina), 0.024 μg/m^3 (Pennsylvania), 0.05 μg/m^3 (Connecticut), 0.07−0.39 μg/m^3 (Montana), 0.67 μg/m^3 (New York), 1.0 μg/m^3 (South Carolina), 2.0 μg/m^3 (North Dakota), 3.3 μg/m^3 (Virginia), 5 μg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301, #7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: The EPA[61] has set a limit of 0.05 μg/L in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Sodium arsenite may irritate or burn the skin, eyes, and mucous membranes. Skin contact can cause burning sensation, itching, and rash. Extremely toxic: probable oral lethal dose (human) 5−50 mg/kg, between 7 drops and one teaspoon for a 70-kg person (150 lb). Poisonous if swallowed or inhaled. Signs and symptoms of acute exposure to sodium arsenite may be severe and include headache, vomiting, stomach pain, vomiting, cough, dyspnea (shortness of breath), hypotension (low blood pressure), and chest pain. Gastrointestinal effects include difficulty in swallowing, intense thirst, generalized abdominal pain, vomiting, and painful diarrhea; blood may be noted in the vomitus and feces. A weak pulse, cyanosis (blue tint to the skin and mucous membranes), and cold extremities may also be observed. Neurological effects include giddiness, delirium, mania, stupor, weakness, headache, dizziness, and fainting. Convulsions, paralysis, and coma may occur.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and dermatitis. May affect the peripheral nervous system, skin, mucous membranes, causing neuropathy, skin thickening and pigmentation disorders, ulcers and perforation of nasal septum, and liver cirrhosis. Nerve damage may include "pins and needles," burning, numbness, and later weakness in the limbs. This substance is carcinogenic to humans. A probable teratogen in humans.

Points of Attack: Liver, kidneys, skin, lungs, lymphatic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nose, skin, eyes, nails, and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a workday). At NIOSH recommended exposure levels, urine arsenic should not be greater than 100 μg/g creatinine in the urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures: For severe poisoning BAL has been used. For milder poisoning penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, *Inorganic Arsenic.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium arsenite must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Sodium arsenite, solid, or sodium arsenite, aqueous solutions, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II. Aqueous solutions fall in DOT Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Sodium arsenite itself does not burn. Poisonous gases are produced in fire, including arsenic and sodium monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The arsenic may be precipitated as calcium arsenite. It should be stored until recycled.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Arsenite*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Sodium Arsenite*. Trenton, NJ

Sodium azide S:0390

Molecular Formula: N_3Na

Common Formula: NaN_3

Synonyms: AI3-50436; Axium; Azida sodico (Spanish); Azide; Azium; Azoture de sodium (French); Dazoe; Hydrazoic acid, Sodium salt; Kazoe; Natriumazid (German); NCI-C06462; Smite; Sodium salt of hydrazoic acid

CAS Registry Number: 26628-22-8; *(alt.)* 12136-89-9

RTECS® Number: VY8050000

UN/NA & ERG Number: UN1687/153

EC Number: 247-852-1 [*Annex I Index No.:* 011-004-00-7]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); no evidence: rat; (EPA) Gene-Tox Program: Inconclusive: Carcinogenicity: mouse/rat.

US EPA Gene-Tox Program, Inconclusive: Carcinogenicity—mouse/rat; Positive: L5178Y cells *In vitro*—TK test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—forward mutation; *S. cerevisiae*—reversion; Negative: *In vitro* cytogenetics—human lymphocyte; Negative: Sperm morphology—mouse; *In vitro* UDS—human fibroblast; Negative: TRP reversion; TRP reversion.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P105.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R28; R32; R50/53; Safety phrases: S1/2; S28; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Sodium azide is a colorless to white, odorless, crystalline solid. Combustible solid above 300°C. Molecular weight = 65.02; Specific gravity (H_2O:1) = 1.85 at 25°C; Boiling point = (decomposes); Freezing/Melting point = (the solid crystals decompose with the evolution of nitrogen gas, leaving a residue of sodium oxide) 275°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2. Soluble in water; reaction; solubility = 42% at 17°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Human Data. Sodium azide is used as preservative and diluent. It has been used for a wide variety of military, laboratory, medicine and commercial purposes. It is used extensively as an intermediate in the production of lead azide, commonly used in detonators and other explosives. Reported to be used in automobile air-bag inflation. One of the largest potential exposures is that to automotive workers, repairmen, and wreckers, if sodium azide is used as the inflation chemical. Commercial applications include use as a fungicide, nematocide, and soil sterilizing agent and as a preservative for seeds and wine. The lumber industry has used sodium azide to limit the growth of enzymes responsible for formation of brown stain on sugar pine, while the Japanese beer industry used it to prevent the growth of a fungus which darkens its product. The chemical industry has used sodium azide as a retarder in the manufacture of sponge rubber, to prevent coagulation of styrene and butadiene latexes stored in contact with metals; and to decompose nitrites in the presence of nitrates.

Incompatibilities: Reacts explosively and/or forms explosive and/or shock-sensitive compounds with acids and many metals. Contact with water forms hydrazoic acid. Combustible solid (if heated above 300°C). May explode when heated above its melting point, especially if heating is rapid. Reacts with acids, producing toxic, shock-sensitive, and explosive hydrogen azide. It forms explosive compounds with phosgene, brass, zinc, trifluoroacrylol fluoride, and nitrogen-diluted bromine vapor. Reacts with benzoyl chloride and potassium hydroxide, bromine, carbon disulfide, copper, lead, nitric acid, barium carbonate, sulfuric acid, chromium(II) hypochlorite, dimethyl sulfate, dibromomalononitrile, silver, mercury. Over a period of time, sodium azide may react with copper, lead, brass, or solder in plumbing systems to form an accumulation of the *highly explosive* and shock-sensitive compounds of lead azide and copper azide.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.1 ppm (as HN_3) [skin] Ceiling Concentration; 0.3 mg/m^3 (as NaN_3) [skin] Ceiling Concentration.

ACGIH TLV®[1]: 0.11 ppm (as HN_3) [skin] Ceiling Concentration; 0.29 mg/m^3 (as NaN_3) [skin] Ceiling Concentration; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 25 mg/m^3

DFG MAK: 0.2 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 0.1 ppm (0.3 mg/m^3), 1993; Austria: MAK 0.07 ppm (0.2 mg/m^3), 1999; Belgium: STEL 0.11 ppm (0.3 mg/m^3), 1993; Denmark: TWA 0.3 mg/m^3, 1999; Finland: TWA 0.1 ppm (0.3 mg/m^3); STEL 0.3 ppm (0.9 mg/m^3), 1999; France: VLE 0.1 ppm (0.3 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Switzerland: MAK-W 0.07 ppm (0.2 mg/m^3), 1999; United Kingdom: STEL 0.3 mg[NaN_3], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.29 mg/m^3. Several states have set guidelines or standards for sodium azide in ambient air[60] ranging from 0.7 μg/m^3 (Nevada) to 2.5 μg/m^3 (Virginia) to 3.0 μg/m^3 (North Dakota).

Determination in Air: Use OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set. (Sodium azide reacts with water to produce hydrazoic acid).

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Contact of skin causes redness and pain. Contact with eyes causes redness, pain, and blurred vision; may cause loss of vision. Inhalation or ingestion causes dizziness, weakness, blurred vision, slight shortness of breath, hypotension, slow heart rate, abdominal pain, and spasms. Serious cases of exposure may result in convulsions, unconsciousness, and death. Exposure slightly above the exposure limits in air can cause death by affecting the central nervous system. Azides can cause blood pressure to drop and thus have action similar to cyanides and nitrites. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Sodium azide is a broad-spectrum metabolic poison that interferes with oxidation enzymes and inhibits nuclear phosphorylation. Although the effects in these systems are complex, there is general agreement that azide causes a dissociation of phosphorylation and cellular respiration. For this reason parallels have been drawn to other metabolic inhibitors, such as cyanide, malonitrile, and fluoride.

Long Term Exposure: May cause kidney damage. Sodium azide is a potent mutagen in barley, peas, rice, and soybeans. It is also a very effective mutagen in bacteria. Its potency as a mutagen is comparable to the nitrosamines as a class. For these reasons sodium azide has been suspected of being a carcinogen. However, several studies have been performed to determine whether it is a carcinogen. In each instance the results were negative.

Points of Attack: Eyes, skin, central nervous system, cardiovascular system, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system and vision (including visual fields). Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Where sodium azide may be present in solution, wear splash-proof chemical goggles and face shield, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over 0.1 ppm as a dust, fume, or mist, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, or for exposures to hydrazoic acid vapor, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium azide must be stored to avoid contact with benzoyl chloride, potassium hydroxide, bromine, copper, and lead, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, heat, and acids. On contact with water it forms hydrazoic acid which is explosive. Danger of explosion exists from friction, heat, or contamination. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Rapid heating above 275°C can cause rapid decomposition and explosion. If material is on fire or involved in fire, use water in flooding quantities as fog. Use foam, carbon dioxide, or dry chemical. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Disposal may be accomplished by reaction with sulfuric acid solution and sodium nitrate in a hard rubber vessel. Nitrogen dioxide is generated by this reaction and the gas is run through a scrubber before it is released to the atmosphere. Controlled incineration is also acceptable (after mixing with other combustible wastes) with adequate scrubbing and ash disposal facilities.

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities: Sodium Azide*, Report PB-274,073. Cincinnati, OH, pp. 306−308

US Environmental Protection Agency. (August 1, 1977). *Chemical Hazard Information Profile: Sodium Azide*. Washington, DC

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 74−78

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Azide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Sodium Azide*. Trenton, NJ

Sodium benzoate S:0400

Molecular Formula: $C_7H_5NaO_2$

Common Formula: C_6H_5COONa

Synonyms: Antimol; Benzoate of soda; Benzoate sodium; Benzoesaeure (Na-salz) (German); Benzoic acid, sodium salt; Sobenate; Sodium benzoic acid

CAS Registry Number: 532-32-1

RTECS® Number: DH6650000

UN/NA & ERG Number: Not regulated.

EC Number: 208-534-8

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: TRP reversion.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium benzoate is a white crystalline solid. It is odorless and nonflammable. Molecular weight = 144.11; Decomposes at 120°C; Melting point = >300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Sodium benzoate is used as a food and feed additive, flavor, packaging material; pharmaceutical; preservative for food products and tobacco; antifungal agent; antiseptic, rust and mildew inhibitor; intermediate in the manufacture of dyes. Used as a human hygiene biocidal product.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 mg/m^3

PAC-1: 12.5 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 400 mg/m^3

Sodium salt

TEEL-0: 100 mg/m^3

PAC-1: 350 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: An eye and skin irritant. The accumulation of dust in the eyes, ears, nose, throat, and lungs may be sufficiently unpleasant and distracting to make work near machinery hazardous. Irritation may result from abrasion or chemical action. Sodium benzoate can cause allergic reactions. Sodium benzoate has been given GRAS (Generally Recognized As Safe) status by the Food and Drug Administration at the levels currently being used as a food preservative. Ingestion of 8−10 g (1/3 oz) may cause nausea and vomiting. Twelve grams has caused gastric pain and loss of appetite. These symptoms disappear when exposure stops. LD_{50} = (oral-rat) 27 mg/kg.

Long Term Exposure: Sodium benzoate may produce an allergic reaction and, in addition, may intensify the symptoms of allergies to other substances.

Points of Attack: Skin, lungs.

Medical Surveillance: Examination by a qualified allergist. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Avoid prolonged skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium benzoate is combustible. It may emit acrid fumes when heated to decomposition (at 120°C/248°F). Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Sodium Benzoate*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sodium bisulfate S:0410

Molecular Formula: $HNaO_3S$

Common Formula: $NaHSO_3$

Synonyms: Amersite 2; Bisulfite de sodium (French); Bisulfito sodico (Spanish); Hydrogen sulfite sodium; Sodium acid sulfite; Sodium hydrogen sulfite; Sodium hydrogen sulfite; Sodium pyrosulfite; Sodium metabisulfite; Sodium sulhydrate; Sulfurous acid, monosodium salt

CAS Registry Number: 7631-90-5; *(alt.)* 57414-01-4; *(alt.)* 69098-86-8; *(alt.)* 89830-27-3; *(alt.)* 91829-63-9

RTECS® Number: VZ2000000

UN/NA & ERG Number: UN2693 (solution)/154

EC Number: 231-548-0 [*Annex I Index No.:* 016-064-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1992.

US EPA Gene-Tox Program, Negative: Rodent dominant lethal; Rodent heritable translocation; Negative: Mouse specific locus; TRP reversion.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R31; Safety phrases: S2; S25; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium bisulfite is a white crystalline solid with a slight odor of sulfur dioxide and a disagreeable taste. Slowly oxidized to the sulfate on exposure to air. Molecular weight = 104.06; Specific gravity (H_2O:1) = 1.48 at 25°C; Boiling point = (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen. Sodium bisulfite is used in the digestion of wood pulp; in the tanning of leather; in the dyeing of textiles; as a photographic reducing agent; as a food preservative; as an additive in electroplating; as disinfectant, bleach, antioxidant; and as inhibitor of yeast and bacteria in winemaking.

Incompatibilities: Aqueous solution is a weak acid. Incompatible with strong acids, such as hydrochloric and nitric, and oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates. Reacts with bases forming sulfate. Slowly oxidizes to sulfate in air. Heat causes decomposition. Slowly oxidized to the sulfate on exposure to air. Contact with oxidizers or acids forms sulfur dioxide gas. Attacks some metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 25 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Sensitizing substances as sulfites.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for sodium bisulfite in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 80.0 μg/m^3 (Virginia) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: Maryland[61] has set a guideline of 70.0 μg/L for sodium bisulfite in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive and can cause severe skin and eye irritation and burns. Irritates the respiratory tract, causing cough, wheezing, and shortness of breath. Ingestion may cause irritation to mouth, throat, and stomach. Allergic response may occur. This could include itching of ears and legs, nausea, cough, tightening of throat, and reddening of the skin.

Long Term Exposure: An asthma-like allergy may develop after repeated exposure. Skin allergy may develop. May irritate the lungs, causing bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: Converted to sulfuric acid in stomach. Acute obstruction of alimentary canal may occur up to 3 weeks following ingestion.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area away from strong acids, such as hydrochloric and nitric, and oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates.

Shipping: Bisulfites, inorganic, aqueous solutions, n.o.s. require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Cover spilled liquid with soda ash, absorb on vermiculite or other inert material. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is noncombustible. Extinguish fire using an agent suitable for type of surrounding fire. Sodium bisulfite itself does not burn. Poisonous gases are produced in fire, including sulfur oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dump into water, add soda ash, then neutralize with HCl; flush to sewer with large volumes of water.

References

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Sodium Bisulfite*. Trenton, NJ

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Sodium Bisulfite*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sodium cacodylate S:0420

Molecular Formula: $C_2H_6AsNaO_2$

Common Formula: $(CH_3)_2AsOONa$

Synonyms: Alkarsodyl; Ansar 160; Arsecodile; Arsycodile; Bolls-Eye; Cacodilato sodico (Spanish); Cacodylate de sodium (French); Cacodylic acid sodium salt; Chemaid; Dimethylarsinic acid, sodium salt; [(Dimethylarsino)oxy] sodium-arsenic-oxide; [(Dimethylarsino)oxy]sodium As-oxide; Dutch-treat; Hydrodimethylarsine oxide, sodium salt; Kakodylan Dodny; Phytar 560; Rad-E-Cate; Rad-E-Cate 16; Rad-E-Cate-25; Rad-E-Cate-35; Silvisar; Sodium dimethylarsinate; Sodium dimethyl arsonate; Sodium salt of cacodylic acid

CAS Registry Number: 124-65-2; 6131-99-3 (trihydrate)

RTECS$^{®}$ Number: CH7890000

UN/NA & ERG Number: UN1688/152

EC Number: 204-708-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

Banned or Severely Restricted (Portugal) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

As arsenic compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: organics 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sodium Cacodylate is a white crystalline solid which occurs as the trihydrate. It liquefies in the water of hydration at 60°C and becomes anhydrous at 120°C. Molecular weight = 159.99. Hazard Identification (based on

NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: This material has been used as a nonselective herbicide and for general weed control.

Incompatibilities: Incompatible with oxidizers, strong bases, acids, active metals (iron, aluminum, zinc). Contact with acids forms highly toxic dimethylarsine gas. Attacks some metals.

Permissible Exposure Limits in Air

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA.

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A.

ACGIH TLV®[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

Protective Action Criteria (PAC)

TEEL-0: 1.07 mg/m^3

PAC-1: 3.2 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #5022, arsenic, Organo-.

Permissible Concentration in Water: The EPA[61] has set a limit of 0.05 μg/L in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sodium cacodylate is corrosive to the skin, eyes, and mucous membranes. Moderately toxic; probable oral lethal dose in humans is 0.5−5 g/kg or between 1 oz and 1 pint (or 1 lb) for a 70-kg (150-lb) person. It may cause disturbances of the blood, kidneys, and nervous system. Acute exposure to sodium cacodylate may be fatal. Headache, red-stained eye, and a garlicky odor of the breath may be the first effects noticed. Other signs and symptoms include generalized weakness, intense thirst, muscle cramping, seizures, toxic delirium, and shock. Nausea, vomiting, anorexia, abdominal pain, and diarrhea may occur. Hypotension (low blood pressure), tachycardia (rapid heart rate), pulmonary edema, ventricular fibrillation, and other cardiac abnormalities are usually found following severe exposure.

Long Term Exposure: Repeated exposure may cause ulcers and hole in the nasal septum. Hoarseness and sore eyes also occur. Repeated contact may cause thickened skin, pigmentation changes. May cause liver damage and nerve damage, causing sensation of "pins and needles," weakness, and loss of coordination in the limbs. May cause gastrointestinal tract and reproductive effects. Repeated exposures can cause metallic taste; poor appetite; nausea, vomiting, diarrhea, and stomach pain; seizures and death.

Points of Attack: Skin, respiratory system, kidneys, central nervous system, liver, gastrointestinal tract, reproductive system.

Medical Surveillance: Examination of the nose, skin, eyes, and nails. Examination of the nervous system. Liver function tests. Test for urine arsenic. NIOSH recommended that exposure levels should not exceed 100 μg/L of creatinine in the urine. Results may be accurate within 2 days of eating shellfish or fish (which may increase arsenic levels); they are most accurate at the end of a workday.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Note to physician: For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-plate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Sodium cacodylate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium cacodylate itself does not burn. Use any agent suitable for surrounding fire. Stay upwind; keep out of low areas. Wear self-contained breathing apparatus and full protective clothing. Move container from fire area, if you can do so without risk. Poisonous gases are produced in fire, including arsenic oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For cacodylic acid, precipitate as calcium arsenate and calcium arsenite by treatment with excess lime water. Recycle if possible. If not, put in secure storage for possible disposal in leach-proof dumps.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Cacodylate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Sodium Cacodylate*. Trenton, NJ

Sodium chlorate S:0430

Molecular Formula: $ClNaO_3$

Common Formula: $NaClO_3$

Synonyms: Asex; Atlacide; Atratol B-herbatox; Chlorate of soda; Chlorate salt of sodium; Chlorax; Chloric acid, Sodium salt; Chlorsaure (German); De-Fol-Ate; Desolet; Drexel defol; Drop leaf; Evau-superfall; Grain sorghum harvest aid; Granex OK; Harvest-aid; Klorex; Kusa-tohrukusatol; Lorex; Natriumchlorat (German); Ortho C-1 defoliant & weed killer; Oxycil; Rasikal; Shed-α-leaf; Shed-α-leaf "L"; Soda chlorate; Sodium (chlorate de) (French); Travex; Tumbleaf; United Chemical defoliant No. 1; Val-Drop

CAS Registry Number: 7775-09-9; *(alt.)* 11096-45-0

RTECS® Number: FO0525000

UN/NA & ERG Number: UN1495 (solid)/140; UN2428 (solution)/140

EC Number: 017-005-00-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Highly Reactive Substance and Explosive (World Bank).[15]

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Sodium chlorate is a white crystalline solid. Molecular weight = 106.44; Decomposes below boiling point at ca. 300°C; Freezing/Melting point = 248°C (also listed at 255°C and 264°C). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen, Human Data; Primary Irritant. Sodium chlorate is used to manufacture dyes, explosives, in paper pulp processing and as a weed killer; used as a constituent of atratol and pramitol.

Incompatibilities: A strong oxidizer. Reacts violently with combustibles, sulfuric acid, and reducing materials. Reacts with strong acids giving off carbon dioxide. Explosions may be caused by contact with ammonia salts, ammonium thiosulfate, antimony sulfide, arsenic, carbon, charcoal, organic matter, organic acids, thiocyanates, chemically active metals, oils, metal sulfides, nitrobenzene, powdered metals, sugar. Reacts with some organic contaminants forming shock-sensitive mixtures. Decomposes on heating above 300°C or on burning, producing oxygen and toxic chlorine fumes. Attacks zinc, magnesium, and steel.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.15 mg/m^3
PAC-1: 0.4 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 75 mg/m^3

Permissible Concentration in Water: Russia[43] set a MAC of 20 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sodium chlorate can affect you when breathed in. Eye or skin contact can cause severe irritation and even burns. Breathing sodium chlorate, especially dust or mist, can irritate the nose and throat. It can also cause cyanosis, causing the skin to turn blue (methemoglobinemia), because it interferes with the blood's ability to carry oxygen. Damage to red blood cells (hemolytic anemia) can also occur. If severe or repeated, this can cause kidney damage. Ingestion can cause kidney damage. The effects may be delayed.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Kidney damage can occur from severe or repeated damage to red blood cells resulting from exposure. Very irritating substances may cause lung damage.

Points of Attack: Kidneys, lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: complete blood count (CBC). Test for methemoglobin if skin is blue.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim under medical observation.

Antidotes and Special Procedures: Do not use methylene blue to treat methemoglobinemia from sodium chlorate as it can cause increased toxicity.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to sodium chlorate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium chlorate must be stored to avoid contact with ammonium thiosulfate, antimony sulfide, arsenic, carbon, charcoal, organic matter, organic acids, sulfuric acid, thiocyanates, and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Protect storage containers against physical damage. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep sodium chlorate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or

federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium chlorate may burn, but does not readily ignite. Heat above 300°C produces oxygen which can increase the intensity of fire and may ignite other combustible materials. Flood areas with water unless that is incompatible with other materials in the fire area. Poisonous gases are produced in fire, including chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 28−32

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Sodium Chlorate*. Trenton, NJ

Sodium chloroplatinate S:0440

Molecular Formula: $Cl_6Pt \cdot 2Na \cdot 4H_2O$

Synonyms: Platinate(2-), hexachlorodisodium, tetrahydrate; Platinic sodium chloride; Sodium hexachloroplatinate(IV); Sodium platinic chloride; Sodium platinic chloride

CAS Registry Number: 1307-82-0

EC Number: None assigned

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% as platinum, water-soluble salts.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sodium chloroplatinate is a yellow-orange or red-brown crystalline solid. Odorless. Molecular weight = 561.9; Melting point = loses water at 100°C; Vapor pressure = essentially zero. Soluble in water; solubility = 50 g/100 g at 20°C.

Potential Exposure: Used as a catalyst.

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.002 mg[Pt]/m^3 TWA.

NIOSH REL: 0.002 mg[Pt]/m^3 TWA.

ACGIH TLV®[1]: 1 0.002 mg[Pt]/m^3 TWA.

No TEEL available.

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

NIOSH IDLH: 4 mg [Pt]/m^3.

Several states have set limits on platinum in ambient air[60] as well. See the entry on platinum for details.

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Chloroplatinates can affect you when breathed in. Severe allergy can develop to potassium chloroplatinates. Symptoms include asthma (with cough, wheezing, and/or shortness of breath), runny nose, and/or skin rash, sometimes with hives. If allergy develops, even small future exposure can trigger significant symptoms. Some persons exposed to this type of chemical have developed lung scarring. Family members can develop allergy to dust carried home on work clothing. It may irritate the eyes, nose, and throat. High exposure may cause irritability and even seizures.

Long Term Exposure: May cause skin sensitization and dermatitis and/or asthma-like allergy. Repeated exposures can cause sores or ulcers in the lining of the nose. Tetrachloroplatinates are mutagens.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray every 3 years should be considered if above tests are not normal. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (for soluble Pt salts): *Up to 0.05 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 4 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance cause eye irritation and damage; eye protection needed.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chlorides and sodium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Sodium Chloroplatinate*. Trenton, NJ

Sodium chromates S:0445

Common Formula: $CrO_4 \cdot 2Na$; $Cr_2O_7 \cdot 2Na$ (dihydrate); $CrO_4 \cdot {}_2Na \cdot 10H_2O$ (decahydrate)

Synonyms: Chromate of soda; Chromium disodium oxide; Chromium sodium oxide; Cromato sodico (Spanish); Disodium chromate; Neutral sodium chromate; Sodium chromate(VI)

Bichromate: Bichromate of soda; Bichromate de sodium (French); Chromic acid, disodium salt; Chromium sodium oxide; Disodium dichromate; Natriumdichromat (German); Sodium bichromate; Sodium chromate; Sodium dichromate de (French); Sodium dichromate (dihydrate); Sodium dichromate(VI)

Decahydrate: Chromic acid, disodium salt, decahydrate; Sodium chromate decahydrate

CAS Registry Number: 10588-01-9; 7775-11-3 (disodium chromate); 7789-12-0 (dihydrate); 13517-17-4 (decahydrate); 10034-82-9 (tetrahydrate)

RTECS® Number: GB2955000; GB2957000 (decahydrate)

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-889-5 [*Annex I Index No.:* 024-018-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

US EPA Gene-Tox Program, Positive/dose response: TRP reversion.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 10 lb (4.54 kg).

As chromium compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: O, T+, N; Risk phrases: R45; R46; R60; R61; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61.

European/International Regulations: Hazard Symbol: E, T+, N; Risk phrases: R45; R46; R60; R61; R2; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium chromate, including the hexahydrate, is a yellow crystalline solid that can also be used in solution. Molecular weight = 161.98; Freezing/Melting point = 760−792°C. Soluble in water. The dichromate is a red or red-orange crystalline solid. Molecular weight = 161.98; Freezing/Melting point = 357°C (decomposes at 400°C). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Used to make dyes, inks, pigments, and other chromates; in leather tanning, a corrosion inhibitor in circulating water systems; metal treatment; a drilling mud additive; chemical intermediate for chromium catalysts; colorimetry, oxidizing agent; bleaching agent; an algicide, fungicide, insecticide; in wood preservation.

Incompatibilities: Aqueous solution in a base. A strong oxidizer. Violent reaction with reducing agents, combustibles, strong acids, organic materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Disodium chromate

TEEL-0: 0.0156 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 46.7 mg/m^3

Dichromate

TEEL-0: 0.0126 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 37.8 mg/m^3

PAC-3: 37.8 mg/m^3

Decahydrate

TEEL-0: 0.0329 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 98.7 mg/m^3

Tetrahydrate

TEEL-0: 0.0291 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 87.4 mg/m^3

As chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

DFG MAK: Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

United Kingdom: carcinogen, 2000. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 0.01 mg/m^3 in work-place air. Connecticut[60] has set a guideline of 0.25 μg/m^3 for chromium trioxide in ambient air.

Determination in Air: Use NIOSH Analytical Methods #7600, #7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. To protect human health, the limits are trivalent chromium (in chromates): 170 μg/L and hexavalent chromium (in dichromates) 50 μg/L.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption or by colorimetry (diphenylcarbazide) or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μm filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sodium chromate can affect you when breathed in. It can also pass into inner layers of the skin. A corrosive. Eye contact can cause severe damage with possible loss of vision. Irritation of nose, throat, and bronchial tubes can occur, with cough and/or wheezing. Skin contact can cause severe irritation, deep ulcers, or an allergic skin rash.

Long Term Exposure: Sodium chromate is a human carcinogen. Sodium chromates can cause a sore or perforated nasal septum, with bleeding, discharge, or crusting. May cause skin allergy with eczema-like rash. Can cause lung irritation or allergy; bronchitis may develop. May cause kidney damage.

Points of Attack: Skin, lungs, kidneys. *Cancer site:* throat and lungs.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, complete blood count; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Examination of the nose and skin. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Also check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure. Urine test for chromates. This test is most accurate shortly after exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. (As chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH criteria document #76-129 [Chromium(VI)].

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustibles, organics, or other easily oxidized materials. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including chromium oxide and sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Sodium Dichromate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Sodium Chromate*. Trenton, NJ

Sodium cyanide S:0450

Molecular Formula: NaCN

Synonyms: Cianuro sodico (Spanish); Cyanide of sodium; Cyanobrik; Cyanogran; Cyanure de sodium (French); Cymag; Hydrocyanic acid, sodium salt; Prussiate of soda; Sodium cyanide, solid; Sodium cyanide, solution

CAS Registry Number: 143-33-9; 10034-82-9 (tetrahydrate)

RTECS® Number: VZ7530000

UN/NA & ERG Number: UN1689/157

EC Number: 205-599-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P106.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313: See Cyanide Compounds.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

As cyanide compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as cyanides, soluble salts and complexes, n.o.s.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R26/27/28; R32; Safety phrases: S1/2; S7; S28; S29; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium cyanide is found as white granules, flakes, or lumps. Sodium cyanide is shipped as pellets or briquettes. Odorless when dry. It absorbs water from air (is hygroscopic or deliquescent). Hydrogen cyanide gas released by sodium cyanide has a distinctive mild, bitter almond odor, but a large proportion of people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. Molecular weight = 49.01; Boiling point = 1496°C; Freezing/Melting point = 564°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water (reactive).

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Sodium cyanide is used as a solid or in solution to extract metal ores, in electroplating and metal cleaning baths; in metal hardening; in treatment of rabbit and rat burrows and holes and termite nests; in insecticides.

Incompatibilities: Strong oxidizers, such as acids, acid salts, chlorates, and nitrates. Sodium cyanide decomposes on contact with acids, acid salts, water, moisture, and carbon dioxide, releasing highly toxic and flammable hydrogen cyanide gas. Aqueous solution is a strong base; it reacts violently with acid and is corrosive. Reacts violently with acid, strong oxidizers, such as nitrates and chlorates. Decomposes in the presence of air, moisture, or carbon dioxide producing highly toxic and flammable hydrogen cyanide gas. Absorbs moisture from the air forming a corrosive syrup. Corrosive to active metals, such as aluminum, copper, and zinc.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg[CN]/m^3 TWA.

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 min] Ceiling Concentration.

ACGIH TLV®[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration.

NIOSH IDLH: 25 mg[CN]/m^3.
Protective Action Criteria (PAC)*
TEEL-0: **4** mg/m^3
PAC-1: **4.0** mg/m^3
PAC-2: **14** mg/m^3
PAC-3: **30** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 3.8 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C. Skin contact may contribute significantly in overall exposure.

Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg [CN]/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 mg/m^3 [skin]. Russia[43] has set a MAC value of 0.009 mg/m^3 for ambient air in residential areas on a momentary basis and 0.004 mg/m^3 on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μg/m^3 (New York) to 50.0 μg/m^3 (Florida and North Dakota) to 80.0 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut and South Dakota) to 125 μg/m^3 (South Carolina) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide.[18]

Permissible Concentration in Water: In 1976 the EPA criterion was 5.0 μg/L for freshwater and marine aquatic life and wildlife. As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for man is 8.4 mg/day.[6]

On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L, and Germany 50 μg/L as drinking water standards.

Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes.

The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). Octanol−water coefficient: Log K_{ow} (estimated) = −1.69.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Sodium cyanide releases hydrogen cyanide gas, a highly toxic chemical asphyxiant that interferes with the body's ability to use oxygen. Exposure to sodium cyanide can be rapidly fatal. It has whole-body (systemic) effects, particularly affecting those organ systems most sensitive to low oxygen levels: the central nervous system (brain), the cardiovascular system (heart and blood vessels), and the pulmonary system (lungs).[NIOSH]

Short Term Exposure: Sodium cyanide can be absorbed through the skin, thereby increasing exposure. Sodium cyanide is corrosive to the eyes, skin, and respiratory tract. Contact can cause skin and eye burns, and possible permanent eye damage. Inhalation can cause lung irritation with coughing, sneezing, and difficult breathing; slow gasping respiration. Corrosive if swallowed. These substances may affect the central nervous system. Symptoms include headaches, confusion, nausea, pounding heart, weakness, and unconsciousness.

Long Term Exposure: Repeated or prolonged contact with sodium cyanide may cause thyroid gland enlargement and interfere with thyroid function. May cause nosebleed and sores in the nose; changes in blood cell count. May cause central nervous system damage with headache, dizziness, confusion, nausea, vomiting, pounding heart, weakness in the arms and legs, unconsciousness, and death. May affect liver and kidney function. Repeated lower exposures can cause sores in the nose with nosebleeds.

Points of Attack: Liver, kidneys, skin, cardiovascular system, central nervous system, thyroid gland.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG. Smokers may have somewhat higher blood cyanide and urine thiocyanate levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. *Polyethylene (for sodium cyanide, less than 30%, only) is among the recommended protective materials.* All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, acid salts, oxidizers, light, and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Sodium cyanide requires a "POISONOUS/TOXIC MATERIALS" label. It falls in Hazard Class 6.1 and in Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Keep water away from release. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

UN 1689 (Sodium cyanide) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: Material does not burn; fight surrounding fire with an agent appropriate for the burning material. NaCN decomposes in the presence of moisture, damp air, or carbon dioxide, producing highly toxic and flammable hydrogen cyanide gas and oxides of nitrogen. *NO* acidic dry chemical extinguishers; *NO* hydrous agents; *NO* water; *NO* carbon dioxide directly on material. Vapors are heavier than air and may collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not allow water to enter open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Add strong alkaline hypochlorite and allow to react for 24 h. Then flush to sewer with large volumes of water.[22]

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2006). *Hazardous Substances Fact Sheet: Sodium Cyanide*. Trenton, NJ

Sodium dichloroisocyanurate S:0460

Molecular Formula: $C_3HCl_2N_3O_3 \cdot Na$

Synonyms: ACL 60; CDB 63; Dichloroisocyanuric acid sodium salt; Dikonit; Dimanin C; FI Clor 60S; OCI 56; SDIC; Simpla; Sodium dichlorisocyanurate; Sodium dichlorocyanurate; Sodium dichloroisocyanurate; Sodium-1,3-dichloro-1,3,5-triazine-2,4-dione-6-oxide; 1-Sodium-3,5-dichloro-*s*-triazine-2,4,6-trione; 1-Sodium-3,5-dichloro-1,3,5-triazine-2,4,6-trione; Sodium dichloro-*s*-triazinetrione, dry, containing more than 39% available chlorine; Sodium salt of dichloro-*s*-triazinetrione

CAS Registry Number: 2893-78-9

RTECS® Number: XZ1900000

UN/NA & ERG Number: UN2465/140

EC Number: 220-767-7 [*Annex I Index No.:* 613-030-00-X]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R31; R36/37; R50/53; Safety phrases: S2; S8; S26; S41; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Dichloroisocyanuric acid, sodium salt, is a white crystalline powder having a chlorine odor. Thermally unstable. Molecular weight = 220.96; Specific gravity (H_2O:1) = 1.10 at 25°C; Freezing/Melting point = (decomposes) 230°C. NFPA 704 M Hazard Identification (anhydrous): Health 2, Flammability 0, Reactivity 2 (Oxidizer). Soluble in water; solubility = 25%.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Human Data; Primary Irritant. It is used in cleaning; making dry bleaches, detergents, sanitizers, and disinfectants; in swimming pool and sewage treatment.

Incompatibilities: Contact with water, acids, or acid fumes releases toxic chlorine gas. A powerful oxidizer. Violent reaction with reducing agents, organic matter, easily chlorinated or oxidized materials. Incompatible with ammonium salts; amines forming nitrogen trichloride.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact can cause severe eye and permanent damage. Skin contact can cause severe irritation especially if skin is moist or material is in solution. Inhalation can cause irritation of the respiratory tract. The dry material is less irritating to the skin. A strong poison and corrosive if ingested; may cause liver damage.

Long Term Exposure: Highly irritating substances may affect the lungs.

Points of Attack: Lungs, eyes, skin, liver.

Medical Surveillance: Lung function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from ammonium compounds, hydrated salts, moisture, and combustible materials. Where possible, automatically transfer material from drums or other storage containers to process containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Dichloroisocyanuric acid salts require a shipping label of "OXIDIZER." They fall in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Keep water away from release. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid but it is a powerful oxidizer and may increase the activity of an existing fire. May burn rapidly. Use flooding quantities of water, from a distance. Do *NOT* use extinguishers containing ammonia. Poisonous gases are produced in fire, including sodium oxide, chlorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 2002). *Hazardous Substances Fact Sheet: Sodium Dichloro-Isocyanate*. Trenton, NJ

Sodium fluoride S:0470

Molecular Formula: NaF

Synonyms: Alcoa sodium fluoride; Antibulit; Cav-trol; Checkmate; Chemiflour; Credo; Disodium difluoride; F1-Tabs; FDA 0101; Floridine; Florocid; Flour-O-kote; Flozenges; Fluoral; Fluorident; Fluorigard; Fluorineed; Fluorinse; Fluoritab; Fluorure de sodium (French); Fluoruro sodico (Spanish); Flura-gel; Flurcare; Fungol B; Gel II; Gelution; Iradicav; Karidium; Karigel; Kari-rinse; Lea-cov; Lemoflur; Luride; Nafeen; Natrium fluoride; NCI: C55221; Nuflour; Ossalin; Ossin; Pediaflor; Pedident; Pennwhite; Pergantene; Phos-flur; Point two; Pro-portion; Rafluor; Rescue squad; Roach salt; Sodium hydrofluoride; Sodium monofluoride; So-Flo; Stay-Flo; Studaflour; Super-Dent; T-Fluoride; the ra-flur-N; Trisodium trifluoride; Villiaumite; Zendium

CAS Registry Number: 7681-49-4; *(alt.)* 39287-69-9

RTECS® Number: WB0350000

UN/NA & ERG Number: UN1690/154

EC Number: 231-667-8 [*Annex I Index No.:* 009-004-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (water); equivocal evidence: rat; no evidence: mouse; IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: *D. melanogaster*—whole sex chrom. loss; Negative: *D. melanogaster*—nondisjunction; *N. crassa—aneuploidy*; Negative: *In vivo* SCE—nonhuman; *S. cerevisiae* gene conversion; Inconclusive: *D. melanogaster*—partial sex chrom. loss; Inconclusive: Histidine reversion—Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

FDA—over-the-counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

European/International Regulations: Hazard Symbol: T; Risk phrases: R25; R32; R36/38; Safety phrases: S1/2; S22; S36; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium fluoride is a white powder or colorless crystals. Often used in a solution. Odorless. Pesticide grade is often dyed blue. Molecular weight = 41.99; Specific gravity (H_2O:1) = 2.78 at 25°C; Boiling point = 1703.9°C; Freezing/Melting point = 992.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 4%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Widely used in the chemical industry; in water treatment and fluoridation of drinking water; as an insecticide, fungicide, and rodenticide; chemical cleaning; electroplating, glass manufacture; vitreous enamels; preservative for adhesives; toothpastes, disinfectant, dental prophylaxis; also used orally in the treatment of various bone diseases to increase bone density and to relieve bone pain.

Incompatibilities: Strong oxidizers, acids.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.

ACGIH TLV$^{®}$[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 5.53 mg/m^3

PAC-1: 5.53 mg/m^3

PAC-2: 5.53 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV$^{®}$: not classifiable as a human carcinogen. Several states have set limits for fluoride in ambient air[60] ranging from as low as 2.85 μg/m^3 (Iowa) to as high as 60,000 μg/m^3 (Kentucky).

Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluorides; #7906; OSHA Analytical Method ID-110.

Permissible Concentration in Water: As with air, the applicable regulations are those for the fluoride ion. The values which have been set for drinking water[61] are a standard of 4.0 mg/L set by EPA and a guideline of 2.4 mg/L set by the state of Maine.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Liquid can be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Sodium fluoride can affect you when breathed in. Inhalation of dust or mist can cause severe irritation and burns of the eyes and skin. Irritates the eyes and respiratory system. May cause permanent eye damage. Exposure can cause nausea, abdominal pain, diarrhea, salivation, thirst, sweating.

Long Term Exposure: Repeated or prolonged industrial contact can cause dermatitis. Repeated exposure can cause fluoride to build up in the body. Can irritate the lungs; bronchitis may develop. Repeated exposure can cause fluoride to build up in the body causing stiffness, brittle bones; stiff spine; calcification of ligaments of ribs, pelvis; and crippling. Repeated exposures can cause weakness and muscle twitching; tremors, convulsions, coma, and even death. May cause kidney damage. Prolonged contact can cause sores in the nose and perforated septum. High concentrations can damage the developing fetus. These effects *DO NOT* occur when sodium fluoride is used in drinking water for dental cavity prevention.

Points of Attack: Eyes, skin, respiratory system, central nervous system, skeleton, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Sodium fluoride requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including fluorine and oxides of sodium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Sodium Fluoride*. Trenton, NJ

Sodium fluoroacetate S:0480

Molecular Formula: $C_2H_2FNaO_2$

Common Formula: FCH_2COONa

Synonyms: 1080; Acetic acid, fluoro-, sodium salt; AI3-08434; Compound 1080; Fluoacetato sodico (Spanish); Fluorakil 3; Fluoressigsaeure (German); Fluoroacetic acid, sodium salt; Fratol; Furatol; Monofluoressigsaure, natrium (German); Natriumfluoracetat (German); NSC 77690; Ratbane 1080; SMFA; Sodium fluoacetate; Sodium fluoacetic acid; Sodium fluoracetate; Sodium fluoracetate de (French); Sodium monofluoroacetate; Ten-Eighty; TL 869; Yasoknock

CAS Registry Number: 62-74-8

RTECS® Number: AH9100000

UN/NA & ERG Number: UN2629/151

EC Number: 200-548-2 [*Annex I Index No.:* 607-169-00-5]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA PESTICIDE CHEMICAL CODE 075003.

US EPA Hazardous Waste Number (RCRA No.): P058.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer; Developmental/Reproductive toxin 11/6/98.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/27/28; R50; Safety phrases: S1/2; S13; S22; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium fluoroacetate is a fluffy, colorless, odorless, hygroscopic solid (sometimes dyed black). Molecular weight = 100.03; Boiling point = (decomposes); Freezing/Melting point = 200°C (decomposes below MP). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. Those involved in the manufacture, formulation, and application of this highly toxic, immediate-action rodenticide.

Incompatibilities: Alkaline metals and carbon disulfide.[24]

Permissible Exposure Limits in Air

OSHA PEL: 0.05 mg/m^3 TWA [skin].

NIOSH REL: 0.05 mg/m^3 TWA; 0.15 mg/m^3 STEL [skin].

ACGIH TLV®[1]: 0.05 mg/m^3 TWA [skin].

NIOSH IDLH: 2.5 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.05 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 0.5 mg/m^3

PAC-3: 2.5 mg/m^3

DFG MAK: 0.05 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(4) [skin]; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.05 mg/m^3, 1993; Australia: TWA 0.05 mg/m^3; STEL 0.15 mg/m^3, [skin], 1993; Austria: MAK 0.05 mg/m^3, [skin], 1999; Belgium: TWA 0.05 mg/m^3; STEL 0.15 mg/m^3, [skin], 1993; Denmark: TWA 0.05 mg/m^3, [skin], 1999; Finland: TWA 0.05 mg/m^3, STEL 0.15 mg/m^3, [skin], 1993; France: VME 0.05 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.05 mg/m^3, [skin], 2003; Norway: TWA 0.05 mg/m^3, 1999; the Philippines: TWA 0.05 mg/m^3, [skin], 1993; Switzerland: MAK-W 0.05 mg/m^3, KZG-W 1 mg/m^3, [skin], 1999; Turkey: TWA 0.05 mg/m^3, [skin], 1993; United Kingdom: TWA 0.05 mg/m^3; STEL 0.15 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 mg/m^3 [skin].

Determination in Air: Use NIOSH II(5) Method #S-301.

Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: May affect the cardiovascular system and central nervous system, causing cardiac disorders and respiratory failure. Exposure may result in death. This material is super toxic. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The probable oral lethal dose in humans is less than 5 mg/kg, or a taste (less than 7 drops) for a 150-lb person. Symptoms include nausea, vomiting, apprehension, auditory hallucinations, facial paresthesia, twitching face muscle, pulsus altenans, ectopic heartbeat, ventricular fibrillation. Symptoms are usually seen within one-half hour of exposure, but severe effects may be delayed as long as 20 h. A rebuttable presumption against registration of sodium fluoroacetate for pesticidal uses was issued on December 1, 1976 by the US EPA on the basis of reductions in nontarget and endangered species and because there is no human antidote.

Long Term Exposure: May cause liver and kidney damage. Affects the central nervous system, causing epileptiform convulsive seizures that may be followed by severe depression.

Points of Attack: Cardiovascular system, lungs, kidneys, liver, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 0.25 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 0.5 mg/m^3:* 95QX [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to*

2.5 mg/m³: 100SaT (100F) (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Sodium fluorosilicate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including fluorine and sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. This compound is unstable at temperatures above 110°C and decomposes at 200°C. Thus, careful incineration has been suggested as a disposal procedure. According to their procedure, the product should be mixed with large amounts of vermiculite, sodium bicarbonate, and sand-soda ash. Slaked lime should also be added to the mixture. Two incineration procedures for this mixture are suggested. The better of these procedures is to burn the mixture in a closed incinerator equipped with an afterburner and an alkali scrubber. The other procedure suggests that the mixture be covered with scrap wood and paper in an open incinerator. (The incinerator should be lighted by means of an excelsior train).[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Fluoroacetate*. Washington, DC: Chemical Emergency Preparedness Program

Sodium hexafluorosilicate S:0490

Molecular Formula: F_6Na_2Si

Common Formula: Na_2SiF_6

Synonyms: Destruxol applex; (2-)-Disodium hexafluorosilicate; Disodiumsilicofluoride; Ens-zem weevil bait; ENT 1,501; Fluosilicate de sodium; Natriumsilicofluorid (German); Ortho earwig bait; Ortho weevil bait; Prodan; PSC Co-Op weevil bait; Safsan; Salufer; Silicon sodium fluoride; Sodium fluorosilicate; Sodium fluosilicate; Sodium silicofluoride; Super prodan

CAS Registry Number: 16893-85-9; *(alt.)* 1310-02-7; *(alt.)* 39413-34-8

RTECS® Number: VV8410000

UN/NA & ERG Number: UN2674/154

EC Number: 240-934-8 [*Annex I Index No.:* 009-012-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (in UK) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Sodium hexafluorosilicate is a white crystalline solid. Molecular weight = 188.06. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Primary Irritant. This material is used as an intermediate in the production of synthetic cyrolite; as a drinking-water additive; as an insecticide in delousing and in mothproofing of woolens.

Incompatibilities: Reacts with acids to produce hydrogen fluoride, which is a highly corrosive and poisonous gas.

Permissible Exposure Limits in Air

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

Protective Action Criteria (PAC)

TEEL-0: 4.12 mg/m^3

PAC-1: 4.12 mg/m^3

PAC-2: 7.5 mg/m^3

PAC-3: 412 mg/m^3

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 mg/m^3), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg [F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluorides; #7906.

Permissible Concentration in Water: As with air, the applicable regulations are those for the fluoride ion. The values which have been set for drinking water[61] are a standard of 4.0 mg/L set by EPA and a guideline of 2.4 mg/L set by the state of Maine.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause difficult breathing and burning of the mouth, throat, and nose which may result in bleeding. These may be felt at 7.5 mg/m^3. Nausea, vomiting, profuse sweating, and excess thirst may occur at higher levels. *Skin:* May cause rash, itching, and burning of skin. Solutions of 1% strength may cause sores if not removed promptly. *Eyes:* May cause severe irritation. *Ingestion:* Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. Five to forty milligrams may cause diarrhea and vomiting. More severe symptoms of burning and painful abdomen; sores in mouth, throat, and digestive tract; tremors, convulsions, and shock will occur around a dose of 1 g. Death may result by ingestion of 2−5 g.

Long Term Exposure: Fluoride may increase bone density, stimulate new bone growth, or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 mg/m^3 or higher. May cause mottling of the bones or teeth at this level, resulting in fluorosis. May cause lung damage.

Points of Attack: Bones, lungs.

Medical Surveillance: Lung function tests. DEXA bone densitometry scan.

First Aid: *Inhalation:* Move person to fresh air. Give artificial respiration, if necessary. If the nose is bleeding put absorbent material (like cotton) into the nasal openings. Do not pack the nostrils. Change the material often. Seek medical attention. *Skin:* Remove soiled clothing. Wash skin with soap and water for at least 5 min. Seek medical attention, if necessary. *Eyes:* Wash eyes with slow, steady stream of water for at least 15 min. Seek medical attention immediately. *Ingestion:* Seek medical attention. Give aluminum hydroxide gel, if conscious.

Note to physician: Inject intravenously 10 mL of 10% calcium gluconate solution. Gastric lavage with lime water of 1% calcium chloride.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)† [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry area that is well ventilated. Protect from damage and acids.

Shipping: Sodium fluorosilicate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Enter spill area only with protective clothing and devices. Treat with soda ash or slaked lime. Use an industrial vacuum cleaner to remove the spill. Clean up with soap and water is allowed only if exposure and contamination are not increased to above the recommended levels. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agents suitable to surrounding fire. Poisonous gases are produced in fire, including fluorine and sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Sodium Hexafluorosilicate* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

Sodium hydroxide S:0500

Molecular Formula: HNaO

Common Formula: NaOH

Synonyms: Caustic soda; Caustic soda, bead; Caustic soda, dry; Caustic soda, flake; Caustic soda, granular; Caustic soda, solid; Hidroxido sodico (Spanish); Hydroxyde of sodium (French); Lewis Red Devil Lye; Lye; Lye solution; Natriumhydroxid (German); Pels® soda lye; Sodium hydrate; Sodium hydrate solution; Sodium hydroxide, bead; Sodium hydroxide caustic soda solution; Sodium hydroxide, dry; Sodium hydroxide, flake; Sodium hydroxide, granular; Sodium hydroxide liquid; Sodium hydroxide, solid; Sodium hydroxide solution; Sodium (hydroxyde de) (French); White caustic; White caustic, solution

CAS Registry Number: 1310-73-2; *(alt.)* 8012-01-9

RTECS® Number: WB4900000

UN/NA & ERG Number: UN1823 (dry, solid)/154; UN1824 (solution)/154

EC Number: 215-185-5 [*Annex I Index No.:* 011-002-00-6]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium hydroxide is a white, odorless, deliquescent material sold as pellets, flakes, lumps, or sticks. Aqueous solutions are known as soda lye. Molecular weight = 40.00; Specific gravity (H_2O:1) = 2.13 at 25°C; Boiling point = 1390°C; Freezing/Melting point = 318.3°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Highly soluble in water; solubility = 111%.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen, Human Data; Primary Irritant. Sodium hydroxide is utilized to neutralize acids and make sodium salts in petroleum refining, viscose rayon, cellophane, plastic production; and in the reclamation of solutions of their salts. It is used in the manufacture of mercerized cotton, paper, explosives, and dyestuffs in metal cleaning; electrolytic extraction of zinc; tin plating; oxide coating; laundering, bleaching, dishwashing; and it is used in the chemical industries.

Incompatibilities: A strong base and a strong oxidizer. Violent reaction with acid. Incompatible with water, flammable liquids, organic halogens, nitromethane, nitrocompounds, and combustibles. Rapidly absorbs carbon dioxide and water from air. Contact with moisture or water may generate heat. Corrosive to metals. Contact with zinc, aluminum, tin, and lead in the presence of moisture, forming explosive hydrogen gas. Attacks some forms of plastics, rubber, or coatings.

Permissible Exposure Limits in Air

OSHA PEL: 2 mg/m^3.

NIOSH REL: 2 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 2 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)*

TEEL-0: 0.5 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: **5** mg/m^3

PAC-3: **50** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: No numerical value established.

NIOSH IDLH: 10 mg/m^3.

Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: STEL 2 mg/m^3, 1993; Denmark: TWA 2 mg/m^3, 1999; Finland: TWA 2 mg/m^3, 1999; France: VME 2 mg/m^3, 1999; Japan: 2 mg/m^3, 1999; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 2 mg/m^3, 1999; the Philippines: TWA 2 mg/m^3, 1993; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 1 mg/m^3, 1999; Sweden: TGV 2 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3, KZG-W 4 mg/m^3, 1999; Thailand: TWA 2 mg/m^3, 1993; Turkey: TWA 2 mg/m^3, 1993; United Kingdom: STEL 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 2 mg/m^3. Russia has set 10 μg/m^3 as a MAC for ambient air in residential areas on a once-daily basis. Several states have set guidelines or standards for sodium hydroxide in ambient air[60] ranging from 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (North Dakota and South Carolina) to 40.0 μg/m^3 (Connecticut and South Dakota) to 48.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7401, alkaline Dusts; OSHA Analytical Method ID-121.

Permissible Concentration in Water: There are no criteria for NaOH as such. The EPA has, however, recommended criteria for pH as follows: to protect freshwater aquatic life: pH 6.5−9.0; to protect saltwater aquatic life: pH 6.5−8.5; and to protect humans' drinking water: pH 5−9.

Routes of Entry: Inhalation of dust or mist, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Highly corrosive to the eyes, skin, and the respiratory tract. *Inhalation:* Can cause severe irritation of the nose and throat and inflammation of the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Can cause severe irritation and deep burns. *Eyes:* Can cause severe irritation, corneal burns, and blindness. *Ingestion:* Can cause burning of the mouth and throat, nausea, vomiting, abdominal pains, and diarrhea (occasionally with blood). Can also cause swelling of the larynx and subsequent suffocation, holes in stomach and intestines, heart failure, coma. Death has resulted from swallowing less than 1/3 oz of the solid.

Long Term Exposure: Skin irritation may develop from repeated exposure to the solid or low concentrations of the liquid. Irritation to the lungs, nose, throat, and mouth may occur if exposed to low levels for long periods of time. May cause temporary loss of hair.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with large amounts of water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation.

For 30–70% solution: Sealed chemical materials with good to excellent resistance: butyl rubber; natural rubber; Neoprene™, nitrile rubber; polyethylene, PVC, Teflon™, Viton™, Viton™/chlorobutyl rubber; Saranex™, Silvershield™, Sol-vex® nitrile.

For less than 30% solution: Viton + chlorobutyl rubber, Silvershield™, polyvinyl chloride; polyethylene, Nitrile + polyvinyl chloride; and chlorinated polyethylene are among the recommended protective materials. Neoprene™ + Natural rubber and polyethylene.

All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—White Stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical you should be trained on its proper handling and storage. Sodium hydroxide must be stored to avoid contact with water, acids, flammable liquids, organic halogen compounds, metals, or nitro compounds, because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Sodium hydroxide, solid, or sodium hydroxide solution requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II. The solution falls in Hazard Class 8 and Packing Groups II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wear protective clothing. For the solid, sweep into large vessel containing a large amount of water. Neutralize with weak hydrochloric acid. For solution, neutralize with weak hydrochloric acid. Pick up with mop or water vacuum. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Sodium hydroxide itself does not burn, but it is a strong oxidizer and may ignite combustibles, such as wood, paper, oil, etc. Poisonous gases are produced in fire, including sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Discharge into tank containing water, neutralize, then flush to sewer with water.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Sodium Hydroxide*, NIOSH Document No. 76-105. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 85−89

New York State Department of Health. (February 1986). *Chemical Fact Sheet: Sodium Hydroxide* (Version 3). Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Sodium Hydroxide*. Trenton, NJ

Sodium metabisulfite S:0510

Molecular Formula: $O_5S_2 \cdot 2Na$

Common Formula: $Na_2S_2O_5$

Synonyms: Disodium disulfite; Disodium disulphite; Disodium pyrosulfite; Disulfurous acid, disodium salt; Pyrosulfurous acid, sodium salt; Sodium disulfite; Sodium metabisulfite; Sodium metabisulphite; Sodium pyrosulfite

CAS Registry Number: 7681-57-4; *(alt.)* 7757-74-6; *(alt.)* 15771-29-6

RTECS® Number: UX8225000

UN/NA & ERG Number: UN2693/154

EC Number: 231-673-0 [*Annex I Index No.:* 016-063-00-2] (disodium disulphite)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1992.

US EPA Gene-Tox Program, Negative: TRP reversion.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R31; R41; Safety phrases: S2; S26; S39; 46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium metabisulfite is a white crystalline powder with a sulfur dioxide odor. It may be considered the anhydride of 2 molecules of sodium disulfite. Molecular weight = 190.10; Specific gravity (H_2O:1) = 1.40 at 25°C; Boiling point = (decomposes); Freezing/Melting point = (decomposes) $\geq$ 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 54%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Sodium metabisulfite is used as an antioxidant in pharmaceutical preparations and as a preservative in foods. People with asthma have a greater chance of having an allergic reaction with this chemical. Individuals allergic to *sodium bisulfite* (a food preservative found in some wine, fresh shrimp, packaged foods, and restaurant salads and potatoes) may have a severe reaction when exposed to sodium metabisulfite.

Incompatibilities: A strong reducing agent. Mixtures with water form a strong corrosive. Incompatible with reducing agents and combustibles. Heat causes decomposition. Slowly oxidized to the sulfate on exposure to air and moisture. Attacks metals.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: 5 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 15 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: Sensitizing substances as sulfites.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for sodium metabisulfite in ambient air[60] ranging from 50.0 μg/m^3 (North Dakota) to 80.0 μg/m^3 (Virginia) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, skin and/or eye contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Sodium metabisulfite can affect you when breathed in. Exposure can irritate the nose, throat, and sinuses. It can also irritate the lungs, causing coughing, wheezing, and shortness of breath. Very severe general (anaphylactic) reactions can also occur in those allergic to sodium metabisulfite that can be fatal. Contact can irritate the skin.

Long Term Exposure: Sodium metabisulfite may cause an asthma-like allergy. Future exposures can cause asthma attacks with cough, shortness of breath, wheezing, and/or chest tightness. Can cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5* mg/m^3, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood and paper. DOT requires sodium metabisulfite to be packed in earthenware, glass, metal, or plastic during transport.

Shipping: Bisulfites, inorganic, aqueous solutions, n.o.s. require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium metabisulfite may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Sodium metabisulfite may ignite nearby combustible materials. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Sodium Metabisulfite*. Trenton, NJ

Sodium pentachlorophenate S:0520

Molecular Formula: C_6Cl_5NaO

Common Formula: C_6Cl_5ONa

Synonyms: AI3-16418; Dow dormant fungicide; Dowicide G; Dowicide G-ST; GR 48-11PS; GR 48-32S; Napclor-G; PCP-sodium; PCP sodium salt; Pentachlorophenate sodium; Pentachlorophenol, sodium salt; Pentachlorophenoxy sodium; Pentaclorofenato sodico (Spanish); Pentaphenate; Phenol, pentachloro-, sodium salt; Phenol, pentachloro-, sodium salt, monohydrate; PKHFN; Santobrite; Santobrite D; Sodium PCP; Sodium pentachlorophenol; Sodium pentachlorophenolate; Sodium pentachlorophenoxide; Sodium, (pentachlorophenoxy)-; Sodium pentachlorphenate; Weedbeads

CAS Registry Number: 131-52-2

RTECS® Number: SM6490000

UN/NA & ERG Number: UN2567/154

EC Number: 205-025-2 [*Annex I Index No.:* 604-003-00-3]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay; Inconclusive: *D. melanogaster* sex-linked lethal.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): listed as "None."

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24/24; R26; R36/37/38; R40; R51/53; Safety phrases: S1/2; S28; S52; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sodium pentachlorophenate is a crystalline solid with a phenolic odor. Molecular weight = 288.30. Soluble in water; solubility = 33% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector. Uses include: wood preservative; as a fungicide in water-based latex paints; preservation of cellulose products, textiles, adhesives, leather, pulp, paper and industrial waste systems; a contact and preemergence herbicide; general disinfectant and control of the intermediate snail host of schistosomiasis. The technical grade of sodium pentachlorophenate usually contain toxic microcontaminants including polychlorinated dibenzodioxins and dibenzofurans (132-64-9 and others).

Incompatibilities: Oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3.5 mg/m^3

PAC-2: 24 mg/m^3

PAC-3: 75 mg/m^3

Russia[43] set a MAC of 0.1 mg/m^3 in work-place air and MAC values for ambient air in residential areas as follows: 0.005 mg/m^3 on a momentary basis and 0.001 mg/m^3 on a daily average basis.

Determination in Air: No method available.

Permissible Concentration in Water: Russia[43] set a MAC of 5 mg/m^3 in water bodies used for domestic purposes and 0.0005 mg/L in water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure to fine dusts or sprays cause burning in eyes and painful irritation in upper respiratory tract. If inhaled, it will induce violent coughing and sneezing. Skin irritation results from brief exposures, causing a burning sensation or rash. Symptoms of severe systemic intoxication include loss of appetite, respiratory difficulties, anesthesia, fever, sweating, difficulty in breathing, and rapidly progressive coma. Severe intoxications, including fatalities, have been reported from uncontrolled use. This compound causes inflamed gastric mucosa, congestion of the lungs, edema in the brain, cardiac dilatation, degeneration of the liver and kidneys. Individuals suffering from kidney and liver diseases have a lowered resistance and should not be exposed.

Long Term Exposure: May cause skin allergy. May cause anemia. May damage the liver and kidneys. Repeated exposure can cause headache, weakness, sweating, fever, muscle twitching, dizziness, confusion, and death.

Points of Attack: Skin, blood, liver, kidneys.

Medical Surveillance: Complete blood count (CBC). Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Sodium pentachlorophenate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Collect spilled material in most convenient manner and deposit in sealed containers for later disposal. Liquids should be absorbed in vermiculite, dry sand, earth, or similar material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It is noncombustible. For small fires, use dry chemical, carbon dioxide, water spray, or foam. For large fires, use water spray, fog, or foam. Wear self-contained (positive pressure) breathing apparatus and full protective clothing. Move container from fire area if possible. Runoff from fire control or dilution water may cause pollution. Poisonous gases are produced in fire, including hydrogen chloride, chlorides, and sodium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 2, 5−30

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Pentachlorophenate*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Sodium Pentachlorophenate*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sodium selenite S:0530

Molecular Formula: Na_2O_3Se

Common Formula: Na_2SeO_3

Synonyms: Disodium selenite; Natriumselenit (German); Selenious acid, Disodium salt; Selenito sodico (Spanish)

CAS Registry Number: 10102-18-8

RTECS® Number: VS73500000

UN/NA & ERG Number: UN2630/151

EC Number: 233-267-9 [*Annex I Index No.:* 034-003-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence Group 3, 1987.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test; Positive/dose response: *In vitro* SCE—human lymphocytes; Positive/dose response: *In vitro* SCE—human; Positive/dose response: *In vitro* UDS—human fibroblast.

Very Toxic Substance (World Bank).[15]

NTP: Toxicity studies, Report TOX-38, October, 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Water Pollution Standard Proposed (EPA) (6, 62).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).[7]

Hazardous Substance RQ = 100 lb (45.4 kg).[4]

Priority Toxic Pollutant (EPA).[6]

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R23; R28; R31; R43; R51/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Sodium selenite is a white crystalline substance. Molecular weight = 172.94; Freezing/Melting point = (decomposes) 320°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Highly soluble in water; solubility = >80% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Sodium selenite is used in glass manufacturing and as an alkaloidal reagent; for removing green color from glass during its manufacture; alkaloidal reagent; reagent in bacteriology; testing germination of seeds; decorating porcelain; as a livestock feed additive.

Incompatibilities: The aqueous solution is a medium strong base. Reacts with water, strong acids, hot surfaces, causing decomposition and a toxic hazard.

Permissible Exposure Limits in Air

OSHA PEL: 0.2 mg[Se]/m^3 TWA.

NIOSH REL: 0.2 mg[Se]/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg[Se]/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 0.438 mg/m^3

PAC-1: 1.31 mg/m^3

PAC-2: 2.19 mg/m^3

PAC-3: 2.19 mg/m^3

DFG MAK: 0.05 mg[Se]/m^3 inhalable fraction; Carcinogen Category 3; Pregnancy Risk Group C.

NIOSH IDLH: 1 mg [Se]/m^3.

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg [Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 mg[Se]/m^3. Russia[43] set a MAC of 0.1 μg/m^3 in ambient air in residential areas on a momentary basis and 0.05 μg/m^3 on a daily average basis.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 35 μg/L as a 24-h average, never to exceed 260 μg/L for recoverable inorganic selenite. *To protect saltwater aquatic life:* 54 μg/L as a 24-h average, never to exceed 410 μg/L. To protect human health: 10 μg/L.[6] There are a variety of foreign standards for selenium in water.[35] The Czech Republic has set 0.1 mg/L in surface water, 0.05 mg/L in drinking water reserve, and 0.01 mg/L in drinking water. Germany[35] has set 0.008 mg/L as a maximum permissible concentration in drinking water. The EEC has set 0.01 mg/L as a MAC for drinking water. Mexico has set 0.01 mg/L for receiving waters used for drinking purposes. Russia has set 0.001 mg/L as a MAC for drinking water. WHO has set 0.01 mg/L as a limit for drinking water. Maine has set[61] a guideline of 0.01 mg/L and Minnesota 0.045 mg/L for drinking water. EPA[62] has proposed 0.05 mg/L as a limit for drinking water.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation of the dust can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. May affect the liver, kidneys, heart, nervous system, and gastrointestinal tract. *Inhalation:* Dust or fumes can cause irritation of the nose, throat, and lungs; nausea, vomiting, intestinal disturbance; garlic odor on breath; headache, fatigue, and irritability. *Skin:* Can cause irritation, burning, and red or yellow discoloration. *Eyes:* Can cause irritation and injury. *Ingestion:* Can cause nausea, vomiting, abdominal pain, diarrhea, metallic taste, and garlic odor on breath. Elemental selenium has low acute systemic toxicity, but dust or fumes can cause serious irritation of the respiratory tract. In humans, a concentration of 5 ppm in food or 0.5 ppm in milk or water has been estimated to be dangerous (selenium compounds). Animal studies suggest that the lethal dose for an adult may be as low as 1/200 oz.

Long Term Exposure: Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the central nervous system, blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic breath.

Points of Attack: Liver, kidneys, heart, nervous system, gastrointestinal tract.

Medical Surveillance: Urine test for selenium (should be less than 100 μg/L of urine). Liver and kidney function tests. Examination of the nervous system. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Wear protective gloves when inducing vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Change gloves frequently. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For levels up to 2 mg/m^3 use a respirator with full face-piece and dust and mist filters. For levels up to 7.5 mg/m^3 use a powered air-purifying respirator with dust and mist filters or supplied-air respirator operated in continuous-flow mode. For levels up to 10 mg/m^3 use a high-efficiency particulate filter respirator with a full face-piece. For levels up to 100 mg/m^3 use a Type C supplied-air respirator with a full face-piece operated in a positive-pressure mode. For levels above 100 mg/m^3 or use in areas of unknown concentrations use a self-contained Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, both with full face-piece and operated in a positive-pressure mode. For firefighting use a self-contained breathing apparatus with a full face-piece operated in a positive-pressure mode. For escape from a contaminated area use a high-efficiency particulate filter respirator with a full face-piece or an escape self-contained breathing apparatus with a full face-piece.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store at room temperature in watertight containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but will not ignite readily. When heated to decomposition, may emit toxic fumes of selenium and sodium oxide. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Poisonous gases are produced in fire, including selenium and sodium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Liquid or solid: make a strongly acidic solution using hydrochloric acid. Slowly add sodium sulfite to the cold solution. Stir mixture producing sulfur dioxide. Heat, forming dark-gray selenium and black tellurium. Let stand overnight. Filter and dry. Ship to supplier.

References

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 75−77

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Selenite*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Sodium Selenite* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

Sodium sulfate S:0540

Molecular Formula: Na_2O_4S

Common Formula: Na_2SO_4

Synonyms: Disodium sulfate; Glaubers salt; Natriumsulfat (German); Salt cake; Sodium sulphate; Sulfuric acid, Disodium salt; the nardite; Trona

CAS Registry Number: 7757-82-6

RTECS® Number: WE1650000

EC Number: 231-820-9

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sodium sulfate is a white crystalline solid. It is frequently found as the decahydrate. Molecular weight = 142.04; Specific gravity (H_2O:1) = 2.71 at 25°C; Freezing/Melting point = 888°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Sodium sulfate is used in the manufacture of glass; as a precipitating agent in the manufacture of silver emulsions; as an analytical reagent; in making ultramarine and paper pulp; in ceramic glazes and pharmaceuticals; as a food additive; and as a filler in synthetic detergents.

Incompatibilities: Violent reaction with aluminum, magnesium. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 75 mg/m^3

PAC-1: 200 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: Maryland[61] has set a guideline of 210 μg/L for sodium sulfate in drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation of nose and throat at high dust levels. *Skin:* No information found. *Eyes:* May cause irritation of nose and throat at high dust levels. *Ingestion:* Irritation of the digestive tract, vomiting, and diarrhea may result from ingestion of 1/2 oz.

Long Term Exposure: No information found.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wear a dust mask if necessary.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Keep tightly closed in a cool place.

Shipping: Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge waste sodium sulfate directly into sewers or surface waters. Recovered sodium sulfate may be disposed of by burial in a landfill.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Sodium Sulfate*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sodium sulfite S:0550

Molecular Formula: Na_2O_3S
Common Formula: Na_2SO_3
Synonyms: Disodium sulfite; Sodium sulfite(2:1); Sodium sulfite, anhydrous; Sulftech; Sulfurous acid, Sodium salt(1:2)
CAS Registry Number: 7757-83-7; *(alt.)* 10579-83-6; 68135-69-3
RTECS® Number: WE2150000
UN/NA & ERG Number: UN3260/154
EC Number: 231-821-4
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence Group 3, 1992.
US EPA Gene-Tox Program, Positive: *S. cerevisiae*—reversion.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.
Description: Sodium sulfite is a white crystalline solid. Molecular weight = 126.04; Specific gravity (H_2O:1) = 2.63 at 25°C; Freezing/Melting point = (decomposes) 538°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen. Sodium sulfite is used as a reducing agent; in boiler water treatment; food applications; in photographic developers and fixers; in bleaching of wool, paper, textiles, straw, and silk; manufacture of dyes; dechlorination; preservation of meat, fruit, and egg products; silvering of glass.
Incompatibilities: A strong reducing agent. Incompatible with strong oxidizers, combustibles, organic materials. Reacts with strong acids, producing toxic sulfur dioxide.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 100 mg/m^3
Permissible Concentration in Water: Maryland[61] has set a guideline of 100 μg/L for sodium sulfite in drinking water.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: *Inhalation:* May cause asthmatic reactions. Animal studies indicate that levels of 1 mg/m^3 may cause slight swelling of lung tissue and irritation. *Skin:* Corrosive. Causes irritation and burns. *Eyes:* Corrosive. Causes severe irritation and burns. *Ingestion:* Solutions cause gastric irritation by the liberation of sulfurous acid. Because of rapid oxidation to sulfate, sulfites are well tolerated until large doses are reached; then violent colic and diarrhea, circulatory disturbances; central nervous depression; and death can occur. Increased dosage will result in sudden, violent colic and diarrhea, circulatory disturbances; slowed breathing; fainting, rapid pulse; and death. The lethal dose may be about 10 g (about 1/3 oz).
Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma.
Points of Attack: Skin, lungs.
Medical Surveillance: Examination by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials.

Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry location in closed containers.

Shipping: Corrosive solid, acidic, inorganic, n.o.s. requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Use agents suitable for surrounding fire. Decomposes above 538°C; Toxic sulfur dioxide gases formed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Sodium Sulfite*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sodium tellurite S:0560

Molecular Formula: Na_2O_3Te

Common Formula: Na_2TeO_3

Synonyms: Sodium tellurate(IV); Telluric acid, disodium salt; Tellurous acid, disodium salt; Telurito sodico (Spanish)

CAS Registry Number: 10102-20-2

RTECS® Number: WY24500000

UN/NA & ERG Number: UN3284 (tellurium compound, n.o.s.)/151

EC Number: 233-268-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sodium tellurite is a white crystalline solid. Molecular weight = 221.58; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used in bacteriology and medicine. Formerly used as pesticide.

Incompatibilities: Cadmium, nitric acid, halogens, oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Te]/m^3 TWA.

NIOSH REL: 0.1 mg[Te]/m^3 TWA.

ACGIH TLV®[1]: 0.1 mg[Te]/m^3 TWA.

NIOSH IDLH: 25 mg[Te]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.174 mg/m^3

PAC-1: 0.521 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 43.4 mg/m^3

DFG MAK: 0.1 mg[Te]/m^3, inhalable fraction.

Australia: TWA 0.1 mg/m^3, 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg[Te]/m^3, 2003; the Philippines: TWA 0.1 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3; MAC (STEL) 0.03 mg/m^3, 1999; Sweden: NGV 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.5 mg/m^3, 1999; Turkey: TWA 0.1 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Te]/m^3. Several states have set guidelines or standards for tellurium in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7900. See also #7300, Elements; #7301; #7303; #9102; OSHA Analytical Method ID-121.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[43] set a MAC of 0.01 mg/L for tellurium in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the skin and eyes. Irritates the respiratory tract, causing cough and wheezing. The material is both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70-kg (150 lb) person. Tellurium compounds are regarded as super toxic for skin exposures. Symptoms of exposure are as follows: sleepiness, fatigue, stupor; loss of appetite; nausea, vomiting, stomach pain; metallic taste; garlic odor of the breath and sweat; dryness of the mouth or excessive salivation; renal pain; bronchitis, irregular breathing; cyanosis, fatty degeneration of the liver; and unconsciousness.

Long Term Exposure: Repeated or prolonged exposure to tellurium compounds may cause reproductive damage, liver and kidney damage, lung irritation. Bronchitis may develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: Lung function tests, liver and kidney function tests.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, consider inducing vomiting of this toxic material. Transport at once to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m^3:* 95QX [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full-face-piece). *Up to 25 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: Tellurium compound, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I to III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Do not use halogens. Poisonous gases are produced in fire, including tellurium and sodium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sodium Tellurite*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (August 1999). *Hazardous Substances Fact Sheet: Sodium Tellurite*. Trenton, NJ

Soman (Agent GD, WMD) S:0565

Molecular Formula: $C_7H_{16}FO_2P$

Common Formula: $CH_3P(O)(F)OCH(CH_3)C(CH_3)3$

Synonyms: EA 1210; Fluoromethylpinacolyloxyphosphine Oxide; GD (military designation); Methyl-fluoropinacolyl-phosphonate; Methyl-pinacolyloxyfluorophosphine oxide; Methyl-pinacolyloxyphosphonyl flouride; PFMP; Phosphonofluoridic acid, methyl-, 1, 2, 2-trimethylpropyl ester; Pinacolyl methylphosphonofluoridate; Pinacolyl methanefluorophosphonate; Pinacolyl methylfluorophosphonate; Pinacolyloxymethylphosphonyl flouride; Somain; Thickened GD; TGD; 1,2,2-Trimethylpropylmethylphosphonofluoridate; 1,2,2,-Trimethylpropoxyfluoromethylphosphine oxide; Zoman

Chlorosoman

O-Pinacolyl methylphosphonochloridate; méthylphosphonochloridate de O-pinacolyle (French)

CAS Registry Number: 96-64-0; 50642-24-5; 7040-57-5 (Chlorosoman)

RTECS® Number: None found

UN/NA & ERG Number: UN2810/153

EC Number: Not assigned

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g (*96-64-0; 7040-57-5 chlorosoman*).

Carcinogenicity: GD is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

US DOT 49CFR172.101, Inhalation Hazard Chemical.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Soman (GD) is a fluorinated organophosphorus compound. Exposure to soman can cause death in minutes. A fraction of an ounce (1−10 mL) of soman on the skin can be fatal.[NIOSH] When pure, GD is a colorless liquid with fruity odor. With impurities, or upon aging, GD is an amber to dark-brown oily liquid with an odor of rotten fruit or camphor (like Vicks® Vapo-Rub). Do not rely on odor for detection; not everyone can smell low concentrations of this chemical. Molecular weight = 182.17; Boiling point = 198°C; 167−200°C; Specific gravity ($H_2O = 1$) = 1.022 at 25°C; Melting point: −42°C; Vapor pressure = 0.40 mmHg at 25°C; Vapor density (air = 1) = 6.3; Volatility = 3900 mg/m^3 at 25°C; Flash point = 121°C (oc). Flammability limits: Unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1. Slightly soluble in water. Thickened agent GD [TGD] is essentially the same as GD except for viscosity. Viscosity = (approx.) 1180 centistokes uses "K125" (acryloid copolymer, 5%) to create TGD. K125 is not known to be a hazardous material except in a finely divided, powder form.[CDC]

Potential Exposure: Agent GD is a quick-acting chemical warfare nerve agent (nerve gas). Medical treatment of soman is difficult because it permanently binds to receptors in the body in minutes. Large amounts of the vapor or liquid can hurt you in minutes, and can quickly lead to death.

Persistence of Chemical Agent: Soman (GD): Summer: 10 min to 24 h; Winter: 2 h to 3 days.

Incompatibilities: Stable after storage in steel for 3 months at 65°C. GD corrodes steel at the rate of 1×10^{-5} inch/month. Raising the pH increases the rate of decomposition significantly. GD decomposes slowly in water; will hydrolyze to form $HF{-}H{-}H{-}O{-}CH_3$ and $(CH_3)_3{-}C{-}C{-}O{-}P{-}OH$. GD reacts readily with bases and weak acids. Under acid conditions, GD hydrolyzes, forming hydrofluoric acid (HF). Flammable hydrogen gas produced by the corrosive vapors reacting with metals, concrete, etc. may be present.

Permissible Exposure Limits in Air

IDLH: 0.05 mg/m^3.[US Army]

Acute Exposure Guideline Levels (AEGLs)

Level 1—potential minor discomfort or noticeable effects; reversible

10 min—0.00049 ppm; 30 min—0.00028 ppm; 1 h—0.0002 ppm; 4 h—0.0001 ppm; 8 h—0.00050 ppm

Level 2—potentially impacting functional abilities or ability to escape; potential delayed recovery

10 min—0.0062 ppm; 30 min—0.0035 ppm; 1 h—0.0024 ppm; 4 h—0.0013 ppm; 8 h—0.00091 ppm

Level 3—Life threatening; level of potential initial fatalities 10 min—0.053 ppm; 30 min—0.027 ppm; 1 h—0.018 ppm; 4 h—0.0098 ppm; 8 h—0.0071 ppm

Protective Action Criteria (PAC) GD*
TEEL-0: 0.00003 ppm
PAC-1: **0.00018** ppm
PAC-2: **0.0022** ppm
PAC-3: **0.017** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

The suggested permissible airborne exposure concentration of soman (GD) for an 8-h workday or a 40-hour workweek is an 8-h time-weighted average (TWA) of 0.00003 mg/m^3 (2×10^{-5} ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*. Also, the general population limits (as recommended by the Surgeon General's Working Group, US Department of Health): 0.000003 mg/m^3.

Determination in Air: Available monitoring equipment for soman (GD) is the Automatic Chemical Agent Detector Alarm (ACADA), bubblers (GC method), and Chemical Agent Monitor (CAM).

Determination in Water: Log K_{ow} (estimated) = 1.02:Log $K_{\text{benzene-water}}$ = 1.61. Soman dissolves in water and remains very dangerous. To prevent anyone from drinking water mixed with soman, notify local health and pollution control officials. Also, notify operators of nearby water intakes and advise shutting water intakes. Hydrolysis by acidic, neutral, and basic mechanisms, giving fluoride and pinacolyl methylphosphonate. Rapidly hydrolyzed in basic solutions (e.g., Na_2CO_3, NaOH, or KOH) with a half-life of approximately 1 min at pH 11 at 25°C. Soman and its hydrolysis products exhibit no significant phototransformations in sunlight. Soman and its hydrolysis products are thermally stable at temperatures less than 49°C. Use M272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Bleaching powder (chlorinated lime) destroys soman but gives rise to cyanogen chloride (CAS: 506-77-4). See table of contents or name index for location of entry for: Cyanogen chloride.

Routes of Entry: Skin absorption, absorption through eyes, and inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Soman (GD) is a lethal anticholinesterase agent with the median lethal dose in humans being: LCt_{50} (inhalation) = 70 mg-min/m^3 (t = 10 min); LD_{50} (PC, bare skin) = 0.35 g/man (70 kg). *One to several minutes following overexposure to airborne soman (GD)*, the following acute symptoms appear: *Local effects* (lasting 1−15 days, increase with dose): *Eyes:* Miosis (constriction of pupils); redness, pressure sensation on eyes. *Inhalation:* Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting. *Systemic effects* (increases with dose): When inhaled soman (GD) will cause excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea, stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming, and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty; memory impairment; confusion, unsteadiness on standing or walking; and progressing to death. After exposure to liquid soman (GD), the following acute symptoms appear: *Local effects*: *Eyes:* Miosis (constriction of pupils); redness, pressure sensation on eyes. *Ingestion:* salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn. *Skin:* Sweating, muscle twitching. If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible central nervous system changes due to anoxemia have occurred.

Long Term Exposure: Limited data suggest delayed neuropathy (postural sway, psychomotor performance). Miosis has been noted up to 62 days.[CDC] Chronic exposure to soman (GD) causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1−2 weeks after the exposure. Although certain organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for soman (GD). The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2−3 months if damage is severe, there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed. Agent GD is not listed by the International Agency for Research on Cancer (IARC); American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase, liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG.

First Aid: *Inhalation:* Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, a lack of coordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s); Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5−20 min intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag of oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *immediately*.

Eye contact: Immediately flush eyes with water for 10−15 min, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken *immediately* to the medical treatment facility for observation.

Skin contact: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are present. Seek medical attention *immediately*.

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. *Immediately* administer Nerve Agent Antidote kit, Mark I. Seek medical attention immediately. If there is no apparent breathing, artificial resuscitation will be started immediately, but *do not* use mouth-to-mouth resuscitation when facial contamination exists; in this case, use mechanical resuscitator. The situation will dictate method of choice. When appropriate and trained personnel are available, cardiopulmonary resuscitation (CPR) may be necessary.

Notes for physician and qualified medical personnel: An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with the MARK I kit autoinjectors. Some of the early symptoms of a *vapor exposure* may be rhinorrhea (runny nose) and/or tightness in the chest with shortness of breath (bronchial constriction). Some of the early symptoms of a *percutaneous exposure* may be local muscular twitching or sweating at the area of exposure followed by nausea or vomiting. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation. Injections using the MARK I kit injectors (or atropine only if directed by the local physician) may be repeated at 5−20 min intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. Administer, in rapid succession, all three MARK I kit injectors (or atropine if directed by the local physician) in the case of SEVERE signs of agent exposure. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. *CAUTION:* atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

Medical Treatment: Electrocardiogram (ECG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5−10 mg in adults and 0.2−0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6−12 h to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Nerve gases stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing; begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate upwind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment; and shampooing or rinsing the hair to prevent vapor-off gassing; patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Remember that the water you use to decontaminate the victims is dangerous. Be sure you have decontaminated the victims as much as you can before they are released from the area, so they do not spread the nerve gas. Rinse the eyes, mucous membranes, or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

*The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach ($NaOCl$ or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

Note: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: *Protective gloves*: Butyl Glove M3 and M4; Norton chemical protective glove set. *Eye protection*: chemical goggles. For splash hazards use goggles and face shield. *Other protective equipment*: Full protective clothing will consist of M9 mask and hood; butyl rubber suit (M3), M2A1 butyl boots; M3 and M4 gloves; unimpregnated underwear; or demilitarization protective ensemble (DPE). For laboratory operations, wear lab coats and have a protective mask readily available.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Positive pressure, full face-piece, NIOSH/MSHA- or European Standard EN 149-approved self contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing.

From the Riegle Report

Less than 0.00003 mg/m^3: M9, M17, or M40 series mask shall be available for escape as necessary. *0.00003 mg/m^3* to *0.06 mg/m^3:* M9 or M40 series mask with Level A or Level B ensemble. *Greater than 0.06 mg/m^3:* or DPE or TAPES used with prior approval from AMC Field Safety Activity.

Note: When DPE or TAPES is not available, the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed 1 h. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to <0.00001 mg/m^3 (averaged over 8 h/day, indefinitely).

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) + 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent GD. Emergency back-up power necessary: Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

Storage: In handling soman (GD), the buddy system will be incorporated. No smoking, eating, or drinking is permitted in areas containing agent GD. Containers should be periodically inspected for leaks (either visually or by a detector kit) and prior to transferring the containers from storage to work areas. Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities shall be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday. *Other precautions:* Agent GD must be double-contained in liquid and vapor-tight containers when in storage or when outside of the ventilation hood.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone B] requires a shipping label of "POISONOUS/TOXIC MATERIALS." (Pinacolyl methyl phosphonofluoridate), Inhalation Hazard. It falls in Hazard Class 6.1 and Packing Group I, Hazard Zone B.

Spill Handling: Warn pollution control authorities and advise shutting water intakes. Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum of 10%). Scoop up all material and place in a fully removable head drum with a high-density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, state, and DOT regulations. Dispose of material used to decontaminate exterior of drum in accordance with IAW, federal, state, and local regulations. Contaminated clothing will be placed in a fully removable head drum with a high-density polyethylene liner and the contents shall be covered with decontaminating solution as above before affixing the drum head. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits (see Section 8). If 10 wt. % aqueous sodium hydroxide solution is not available, then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate, and Supertropical Tropical Bleach Slurry (STB).

GD, when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 1.5/2.4

Fire Extinguishing: When heated, vapors may form explosive mixtures with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Fires involving soman (GD) should be contained to prevent contamination of uncontrolled areas. All persons not engaged in extinguishing the fire should be evacuated immediately. Contact with soman (GD) or its vapors can be fatal. When responding to a fire alarm in buildings or areas containing nerve agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face-piece, NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing.

Disposal Method Suggested: A minimum of 55 g of decon solution is required per gram of soman (GD). Decontaminant/agent solution is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour provided a single phase is obtained. At the end of the first hour the pH should be checked and adjusted up to 11.5 with additional sodium hydroxide as required. An alternate solution for the decontamination of soman (GD) is 10% sodium carbonate in place of the 10% sodium hydroxide solution above. Continue with 55 g of decon per gram of GD. Agitate for 1 h and allow to react for 3 h. At the end of the third hour, adjust the pH to above 10. It is also permitted to substitute 5.25% sodium hypochlorite for the 10% sodium hydroxide solution above. Continue with 55 g of decon per gram of GD. Agitate for 1 h and allow to react for 3 h, then adjust the pH to above 10. Scoop up all material and place in a fully removable head and a high-density polyethylene liner. Cover the contents with additional decontaminating solution before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All contaminated clothing will be placed in a fully removable head drum with a high-density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits. *Waste disposal method*: Open pit burning or burying of GD or items containing or contaminated with GD in any quantity is prohibited. The detoxified GD (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of federal, state, and local RCRA regulations. *NOTE:* Several states define decontaminated surety material as a RCRA Hazardous Waste.

References

The Riegle Report: A Report of Chairman Riegle, D. W., Jr. and Ranking Member Alfonse M. D'Amato of the Committee on Banking, Housing and Urban Affairs with Respect to Export Administration, United States Senate, 103rd Congress, 2d Session, (May 25, 1994)

Schneider, A. L., et al. (2007). *CHRIS + CD-ROM Version 2.0, United Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C).* Washington, DC: United States Coast Guard and the Department of Homeland Security

Stannic chloride, hydrated S:0570

Molecular Formula: $Cl_4H_{10}O_5Sn$
Common Formula: $SnCl_4 \cdot 5H_2O$
Synonyms: Stannic chloride pentahydrate; Tetrachlorostannane pentahydrate
CAS Registry Number: 10026-06-9 (hydrated)
RTECS® Number: XP8870000
UN/NA & ERG Number: UN2440/154
EC Number: 050-001-00-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Stannic chloride is a white to yellow powder with a faint odor of HCl. Molecular weight = 350.59; Boiling point = 114°C; Freezing/Melting point = −33°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Hydrated stannic chloride is used for fixing certain textile dyes, and for treating silk to give weight to the fabric.

Incompatibilities: Reacts violently with water, forming corrosive hydrochloric acid and tin oxide fumes. Reacts with turpentine, alcohols, and amines, causing fire and explosion hazard. Attacks many metals; some forms of plastics, rubber, and coatings. Reacts with moist air to form hydrochloric acid.

Permissible Exposure Limits in Air

OSHA PEL: 2 mg[Sn]/m^3 TWA.

NIOSH REL: 2 mg[Sn]/m^3 TWA.

ACGIH TLV®[1]: 2 mg[Sn]/m^3 TWA.

No TEEL available.

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

NIOSH IDLH: 100 mg[Sn]/m^3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Hydrated stannic chloride can affect you when breathed in. Corrosive to the eyes, skin, and respiratory tract. Eye damage may be permanent. Breathing hydrated stannic chloride can irritate the throat and bronchial tubes, causing cough and/or difficulty in breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Changes may occur on chest X-ray with repeated exposure, resulting in impaired lung functions. Tin may interfere with the body's ability to absorb iron from the diet or from vitamins, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Complete blood count (CBC). Hemoglobin or hematocrit. If acute breathing exposure to heated hydrated stannic chloride with chlorine gas is suspected, also consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA: *Up to 10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 mg/m³:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 mg/m³:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Hydrated stannic chloride must be stored to avoid contact with water, moisture, chlorine, turpentine, ethylene oxide, and alkyl nitrates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep hydrated stannic chloride dry and out of direct sunlight. Hydrated stannic chloride can attack some plastics, rubbers, and coatings.

Shipping: Stannic chloride, pentahydrate, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hydrated stannic chloride itself does not burn. Poisonous gases are produced in fire, including hydrogen chloride, chlorine, and tin. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (September 2002). *Hazardous Substances Fact Sheet: Stannic Chloride, Hydrated.* Trenton, NJ

Stannous chloride S:0580

Molecular Formula: Cl_2Sn; $Cl_2Sn \cdot 2H_2O$ (dihydrate)

Common Formula: $SnCl_2$

Synonyms: C.I. 77864; NCI-C02722; Stannochlor; Tin(II) chloride; Tin dichloride; Tin protochloride

Dihydrate: Stannous dichloride dihydrate; Stannochlor; Stannous chloride dihydrate; Tin(II) chloride, dihydrate (1:2:2)

CAS Registry Number: 7772-99-8; 10025-69-1 (dihydrate)

RTECS® Number: XP8700000; XP8850000 (dihydrate)

UN/NA & ERG Number: UN3260/154

EC Number: 231-868-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); equivocal evidence: rat; no evidence: mouse.

US EPA Gene-Tox Program, Negative: *B. subtilis* rec assay; TRP reversion; Negative/limited: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set: ACGIH[1]; DFG[3]; OSHA.[58]

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Stannous chloride is a white crystalline solid. Molecular weight = 189.59; 225.63 (dihydrate); Boiling point = (decomposes) 652°C; Freezing/Melting point = 246°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 90% at 20°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; (dihydrate) Mutagen; Reproductive Effector. Stannous chloride is used as a dye, pigment, and printing ink; in making chemicals; chemical preservatives; food additives; polymers, textiles, glass, silvering mirrors.

Incompatibilities: A strong reducing agent. Reacts violently with oxidants. Reacts violently with bromine trifluoride, potassium, hydrazine hydrate, sodium, sodium peroxide, ethylene oxide, and nitrates. Keep away from moisture, sources of oxygen, and combustible materials.

Permissible Exposure Limits in Air

Includes dihydrate

OSHA PEL: 2 mg[Sn]/m^3 TWA.

NIOSH REL: 2 mg[Sn]/m^3 TWA.

ACGIH TLV®[1]: 2 mg[Sn]/m^3 TWA.

NIOSH IDLH: 100 mg[Sn]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 3.19 mg/m^3

PAC-1: 9.58 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 160 mg/m^3

EUR OEL: 2 mg[Sn]/m^3 as TWA.

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

Australia: TWA 2 mg[Sn]/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg[Sn]/m^3, 1993; Denmark: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg [Sn]/m^3, 1999; Hungary: TWA 1 mg[Sn]/m^3; STEL 2 mg [Sn]/m^3, [skin], 1993; Norway: TWA 2 mg[Sn]/m^3, 1999; the Philippines: TWA 2 mg[Sn]/m^3, 1993; Poland: TWA 2 mg[Sn]/m^3, 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg [Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg[Sn]/m^3.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Stannous chloride can affect you when breathed in. Contact can cause skin and eye burns. Breathing stannous chloride dust or mist can irritate the throat and bronchial tubes, causing cough and/or difficulty in breathing. May affect the central nervous system and blood when ingested.

Long Term Exposure: Effects on the liver following ingestion. Changes may also occur on chest X-ray with repeated exposures; reduced lung function has been reported. Tin may interfere with the body's ability to absorb iron from the diet or from vitamins, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Complete blood count (CBC); hemoglobin or hematocrit. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™ and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA: *Up to 10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Stannous chloride must be stored to avoid contact with bromine trifluoride, nitrates, potassium hydrazine hydrate, sodium peroxide, ethylene oxide, and hydrogen peroxide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, sources of oxygen, and combustible materials. Sources of ignition, such as smoking and open flames, are prohibited where stannous chloride is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Corrosive solid, acidic, inorganic, n.o.s. requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Stannous chloride itself does not burn. Stannous chloride may ignite combustible materials. Poisonous gases are produced in fire, including chlorine and stannous sulfate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Stannous Chloride*. Trenton, NJ

Stannous fluoride S:0590

Molecular Formula: F_2Sn

Common Formula: SnF_2

Synonyms: Fluoristan®; Stannous fluoride; Tin bifluoride; Tin difluoride

CAS Registry Number: 7783-47-3

RTECS® Number: XQ3450000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-999-3

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Negative: *N. crassa—aneuploidy.*

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Stannous fluoride is a white crystalline solid with a bitter, salty taste. Molecular weight = 156.69; Boiling point = 849°C; Freezing/Melting point = 213°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; 30% at 20°C.

Potential Exposure: Compound Description: Drug, Tumorigen, Mutagen. Stannous fluoride is used in caries prophylactic; as an ingredient of cavity-preventing toothpastes.

Incompatibilities: Reacts with acids, forming hydrogen fluoride fumes. Reacts violently with chlorine.

Permissible Exposure Limits in Air

No TEEL available.

As tin, inorganic compounds

OSHA PEL: 2 mg[Sn]/m^3 TWA.

NIOSH REL: 2 mg[Sn]/m^3 TWA.

ACGIH TLV®[1]: 2 mg[Sn]/m^3 TWA.

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

NIOSH IDLH: 100 mg[Sn]/m^3.

As fluorides

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA.

ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

NIOSH IDLH: 250 mg[F]/m^3.

Australia: TWA 2 mg[Sn]/m^3, 1993; Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg[Sn]/m^3, 1993; Belgium: TWA 2.5 mg[F]/m^3, 1993; Denmark: TWA 2.5 mg[F]/m^3, 1999; Denmark: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA

2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Hungary: TWA 1 mg[Sn]/m^3; STEL 2 mg[Sn]/m^3, [skin], 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; Norway: TWA 2 mg[Sn]/m^3, 1999; the Philippines: TWA 2 mg[Sn]/m^3, 1993; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Poland: TWA 2 mg[Sn]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg [F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; Thailand: TWA 2.5 mg[F]/m^3, 1993; Turkey: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Not classifiable as a human carcinogen.

Determination in Air: Filter; Acid; Hydride generation atomic absorption spectrometry; NIOSH Analytical Method (IV) #7900. See also #7300, Elements.

Permissible Concentration in Water: The EPA has set 4 mg/L as a standard for fluoride[61] but has no level set for tin.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Stannous fluoride can affect you when breathed in. Corrosive to the eyes. Irritates the skin and respiratory tract. Prolonged skin contact can cause burns. Breathing stannous fluoride can irritate the throat and bronchial tubes, causing cough and/or difficulty in breathing. Changes may also occur on chest X-ray with repeated exposures. When heated, toxic fluorine gas can be released, causing pulmonary edema (fluid in the lungs), a medical emergency that can be delayed for several hours. This can cause death. If swallowed, may affect the gastrointestinal tract, causing shock.

Long Term Exposure: May affect the teeth and bones. Repeated exposure, usually after years, may cause changes in the chest X-ray; reduced lung function has been reported. Tin released by stannous fluoride may interfere with the body's ability to absorb iron, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: lung function tests. For persons exposed to levels half the TLV or greater, the following is recommended: hemoglobin or hematocrits. If acute breathing overexposure to heated stannous fluoride with fluorine gas is suspected, also consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. For heated stannous fluoride exposure, medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If swallowed, watch for symptoms of shock.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA: *Up to 10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) * (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Stannous fluoride must be stored to avoid contact with chlorine and turpentine, since violent reactions occur.

Shipping: Toxic solid, inorganic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical or CO_2 extinguishers. Poisonous fluorine gas is produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Stannous Fluoride*. Trenton, NJ

Stibine S:0600

Molecular Formula: H_3Sb

Common Formula: SbH_3

Synonyms: Antimonwasserstoffes (German); Antimony hydride; Antimony trihydride; Hydrogen antimonide

CAS Registry Number: 7803-52-3

RTECS® Number: WJ0700000

UN/NA & ERG Number: UN2676/119

EC Number: 051-003-00-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥0.67% concentration).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As antimony compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as antimony compounds, n.o.s.

Safe Drinking Water Act: MCL 0.006 mg/L; MCLG, 0.006 mg/L.

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Stibine is a colorless gas with a characteristic disagreeable odor. It is produced by dissolving zinc/antimony or magnesium-antimony in hydrochloride acid. Molecular weight = 124.78; Boiling point = −18.3°C; Freezing/Melting point = −87.8°C; Flash point = Flammable gas; Relative vapor density (air = 1) = 4.31; Vapor pressure = >1 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Poor solubility in water.

Potential Exposure: Stibine is used as a fumigating agent. Exposure to stibine usually occurs when stibine is released from antimony-containing alloys during the charging of storage batteries, when certain antimonial drosses are treated with water or acid, or when antimony-containing metals come in contact with acid. Operations generally involved are metallurgy, welding, or cutting with blow torches; soldering, filling of hydrogen balloons; etching of zinc; and chemical processes.

Incompatibilities: A flammable gas. Incompatible with acids, halogenated hydrocarbons, oxidizers, moisture, chlorine, ammonia. Reacts violently with chlorine, concentrated nitric acid, and ozone. Decomposes in air. Thermally unstable: quick decomposition at 200°C producing metallic antimony and explosive hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 ppm/0.5 mg/m^3 TWA.

NIOSH REL: 0.1 ppm/0.5 mg/m^3 TWA.

ACGIH TLV®[1]: 0.1 ppm/0.5 mg/m^3 TWA.

NIOSH IDLH: 5 ppm

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 0.2 ppm

PAC-2: 1.5 ppm

PAC-3: 9.6 ppm

Austria: MAK 0.1 ppm (0.5 mg/m^3), 1999; Denmark: TWA 0.05 ppm (0.25 mg/m^3), 1999; France: VME 0.1 ppm (0.5 mg/m^3), 1999; Norway: TWA 0.05 ppm (0.25 mg/m^3), 1999; Poland: MAC (TWA) 0.2 mg/m^3; MAC (STEL) 1.5 mg/m^3, 1999; Sweden: TWA 0.05 ppm (0.3 mg/m^3), 1999; United Kingdom: TWA 0.1 ppm (0.52 mg/m^3); STEL 0.3 ppm, 2000; the Netherlands: MAC-TGG 0.5 mg[Sb]/m^3. Several states have set guidelines or standards for stibine in ambient air[60] ranging from 5.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6008, Stibine.

Permissible Concentration in Water: See regulatory section.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short Term Exposure: Stibine can affect you when breathed in. May be fatal if absorbed through the skin or inhaled. A strong sensitizer. May cause severe allergic respiratory reaction. Exposure can cause rapid, fatal poisoning, with symptoms of headaches, nausea, dark or bloody urine, pain in the back and abdomen, slowed breathing, and death. Exposure can also irritate the lungs and may lead to a buildup of fluid (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death. Stibine destroys red blood cells and can also cause liver and kidney damage.

Long Term Exposure: Stibine destroys red blood cells (hemolysis). May affect the kidneys, liver; hemoglobinuria, hematuria (blood in the urine), hemolytic anemia; jaundice. May affect the central nervous system.

Points of Attack: Blood, liver, kidneys, respiratory system, CNS.

Medical Surveillance: NIOSH lists the following tests: liver function tests; red blood cells/count, RBC hemolysis; urine (chemical/metabolite), hemoglobin; urinalysis (routine); white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Examination of the central nervous system. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Stibine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids (such as hydrochloric, sulfuric, and nitric), and halogenated hydrocarbons, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, and flames.

Shipping: Stibine requires a shipping label of "POISON GAS, FLAMMABLE GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 1.7/2.8
Night 4.5/7.2

Fire Extinguishing: This chemical is a flammable gas. Evolves hydrogen and poisonous gases, including antimony, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use flooding quantities of water. Do not use halogenated extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in hydrochloric acid; add water to produce precipitate; add acid to dissolve again; precipitate with H_2S; filter and dry precipitate and return to suppliers.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 17−18

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: Stibine*. Trenton, NJ

Stoddard solvent S:0610

Molecular Formula: C_9H_{20}

Synonyms: Cleaning solvent; Dry cleaner naphtha; Mineral spirits; Naphtha safety solvent; Petroleum solvent; Spotting solvent; Varnoline; White spirits

CAS Registry Number: 8052-41-3

RTECS® Number: WJ8925000

UN/NA & ERG Number: UN1268/128

EC Number: 232-489-3 [*Annex I Index No.:* 649-345-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R46; R65; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Stoddard solvent is a refined petroleum solvent containing $>65\%$ C_{10} or higher hydrocarbons. Stoddard solvent is a colorless liquid with a kerosene-like odor. Odor threshold = 1 ppm$^{(NY)}$−30 ppm. Molecular weight can vary = 140−160; Specific gravity (H_2O:1) = 0.765−0.795 at 25°C; Boiling point = 154−202°C[1]; 130−230°C; Flash point = 39−60°C; but, may vary from 21°C to 60°C based on composition; Autoignition temperature = 229−240°C; but may vary based on composition. Explosive limits: LEL = 0.6%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 20, Flammability 2, Reactivity 0. Insoluble in water. See also "Naphthas" for related materials.

Potential Exposure: Compound Description: Primary Irritant. Stoddard solvent is used as a diluent in paints, coatings, and waxes; as a paint thinner; as a dry-cleaning agent; as a degreaser for metal parts; as an herbicide.

Incompatibilities: Forms explosive mixture with air. Keep away from strong oxidizers. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 500 ppm/2900 mg/m^3 TWA.

NIOSH REL: 350 mg/m^3 TWA; 1800 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 100 ppm/525 mg/m^3 TWA.

NIOSH IDLH: 20,000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 100 ppm

PAC-1: 100 ppm

PAC-2: 350 ppm

PAC-3: 3850 ppm

Australia: TWA 790 mg/m^3, 1993; Belgium: TWA 100 ppm (525 mg/m^3), 1993; Denmark: TWA 25 ppm (140 mg/m^3), 1999; the Philippines: TWA 200 ppm (1150 mg/m^3), 1993; the Netherlands: MAC-TGG 575 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 100 ppm. Several states have set guidelines or standards for Stoddard solvent in ambient air[60] ranging from 5.25−10.50 mg/m^3 (North Dakota) to 7.0 mg/m^3 (Connecticut) to 12.5 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 1550, Naphthas; OSHA Analytical Method 48.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.2−7.1.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Causes irritation of the eyes and respiratory tract. Exposure to levels above 2400 mg/m^3 may cause headache, dizziness, nose and throat irritation. More severe exposures may cause nausea and vomiting, a feeling of intoxication, weakness, muscle twitches; and in extreme cases, convulsions, unconsciousness, and death. *Skin:* Contact with liquid may cause irritation and drying of skin. This can result in dermatitis. *Eyes:* Contact with liquid or vapor levels of 900−2400 mg/m^3 may cause irritation and tearing. *Ingestion:* Small amounts may cause headache, dizziness, nausea, vomiting, intoxication, weakness, muscle twitches, convulsions, and unconsciousness. May cause aspiration into the lungs and chemical pneumonia. As little as 3 oz may be fatal. If liquid is breathed into the lungs, as little as 1 oz may cause death due to respiratory failure.

Long Term Exposure: Prolonged or repeated contact with liquid may cause defatting of the skin with drying, irritation, and skin ulcers. Exposure to vapor may cause eye, nose and throat irritation, fatigue, headaches, anemia, jaundice, and damage to the liver and bone marrow. In animals: kidney damage. Repeated exposure may cause a rare reaction in some people that destroys blood cells (aplastic anemia). This can be fatal. Many petroleum-based solvents have been shown to cause brain and/or nerve damage. Effects may include reduced memory and concentration, personality changes, fatigue, sleep disturbances, reduced coordination, effects on the autonomic nerves and/or nerves to the limbs.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: complete blood count. Evaluation for brain effects. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do *NOT* induce vomiting.

Note to physician: Treat symptomatically for central nervous system depression. Supportive treatment for pulmonary edema using oxygen may be needed when aspiration of liquids or massive exposure to vapors has occurred.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Some of these manufacturers recommend *nitrile* or *polyvinyl alcohol* as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For engineering controls see *Criteria for a Recommended Standard: Occupational Exposure to Refined Petroleum*, NIOSH Doc. No. 77-192.

Respirator Selection: NIOSH: *Up to 3500 mg/m^3:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa* (APF = 10) (any supplied-air respirator). *Up to 8750 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 17,500 mg/m^3:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 20,000 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Stoddard solvent must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Stoddard solvent is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Petroleum distillates, n.o.s. require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Refined Petroleum*, NIOSH Document No. 77-192. Washington, DC

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Stoddard Solvent* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Stoddard Solvent*. Trenton, NJ

Streptozotocin S:0620

Molecular Formula: $C_8H_{15}N_3O_7$

Synonyms: 2-Deoxy-2-([(methylnitrosoamino)carbonyl] amino)-D-glucopyranose; 2-Deoxy-2-(3-methyl-3-nitrosoureido)-a (and b)-D-glucopyranose; 2-Deoxy-2-(3-methyl-3-nitrosoureido)-D-glucopyranose; D-Glucose, 2-deoxy-2-([(methylnitrosoamino)carbonyl]amino)-; *N*-D-Glucosyl

(2)-*N*′-nitrosomethylharstoff (German); *N*-D-Glucosyl-(2)-*N*′-nitrosomethylurea; NCI-C03167; NSC 85598; NSC-85998; STR; Streptozoticin; STRZ; STZ; U-9889; Zanosar

CAS Registry Number: 18883-66-4

RTECS® Number: LX5775000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 242-646-8

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1978, 1999; NTP: Reasonably anticipated to be a human carcinogen.

US EPA Hazardous Waste Number (RCRA No.): U206.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin (male, female) 8/20/99.

Hazard Symbols: T; Risk phrases: R45; Safety phrases: S45; S53.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Streptozotocin is a crystalline substance. Molecular weight = 265.6; Freezing/Melting point = 115°C. Soluble in water.

Potential Exposure: Used as a medicine to treat cancer. Steptozotocin (STR), a water-soluble antibiotic, has been of interest as a potential antineoplastic agent. STR is used in research for studies on diabetes because of its specific toxic action on B-cells of the pancreas, including hyperglycemia. STR is produced by the soil microorganism *Streptomyces achromogenes*. It has also been synthesized by laboratory procedures. Occupational exposure to STR is believed to be limited to pharmaceutical and research workers.

Incompatibilities: Alkalis.

Permissible Exposure Limits in Air

No standards or TEEL available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Can damage the kidneys and pancreas; may damage the nervous system. These effects may be permanent. High exposure can damage the bone marrow causing anemia, reduced white blood cells, and reduced platelets, causing a tendency to bleeding. Symptoms of exposure include abdominal pain; nausea, vomiting; central nervous system depression; renal or hepatic toxicity; proximal tubular damage; hematological toxicity, consisting of anemia, leukopenia, or thrombocytopenia; diabetes mellitus with severe toxic peripheral neuropathy.

Long Term Exposure: This chemical is a probable human carcinogen. There is evidence of liver, kidney, and pancreatic cancer in humans. There is evidence that it is a teratogen in animals. Exposure can cause kidney damage and pancreas damage causing diabetes. May damage the nervous system. This chemical is closely related to pyriminyl, a rat poison.

Points of Attack: Nervous system, kidneys, pancreas, liver.

Medical Surveillance: Liver and kidney function tests. Test for blood sugar. Complete examination of the nervous system, including the autonomic nervous system.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Groups II or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 80

Strontium chromate S:0630

Molecular Formula: CrO_4Sr

Common Formula: $SrCrO_4$

Synonyms: Chromic acid, stontium salt (1:1); Chromic acid, strontium salt; C.I. Pigment yellow 32; Cromato de estronicio (Spanish); Deep lemon yellow; Strontium chromate; Strontium chromate(VI); Strontium chromate 12170; Strontium chromate A; Strontium chromate X-2396; Strontium yellow

CAS Registry Number: 7789-06-2; *(alt.)* 54322-60-0

RTECS® Number: BG3240000

UN/NA & ERG Number: UN3086/141

EC Number: 232-142-6 [*Annex I Index No.:* 024-009-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1990; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 10 lb (4.54 kg).

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Strontium chromate is a light yellow crystalline solid or powder. Molecular weight = 203.62. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Strontium chromate is used as a metal protective coating to prevent corrosion, in wash primers; and aluminum flake coatings; colorant in polyvinyl chloride resins and pyrotechnics.

Incompatibilities: Violent reaction with strong oxidizers, hydrazine. Incompatible with combustible, organic, or other readily oxidizable materials, such as paper, wood, sulfur, aluminum powder. Attacks plastics and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 0.005 mg[Cr]/m^3 TWA.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.0005 mg[Cr]/m^3 TWA, Suspected Human Carcinogen.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

No TEEL available.

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Arab Republic of Egypt: TWA 0.5 mg/m^3, 1993; Australia: TWA 0.5 mg/m^3, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.5 mg/m^3, 1993; Denmark: TWA 0.001 mg [Cr]/m^3, 1999; Finland: TWA 0.5 mg/m^3; carcinogen, 1999; France: VME 0.05 mg[Cr]/m^3, 1999; [skin], 1993; India: TWA 0.5 mg/m^3, 1993; Japan: 0.01 mg[Cr]/m^3, 1999; Norway: TWA 0.02 mg[CrO_3]/m^3, 1999; the Philippines: TWA 0.5 mg/m^3, 1993; Poland: TWA 0.5 mg/m^3, 1999; Sweden: NGV 0.02 mg/m^3, carcinogen, 1999; Switzerland: MAK-W 0.05 mg[Cr]/m^3, 1999; Thailand: TWA 1 mg/m^3, 1993; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.0005 mg[Cr]/m^3. The former USSR-UNEP/IRPTC joint project[43] set a MAC of 0.01 mg/m^3 in work-place air. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μg/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600,#7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: For the protection of freshwater aquatic life: *hexavalent chromium:* 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: *hexavalent chromium:* 18 μg/L as a 24-h average, never to exceed 1260 μg/L. To protect human health: *hexavalent chromium*; 50 μg/L according to EPA.[6] EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62]

Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set guidelines of 50 μg/L and 120 μg/L, respectively, for chromium in drinking water.[61]

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption or by colorimetry (diphenylcarbazide) or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μm filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Strontium chromate can affect you when breathed in. Strontium chromate is a carcinogen; handle with extreme caution. Contact may burn the skin and eyes. The vapor or dust may irritate the mouth, nose, and air passages.

Long Term Exposure: Repeated or prolonged exposure (at 20 mg/m^3) may damage the lungs, heart, liver, kidneys, and affect the nervous system. May affect the blood and brain, resulting in changes in white and red blood cells and neurovegetative disorders. Strontium chromate accumulates in the body with repeated exposure and effects can persist after exposure. Repeated or prolonged contact with skin may cause skin sensitization, dermatitis, or ulcers. Lungs may be affected or asthma may develop from repeated or prolonged exposure; and with some chromate exposures, nasal septim perforation has occurred. This substance is possibly carcinogenic to humans.

Points of Attack: Kidneys, liver, nervous system, heart, lungs.

Medical Surveillance: NIOSH lists the following tests: blood gas analysis, complete blood count; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: tests for kidney and liver function. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and demulcents and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Strontium chromate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, oxidizing, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS, OXIDIZER." Strontium chloride falls in Hazard Class 6.1 and Packing Group I or II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete.

It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. Inhaling the hot fumes may cause cyanosis. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 74–76

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Strontium Chromate*. Trenton, NJ

Strontium nitrate S:0640

Molecular Formula: N_2O_6Sr

Common Formula: $Sr(NO_3)_2$

Synonyms: Nitrate de strontium (French); Nitric acid, strontium salt; Strontium(II) nitrate (1:2)

CAS Registry Number: 10042-76-9

RTECS® Number: WK98000000

UN/NA & ERG Number: UN1507/140

EC Number: 233-131-9

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As nitrate compounds (water dissociable)

EPCRA Section 313: Reportable only when in aqueous solution. Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), as nitrates, inorganic, n.o.s.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Strontium nitrate is a white crystalline solid. Molecular weight = 211.64; Boiling point = 645°C; Freezing/Melting point = 570°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Strontium nitrate is used in matches, pyrotechnics, marine signals, and railroad flares.

Incompatibilities: A strong oxidizer. Violent reaction with reducing agents, combustibles, organics, or other readily oxidizable materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3.5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 500 mg/m^3

Russia[43] set a MAC of 1.0 mg/m^3 in work-place air.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Strontium nitrate can affect you when breathed in. Contact may burn the skin and eyes. The vapor or dust can irritate eyes, mouth, nose, and air passages. Higher levels may cause a chemical pneumonia.

Long Term Exposure: Repeated exposure (at 50 mg/m^3) has caused damage to the lungs, heart muscle, liver, kidneys, and blood forming organs; and affects the nervous system in animals. Strontium nitrate accumulates in the body with repeated exposure and effects can persist after exposure stops.

Points of Attack: Liver, kidneys, nervous system, blood.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: tests for kidney and liver function. Examination of the nervous system. Complete blood count (CBC). If respiratory symptoms are present, lung function tests are recommended. Persons on low calcium diets may be at greater risk of absorbing more strontium nitrate.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 h in case chemical pneumonia or other respiratory symptoms are present.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to strontium nitrate, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Strontium nitrate must be stored to avoid contact with combustible, organic, or other readily oxidizable materials, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Strontium nitrate requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep strontium nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (March 2000). *Hazardous Substances Fact Sheet: Strontium Nitrate*. Trenton, NJ

Strychnine S:0650

Molecular Formula: $C_{21}H_{22}N_2O_2$; $C_{21}H_{22}N_2O_2 \cdot \frac{1}{2}H_2O_4S$ (sulfate)

Synonyms: Boomer-Rid; Certox; Dolco mouse cereal; Estricnina (Spanish); Gopher bait; Gopher-gitter; Hare-rid; Kwik-kil; Mole death; Mouse-nots; Mouse-rid; Mouse-tox; Nux vomica; Pied piper mouse seed; Ro-Dex; Sanaseed; Strychnidin-10-one; Strychnin (German); Strychnos

Strychnine, sulfate(2:1): Antivampire; Strychinium sulfate; Strychnidin-10-one, sulfate (2:1); Strychnine hemisulfate; Strychnine sulfate; Vampirol

CAS Registry Number: 57-24-9; 60-41-3 (sulfate)

RTECS® Number: WL2275000; WL2550000 (sulfate)

UN/NA & ERG Number: UN1692/151

EC Number: 200-319-7 [*Annex I Index No.:* 614-003-00-5]; 200-477-7 (strychnine sulfate)

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

US EPA, FIFRA 1998 Status of Pesticides: Canceled (sulfate).

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P108.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% *(Strychnine and salts).*

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations *(Strychnine and salts)*: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Strychnine is a colorless crystalline prisms or white powder. It is odorless; with a bitter taste. Molecular weight = 333.45; 383.49 (sulfate); Specific gravity (H_2O:1) = 1.36 at 25°C; Boiling point = (decomposes) 270°C at 5 mmHg; Freezing/Melting point = 267.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.02%.

Potential Exposure: Compound Description: Agricultural Chemical; Drug; Reproductive Effector; Human Data; Natural Product; (sulfate). Agricultural Chemical; Drug; Human Data. Strychnine is an alkaloid compound that has been widely used as a rodenticide/bait to kill rodents; a medicine, respiratory stimulant. Those involved in the extraction of the seeds of *Strychnos nux-vomica*, *Strychnos ignatii* (S. sancta Ingnatius), and *Strychnos tiente* (Upas tree); formulation or application of this rodent poison. The sulfate is used to kill gophers and moles. A common adulterant in illicit street drugs. Listed as a potential WMD biotoxin.[NIOSH]

Incompatibilities: Strong oxidizers. Dangerous when heated; forms toxic fumes, including nitrogen oxides. In the body, caffeine may increase the strychnine effect.

Permissible Exposure Limits in Air

OSHA PEL: 0.15 mg/m^3 TWA.

NIOSH REL: 0.15 mg/m^3 TWA.

ACGIH TLV®[1]: 0.15 mg/m^3 TWA.

NIOSH IDLH: 3 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.15 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 3 mg/m^3

PAC-3: 3 mg/m^3

Australia: TWA 0.15 mg/m^3, 1993; Austria: MAK 0.15 mg/m^3, 1999; Belgium: TWA 0.15 mg/m^3, 1993; Belgium: TWA 0.15 mg/m^3, 1999; Finland: TWA 0.15 mg/m^3; STEL 0.45 mg/m^3, 1999; France: VME 0.15 mg/m^3, 1999; the Netherlands: MAC-TGG 0.15 mg/m^3, 2003; the Philippines: TWA 0.15 mg/m^3, 1993; Poland: MAC (TWA) 0.15 mg/m^3, 1999; Switzerland: MAK-W 0.15 mg/m^3, KZG-W 0.3 mg/m^3, 1999; Turkey: TWA 0.15 mg/m^3, 1993; United Kingdom: TWA 0.15 mg/m^3; STEL 0.45 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.15 mg/m^3. Several states have set guidelines or standards for strychnine in ambient air[60] ranging from 1.5 μg/m^3 (North Dakota) to 2.5 μg/m^3 (Virginia) to 3.0 μg/m^3 (Connecticut) to 4.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5016.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.68.

Routes of Entry: Inhalation of dust, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Affects the central nervous system, causing convulsions, muscle contractions, and respiratory failure. Super toxic; probable oral lethal dose in humans is less than 5 mg/kg, a taste (less than 7 drops) for a 70-kg (150 lb) person. It causes violent generalized convulsions. Death results from respiratory arrest as the respiratory muscles are in sustained spasm. The lowest lethal oral dose reported for humans if 30 mg/kg. Respiratory paralysis and arrest are likely to occur following severe exposure to strychnine. Signs and symptoms of acute exposure generally involve excitation of all portions of the central nervous system. Convulsions, bilateral horizontal nystagmus (rapid, synchronous, horizontal, oscillations of the eyeballs), agitation, restlessness, apprehension, and abrupt jerking movements of the extremities may occur. Victims may also experience stiffness, painful muscle cramping (especially in the legs), and opisthotonos (spasm in which the spine and extremities are bent with convexity forward, the body resting on the head and heels). Vomiting and renal failure, as well as cyanosis (blue tint to skin and mucous membranes) and rhabdomyolysis (destruction of skeletal muscle), may be found.

Long Term Exposure: Chronic allergen if inhaled or ingested.

Points of Attack: Central nervous system.

Medical Surveillance: Be aware of possible convulsions. Consider the points of attack in preplacement and periodic physical examinations. Examination by a qualified allergist.

First Aid: Remove victims from exposure. Emergency personnel should avoid self-exposure to strychnine. Warning—Any unnecessary sensory input may induce seizures. Isolate the victims from any avoidable distractions. Rush to a healthcare facility! Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Remove contaminated clothing as soon as possible. If eye exposure has occurred, remove any contact lenses at once; eyes must be flushed with lukewarm water for at least 15 min. Wash exposed skin areas thoroughly with soap and water. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.75 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1.5 mg/m^3:* 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 3 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust and mist filter) or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and heat. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Strychnine or strychnine salts requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Avoid breathing dusts, and fumes from burning materials. Keep upwind. Avoid bodily contact with the material. *Do Not* handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire; material itself does not burn or burns with difficulty. Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide, or dry chemical. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Careful incineration has been recommended for disposal. Two procedures are suggested.[1] Pour or sift onto a thick layer of sand and soda ash mixture (90:10). Mix and shovel into a heavy paper box with much paper packing. Burn in incinerator. Fire may be augmented by adding excelsior and scrap wood. Stay on the upwind side.[2] Waste may be dissolved in flammable solvent (alcohols, benzene, etc.) and sprayed into fire box of an incinerator with afterburner and scrubber.[22]

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 63−65 (1982) and 8, No. 1, 78−83 (1988)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Strychnine*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Strychnine Sulfate*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Styrene S:0660

Molecular Formula: C_8H_8

Common Formula: $C_6H_5CH{=}CH_2$

Synonyms: Annamene; Benzene, ethenyl-; Benzene, vinyl-; Cinnamene; Cinnamenol; Cinnamol; Diarex HF 77; Estireno (Spanish); Ethylbenzene; Ethylene, phenyl-; NCI-C02200; Phenethylene; Phenylethene; Phenylethylene; Styrene monomer; Styrene monomer, inhibited; Styrol (German); Styrole; Styrolene; Styron; Styropol; Styropol SO; Styropor; Vinylbenzene; Vinylbenzol

CAS Registry Number: 100-42-5; *(alt.)* 79637-11-9

RTECS® Number: WL3675000

UN/NA & ERG Number: UN2055/128

EC Number: 202-851-5 [*Annex I Index No.*: 601-026-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); inadequate studies: mouse, rat; IARC: Human Limited Evidence, animal Sufficient Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 2002.

Note: Do not confuse with *Styrene polymer* (CAS: 9003-53-6; RTECS: WL6475000): IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: *In vivo* cytogenetics—human lymphocyte; Host-mediated assay; Positive: *In vitro* human lymphocyte micronucleus; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive/limited: Carcinogenicity—mouse/rat; Negative: Cell transform.—SA7/SHE; *In vitro* UDS—human fibroblast; Negative: V79 cell culture-gene mutation; Inconclusive: *S. pombe*—forward mutation.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL µg/L): 8020 (1); 8240 (5).

Safe Drinking Water Act: MCL, 0.1 mg/L; MCLG, 0.1 mg/L.

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R10; R20; R36/38; Safety phrases: S2; S23.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Styrene is a colorless to yellowish, very refractive, oily liquid with a penetrating odor. The odor threshold = 0.02−0.47 ppm. Molecular weight = 104.16; Specific gravity (H_2O:1) = 0.91 at 25°C; Boiling point = 145°C; Freezing/Melting point = −30.6°C; Vapor pressure = 5 mmHg; Flash point = 31°C; Autoignition temperature = 490°C. Explosive limits: LEL = 0.9%; UEL = 6.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Practically insoluble in water; solubility = 0.03%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Styrene is used in the production of plastics and polystyrene resins. It is also used in combination with 1,3-butadiene or acrylonitrile to form copolymer elastomers, butadiene-styrene rubber, and acrylonitrile-butadiene-styrene (ABS). It is also used in the manufacture of protective coatings; resins, polyesters; in making insulators and in drug manufacture.

Incompatibilities: Styrene forms explosive mixture with air. A storage hazard above 31°C. Upon heating to 200°C, styrene polymerizes to form polystyrene, a plastic. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry area away from oxidizers, catalysts for vinyl polymers, peroxides, strong acids, aluminum chloride. May polymerize if contaminated, subjected to heat; under the influence of light; and on contact with many compounds, such as oxygen, oxidizing agents, peroxides, and strong acids. Usually contains an inhibitor, such as *tert*-butylcatechol. Corrodes copper and copper alloys. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.26 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 600 ppm [5 min max peak in any 3 h].

NIOSH REL: 50 ppm/215 mg/m^3 TWA; 100 ppm/425 mg/m^3 STEL.

ACGIH TLV®[1]: 20 ppm/85 mg/m^3 TWA; 40 ppm/170 mg/m^3 STEL, not classifiable as a human carcinogen. BEI: 800 mg[mendelic acid]/g creatinine in urine/end-of-shift; 300 mg[mendelic acid]/g creatinine in urine, prior to next shift; 240 mg[phenylglyoxylic acid]/g creatinine in urine/end-of-shift; 100 mg[phenylglyoxylic acid]/g creatinine in urine, prior to next shift; 0.55 mg[styrene]/L in blood/end-of-shift; 0.02 mg[styrene]/L in blood, prior to next shift.

Protective Action Criteria (PAC)*
TEEL-0: 20 ppm
PAC-1: **20** ppm
PAC-2: **130** ppm
PAC-3: **1100** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 20 ppm/86 mg/m^3 TWA; Peak Limitation Category II(2); Carcinogen Category 5; Pregnancy Risk Category C; BAT: 600 mg[mendelic acid plus phenylglyoxylic acid]/g creatinine in urine/end-of-shift; for long term exposures: after several shifts.

NIOSH IDLH: 700 ppm.

Australia: TWA 50 ppm (215 mg/m^3); STEL 100 ppm, 1993; Austria: MAK 20 ppm (85 mg/m^3), 1999; Denmark: TWA 25 ppm (105 mg/m^3), [skin], 1999; Finland: TWA 20 ppm (85 mg/m^3); STEL 100 ppm (420 mg/m^3), 1999; France: VME 50 ppm (215 mg/m^3), 1999; Hungary: STEL 50 mg/m^3, carcinogen, 1993; Japan: 50 ppm (210 mg/m^3), 2B carcinogen, 1999; the Netherlands: MAC-TGG 107 mg/m^3, 2003; Norway: TWA 25 ppm (105 mg/m^3), 1999; the Philippines: TWA 100 ppm (420 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3; MAC (STEL) 200 mg/m^3, 1999; Sweden: NGV 20 ppm (90 mg/m^3), KTV 50 ppm (200 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (215 mg/m^3), KZG-W 100 ppm (430 mg/m^3), 1999; Thailand: TWA 100 ppm; STEL 200 ppm, 1993; Turkey: TWA 100 ppm (420 mg/m^3), 1993; United Kingdom: TWA 100 ppm (430 mg/m^3); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 40 ppm. Also, values for styrene in ambient air in residential areas vary. The Czech Republic[35] has set 0.015 mg/m^3, both on a momentary and a daily average basis. Russia has set 0.003 mg/m^3 both on a daily average and momentary basis[43] but values are also given[35] as 0.04 mg/m^3 on a once-daily basis and 0.002 mg/m^3 on a daily average basis. Several states have set guidelines or standards for styrene in ambient air[60] ranging from zero (North Carolina) to 3.45 μg/m^3 (Indiana) to 30.0 μg/m^3 (Rhode Island) to 34.48 μg/m^3 (Kansas) to 39.0 μg/m^3 (Massachusetts) to 716.0 μg/m^3 (New York) to 2150.0−4250.0 μg/m^3 (North Dakota) to 3600.0 μg/m^3 (Virginia) to 4300.0 μg/m^3 (Connecticut) to 5119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1501, Aromatic hydrocarbons; #3800. OSHA Analytical Method 9 or 89.

Permissible Concentration in Water: A lifetime health advisory of 140 μg/L has been determined by EPA.[48] Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes. This same limit applies to water bodies used for fishery purposes. Several states have set guidelines for styrene in drinking water[61] ranging from 10.0 μg/L (Wisconsin) to 140 μg/L (Arizona and Minnesota) to 270 μg/L Maine.

Determination in Water: Styrene may be determined by a purge-and-trap gas chromatographic procedure.[48] Octanol−water coefficient: Log $K_{\mathrm{ow}} = 3.2$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Irritates the eyes, skin, and respiratory tract. *Inhalation:* At or above 100 ppm, styrene causes immediate eye and nose irritation; persistent metallic taste; headache, fatigue, slight muscular weakness; loss of appetite; drowsiness, feelings of drunkenness, decreased coordination; depression, unconsciousness; inflammation of the lung, kidney and liver damage, and death. *Skin:* Can cause drying, cracking, itching, burning, and sores. Absorption is moderate and can cause symptoms described above. *Eyes:* Can cause severe itching, tearing, and injury to the surface of the eye. *Ingestion:* Symptoms are same as inhalation. Additional symptoms may include severe irritation of the mouth, throat, and stomach. Swallowing the liquid may cause chemical pneumonitis.

Long Term Exposure: Repeated exposure to low levels can cause concentration problems, memory problems, learning disability, slowed reflexes; reduced coordination and manual dexterity; and trouble with balance; nausea, headache, fatigue, and a feeling of drunkenness. Continued exposures to levels near 400 ppm can cause eye and throat irritation, and slight impairment of coordination and balance. At higher air concentrations, nasal, eye, throat, and skin irritation becomes pronounced. Prolonged inhalation of vapors may cause respiratory tract obstruction. Very high levels may affect brain function and cause liver damage and death. Cases of liver damage have been found in workers employed for over 5 years in polystyrene plants and exposed to a concentration of 20−150 ppm. Styrene has been found to produce lung tumors in mice and cause changes in the genetic material of laboratory organisms. Whether it does so in humans is not known.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, reproductive system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-workweek; whole blood (chemical/metabolite), prior to next shift; whole blood (chemical/metabolite), Prior to Shift, expired air, Expired Air, During Exposure. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: EEG (brain wave study).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Safety equipment manufacturers and styrene manufacturers recommend Teflon™, Viton™/chlorobutyl rubber, chlorinated polyethylene, and polyvinyl alcohol as the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Before entering a confined space where styrene monomer is present, check the oxygen level (at least 19% must be present) and that explosive concentration does not exist.

Respirator Selection: NIOSH: *500 ppm:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)] or SA* (any supplied-air respirator). *700 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. A storage hazard above 31°C. Before entering a confined space where styrene monomer is present, check the oxygen level (at least 19% must be present) and that explosive concentration does not exist. Styrene monomer must be stored to avoid contact with oxidizing agents; and catalysts for vinyl polymerization, such as peroxides, strong acids (such as hydrochloric, sulfuric, and nitric); and aluminum chlorides, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where styrene monomer is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of styrene monomer should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of styrene monomer. Wherever styrene monomer is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Styrene monomer will corrode copper and copper alloys and dissolve rubber. Styrene monomer must be stored with an inhibitor to prevent explosive reactions. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Styrene monomer, inhibited, requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including styrene oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In some cases, recovery and recycle of styrene monomer is economic and the technology is available.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 92−95 (1981), 2, No. 6, 60−64 (1982), 6, No. 2, 110−115 (1986), 8, No. 3, 10−44 (1988)

New York State Department of Health. (June 1984). *Chemical Fact Sheet: Styrene* (Version 3). Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2006). *Hazardous Substances Fact Sheet: Styrene Monomer*. Trenton, NJ

Styrene oxide S:0670

Molecular Formula: C_8H_8O

Synonyms: Benzene, (epoxyethyl)-; Epoxyethylbenzene; (Epoxyethyl)benzene; 1,2-Epoxyethylbenzene; Epoxystyrene; α,β-Epoxystyrene; Ethane, 1,2-epoxy-1-phenyl-; Oxido de estireno (Spanish); Oxirane, phenyl-; Phenethylene oxide; 1-Phenyl-1,2-epoxyethane; Phenylethylene oxide; 2-Phenyloxirane; Phenyloxirane; Styrene epoxide; Styrene 7,8-oxide; Styryl oxide

CAS Registry Number: 96-09-3; *(alt.)* 62497-63-6

RTECS$^{®}$ Number: CZ9625000

UN/NA & ERG Number: UN3082/171

EC Number: 202-476-7 [*Annex I Index No.:* 603-084-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NTP: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence, 1997; Human, Inadequate Evidence, Group 2A, 1994.

US EPA Gene-Tox Program, Positive: Host-mediated assay; Positive: *In vitro* human lymphocyte micronucleus; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *In vitro* UDS—human fibroblast; Positive: V79 cell culture-gene mutation; Positive: *S. cerevisiae* gene conversion; Weakly Positive: *S. pombe*—forward mutation; Positive/dose response: TRP reversion; Positive/limited: Carcinogenicity—mouse/rat; Negative: Rodent dominant lethal; Inconclusive: Mammalian micronucleus.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 10/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R21; R36; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Styrene oxide is a colorless to pale straw-colored liquid with a pleasant, sweet odor. Molecular weight = 120.16; Specific gravity (H_2O:1) = 1.02 at 25°C; Boiling point = 194°C; Freezing/Melting point = −36.6°C; Flash point = 76°C; Autoignition temperature = 498°C. Explosive limits: LEL = 1%; UEL = 22%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Styrene oxide is used as a reactive intermediate, especially to produce styrene glycol and its derivatives. Substantial amounts are also used in the epoxy resin industry as a diluent. It may also have applications in the preparation of agricultural and biological chemicals, cosmetics, and surface coatings and in the treatment of textiles and fibers. Styrene oxide is made in quantities in excess of a million pounds per year, and further, is a presumed metabolite of styrene which is produced in much greater quantities.

Incompatibilities: Forms an explosive mixture with air. May polymerize on heating above 200°C, under the influence of strong acids, strong bases, oxidizers, metal salts, such as aluminum chloride, catalysts for vinyl polymers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 4 ppm

PAC-1: 12.5 ppm

PAC-2: 50 ppm

PAC-3: 50 ppm

Austria: carcinogen, 1999; France: carcinogen, 1993.

Determination in Air: NIOSH Analytical Method (IV) #1501, aromatic Hydrocarbons.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Toxic by ingestion, inhalation, and skin absorption. May be corrosive. Irritates the skin, eyes, and mucous membranes. If inhaled, causes irritation to mucosal surfaces; may cause headache, fatigue, weakness, nausea, vomiting, diarrhea, central nervous system depression; unsteadiness or feeling of drunkenness; peripheral and hepatic neuropathies. May cause you to pass out.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and skin allergy, with drying and cracking. May cause liver damage. Probable carcinogen in humans; has been shown to cause stomach and liver cancer in animals. May cause decreased fertility in females.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist. Drinking alcohol may increase the liver damage caused by styrene oxide.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is recommended by some safety equipment manufacturers. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH as styrene monomer: *500 ppm:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)] or SA* (any supplied-air respirator). *700 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry place. A fireproof area separated from strong acids is recommended.[57] Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substance, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60−70% ethanol, then with soap and with 60−70% ethanol. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including styrene oxide, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (March 9, 1978). *Chemical Hazard Information Profile: Styrene Oxide*. Washington, DC

New Jersey Department of Health and Senior Services. (December 1999). *Hazardous Substances Fact Sheet: Styrene Oxide*. Trenton, NJ

Subtilisins S:0680

Molecular Formula: None listed.

Synonyms: Alcalase®; Alk®; Bacillus subtilis; Bacillus subtilis BPN; Bacillus subtilis Carlsburg; BPN; Fungosin; Maxatase®; Protease 150®; Proteolytic enzymes; Subtilisin BPN; Subtilisin Carlsburg

CAS Registry Number: 9014-01-1 (Subtilisin); 1395-21-7 (BPN)

RTECS® Number: CO9450000 (BPN); CO9550000 (Carlsburg)

EC Number: 232-752-2 [*Annex I Index No.:* 647-012-00-8] (subtilisin)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (BPN).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R37/38; R41; R42; Safety phrases: S2; S22; S24; S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: These are proteolytic enzymes which take the form of light-colored, free-flowing powders. A protein containing numerous amino acids. Molecular weight = 28,000 (approx.).

Potential Exposure: Compound Description (BPN): Drug, Natural Product; Primary Irritant; (Carlsburg). Primary Irritant. These commercial proteolytic enzymes are used in laundry detergent formulations.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 0.00006 mg/m^3 [60-min] STEL.

ACGIH TLV®[1] (*as crystalline active enzyme*): 0.00006 mg/m^3 Ceiling Concentration.

No TEEL available.

DFG MAK: Danger of airway sensitization.

(*BPN*) Australia: TWA 0.00006 mg/m^3, 1993; Denmark: TWA 0.00006 mg/m^3, 1999; Norway: TWA 0.00006 mg/m^3, 1999; Switzerland: MAK-W 0.00006 mg/m^3, 1999; United Kingdom: LTEL 0.00006 mg/m^3; STEL 0.00006 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.00006 mg/m^3.

(*Carlsburg*) Sweden: TWA 1 glycine unit/m^3, ceiling 3 glycine units/m^3, 1999; United Kingdom: LTEL 0.00006 mg/m^3; STEL 0.00006 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.00006 mg/m^3. Several states have set guidelines or standards for subtilisins in ambient air[60] ranging from zero (North Dakota) to 0.1 μg/m^3 (Nevada) to 1000.0 μg/m^3 (Virginia).

Determination in Air: No method available.

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Short Term Exposure: Subtilisins can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure can cause runny nose, congestion, sore throat, sweating, headache, chest pain, flu-like symptoms, cough, breathlessness, wheezing. Prolonged exposure may lead to chronic lung damage.

Long Term Exposure: Subtilisins may cause respiratory sensitization and enzyme asthma. Future exposures can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Contact can irritate the skin, especially in sweaty areas. Prolonged exposure may lead to chronic lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.00006 mg/m³*, use a NIOSH/MSHA- or European Standard EN149-approved respirator with a high-efficiency particulate filter. More protection is provided by a full face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.

Where there is potential for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (March 2003). *Hazardous Substances Fact Sheet: Subtilisins*. Trenton, NJ

Sucrose S:0690

Molecular Formula: $C_{12}H_{22}O_{11}$

Synonyms: Beet sugar; Cane sugar; Confectioner's sugar; α-δ-Glucopyranosyl β-δ-fructofuranoside; (α-δ-Glucosido)-β-δ-fructofuranoside; Granulated sugar; NCI-C56597; Rock candy; Saccharose; Saccharum; Sugar

CAS Registry Number: 57-50-1

RTECS® Number: WN6500000

EC Number: 200-334-9

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Inconclusive: Mammalian micronucleus.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sucrose is a white crystalline solid; Molecular weight = 342.34; Specific gravity (H_2O:1) = 1.59 at 25°C; Boiling point = (decomposes); Freezing/Melting point = (decomposition) 160−186°C. Maximum Explosive concentration (MEC) = 45 g/m³. Hazard Identification (based on

NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Highly soluble in water; solubility = 200%.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data. Widely used as a sweetener for foods in households and industry; in pharmacy as a preservative; in the manufacture of ink.

Incompatibilities: Oxidizers, sulfuric acid, nitric acid. A noncombustible solid, but fine airborne dust may explode.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA total dust; 5 mg/m^3 respirable fraction TWA.

NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA respirable fraction.

ACGIH TLV®[1]: 10 mg/m^3 TWA; not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; France: VME 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3; STEL 20 mg/m^3, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. The state of Virginia has set 80.0 $\mu g/m^3$ as a guideline for sucrose in ambient air.

Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust, Method #0600 (respirable).

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Acute doses may cause irritation of the eyes, skin, and upper respiratory system; cough may develop.

Long Term Exposure: Chronic doses may cause obesity, peripheral vascular disease, possible exacerbation of diabetes mellitus, hypoinsulinemia, hyperlipemia, and dental cavities.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: Blood sugar.

First Aid: *Skin Contact:* Use soap and water to clean.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline. Seek medical attention if irritation or other symptoms develop.

Inhalation: Inhalation of powdered sucrose can cause coughing and irritation of the lungs. Leave the contaminated area and breathe fresh air. If persistent coughing or other symptoms develop, seek medical attention.

Ingestion: Ingestion of sucrose in moderate amounts poses no acute toxic problems unless the person is a diabetic.

Personal Protective Methods: Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Dust mask.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, potassium hydroxide.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water, then transfer material to a suitable container. Wash surfaces with soap and water. Use absorbent dampened with water to pick up remaining material. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, but airborne particles may explode. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Sulfallate S:0700

Molecular Formula: $C_8H_{14}ClNS_2$

Synonyms: CDEC; Chlorallyl diethyldithiocarbamate; 2-Chlorallyl diethyldithiocarbamate; 2-Chlorallyl-*N,N*-diethyldithiocarbamate; 2-Chloroallyl-*N,N*-diethyldithiocarbamate; 2-Chloro-2-propene-1-thiol diethyldithiocarbamate; 2-Chloro-2-propenyl-diethylcarbamodithioate; CP 4572; Diethylcarbamodithioic acid 2-chloro-2-propenyl ester; Diethyldithiocarbamic acid-2-chloroallyl ester; NCI-COO453; Thioallate; Vegadex; Vegadex super

CAS Registry Number: 95-06-7

RTECS® Number: EZ5075000

UN/NA & ERG Number: UN2992 (Carbamate pesticides, liquid, toxic)/151

EC Number: 202-388-9 [*Annex I Index No.:* 006-038-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1983; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (feed); clear evidence: rat, mouse, 1978; NTP: Report on Carcinogens, 2004.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R50/53; Safety phrases: S53; S45; S60; S61.

California Proposition 65 Chemical: Cancer 1/1/88.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sulfallate is an amber liquid. Molecular weight = 223.80; Boiling point = 128−130°C under 1.0 mm pressure; Flash point = 88°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: The major use for sulfallate in the United States is as a preemergent selective herbicide to control certain annual grasses and broadleaf weeds around vegetable and fruit crops. Sulfallate has also been used for weed control among shrubbery and ornamental plants. Some dithiocarbamates have been used as rubber components.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

DFG MAK: Danger of skin sensitization (dithiocarbamates used as rubber components).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. May be absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. High exposure may cause fatigue, sleepiness, headache, dizziness, upset stomach; severe rash and personality changes, muscle weakness, and collapse may result. LD_{50} = (oral-rat) 850 mg/kg (slightly toxic).

Long Term Exposure: Repeated or prolonged skin contact may cause rash from irritation. A probable carcinogen in humans. Repeated exposure may cause kidney damage. Sulfallate, a chlorinated dithiocarbamate, administered in the feed, was carcinogenic to Osborne-Mendel rats and to B6C3F1 mice, inducing mammary gland tumors in females of both species, tumors of the fore stomach in male rats, and lung tumors in male mice. May be a cholinesterase inhibitor.

Points of Attack: Skin, eyes, kidneys, plasma and red blood cell cholinesterase. Cancer site in animals: stomach, lungs.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.[52]

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry regulated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Carbamate pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." Sulfallate falls in Hazard Class 6.1 and Packing Group II or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, sulfur oxides, and chlorine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be decomposed by strong oxidizing agent. Large amounts should be incinerated in a unit with effluent gas scrubbing.[22]

References

New Jersey Department of Health and Senior Services. (October 2001). *Hazardous Substances Fact Sheet: Sulfallate*. Trenton, NJ

Sulfolane S:0710

Molecular Formula: $C_4H_8O_2S$

Common Formula: $C_4H_8SO_2$

Synonyms: Bondelane A; Bondolane A; Cyclic tetramethylene sulfone; Cyclotetramethylene; Dihydrobutadiene sulphone; 1,1-Dioxidetetrahydrothiofuran; 1,1-Dioxidetetrahydrothiophene; Dioxothiolan; 1,1-Dioxothiolan; Sulfalone; Sulfolan; Sulpholane; Sulphoxaline; Tetrahydrothiofen-1,1-dioxid; Tetrahydrothiophene dioxide; Tetrahydrothiophene 1,1-dioxide; 2,3,4,5-Tetrahydrothiophene-1,1-dioxide; Tetramethylene sulfone; Thiacyclopentane dioxide; Thiocyclopentane-1,1-dioxide; Thiolane-1,1-dioxide; Thiophane dioxide; Thiophan sulfone

CAS Registry Number: 126-33-0

RTECS® Number: XN0700000

EC Number: 204-783-1 [*Annex I Index No.:* 016-031-00-8]

Regulatory Authority and Advisory Bodies

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; Safety phrases: S2; S25 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sulfolane is a colorless oily liquid. Molecular weight = 120.18; Boiling point = 285°C; Freezing/Melting point = 27°C; Flash point = 176°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Primary Irritant. Sulfolane is used primarily as a process solvent for extraction of aromatics and for purification of acid gases. Used as a curing agent for epoxy resins; in medicine as an antibacterial; in fractionation of wood tars, tall oil, and other fatty acids; a component of hydraulic fluid; in textile finishing.

Incompatibilities: Strong oxidizers. Contact with nitronium tetrafluoroborate(1-) is potentially explosive.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 125 mg/m^3

PAC-1: 200 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 200 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritating to the eyes. Lethality data indicate that sulfolane is not highly acutely toxic. Oral LD_{50} values in the rat range from 1846 to 2500 mg/kg. Symptoms of neurotoxicity have been observed in rats, dogs, and monkeys; after ingestion, injection, inhalation, or dermal application of sulfolane. These effects include convulsions, hyperactivity, tremors, and ataxia. Other effects of acute exposure to sulfolane include alterations in stomach, intestines, lungs, and liver following ingestion; and lung and liver inflammation following inhalation.

Long Term Exposure: Sulfolane is neither a dermal sensitizer nor an irritant in the guinea pig, but it does cause eye injuries in rabbits. Subchronic inhalation exposure to sulfolane has resulted in leukopenia in rats and monkeys. No information was found on the carcinogenicity or teratogenicity of sulfolane. The compound was not mutagenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including sulfur oxides, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (June 21, 1984). *Chemical Hazard Information Profile: Sulfolane*. Washington, DC: Office of Toxic Substances

Sulfotep S:0720

Molecular Formula: $C_8H_{20}O_5P_2S_2$

Synonyms: ASP 47; Bay E-393; Bayer-E-393; bis-*O*,*O*-Diethylphosphorothionic anhydride; Bladafum; Bladafume; Bladafun; Dithio; Dithiodiphosphoric acid, tetraethyl ester; Dithiofos; Dithion; Dithione; Dithiophos; Di(thiophosphoric) acid, tetraethyl ester; Dithiopyrophosphate de tetraethyle (French); Dithiotep; E393; ENT 16,273; Ethyl thiopyrophosphate; Lethalaire G-57; Pirofos; Plant dithio aerosol; Plantfume 103 smoke generator; Pyrophosphorodithioic acid, tetraethyl ester; Pyrophosphorodithioic acid, *O*,*O*,*O*,*O*-tetraethyl ester; Sulfatep; TEDP; TEDTP; Tetraethyldithiopyrophosphate; *O*,*O*,*O*,*O*-Tetraethyldithiopyrophosphate; Tetraethyl dithiopyrophosphate; Thiotepp

CAS Registry Number: 3689-24-5

RTECS® Number: XN4375000

UN/NA & ERG Number: UN1704/153

EC Number: 222-995-2 [*Annex I Index No.:* 015-027-00-3]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Banned or Severely Restricted (former USSR) (UN).[13]

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): P109.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S23; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sulfotep is a yellow mobile liquid with a garlic-like odor. Molecular weight = 322.34; Specific gravity (H_2O:1) = 1.20 at 25°C; Boiling point = (decomposes) 131−135°C at 2 mmHg; Vapor pressure = 0.0002 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 1. Practically insoluble in water; solubility = 0.0007%. A pesticide that may be absorbed on a solid carrier or mixed in a more flammable liquid which will change the physical properties listed here.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen. Sulfotep is used in greenhouse fumigant formulations for control of aphids, spider mites, thrips, whiteflies, etc.

Incompatibilities: Strong oxidizers. Hydrolyzes very slowly in aqueous solution. Attacks some forms of plastic, rubber, and coatings. Corrosive to iron.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 13.18 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.2 mg/m^3 TWA [skin].

NIOSH REL: 0.2 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.2 mg/m^3, measured as inhalable fraction and vapor TWA [skin] not classifiable as a human carcinogen.

NIOSH IDLH: 10 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.2 mg/m^3

PAC-1: 0.5 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 10 mg/m^3

DFG MAK: 0.0075 ppm/0.1 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C.

EEC OEL: 0.1 mg/m^3 [skin].

Australia: TWA 0.2 mg/m^3, [skin], 1993; Austria: MAK 0.015 ppm (0.2 mg/m^3), [skin], 1999; Belgium: TWA 0.2 mg/m^3, [skin], 1993; Denmark: TWA 0.015 ppm (0.2 mg/m^3), [skin], 1999; France: VME 0.2 mg/m^3, [skin], 1999; Norway: TWA 0.015 ppm (0.2 mg/m^3), 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Switzerland: MAK-W 0.015 ppm (0.2 mg/m^3), [skin], 1999; Turkey: TWA 0.2 mg/m^3, [skin], 1993; United Kingdom: TWA 0.2 mg/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Several states have set guidelines or standards for sulfotep in ambient air ranging from 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada) to 20.0 μg/m^3 (North Dakota).

Determination in Air: No test available.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.99.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. Can cause rapid, fatal poisoning. Contact may cause eye pain, blurred vision. May affect the nervous system. Symptoms of exposure include lacrimation (discharge of tears); rhinorrhea (discharge of thin nasal mucous); headache, cyanosis, anorexia, nausea, vomiting, diarrhea, localized sweating; weakness, twitching, paralysis, Cheyne-Stokes respiration; convulsions, low blood pressure; cardiac irregular/irregularities; respiratory failure and death. Super toxic; probable oral lethal dose in humans is less than 5 mg/kg, or a taste (less than 7 drops) for a 70-kg (150-lb) person. It is a cholinesterase inhibitor. Material is similar to parathion in symptomatology, including nausea followed by vomiting; abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, weakness, tightness in chest; blurring of vision; tearing, slurring of speech; confusion, troubled breathing; convulsions, coma, and even death.

Long Term Exposure: A cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: Blood serum; cholinesterase, red blood cells/count. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above test as soon as possible and get an examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep under medical observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *Up to 5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 10 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Tetraethyl dithiopyrophosphate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulfotep may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including oxides of phosphorus and sulfur and phosphoric acid mist, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office. Incineration with added flammable solvent in furnace equipped with afterburner and alkaline scrubber.[22]

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sulfotep*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Sulfotep*. Trenton, NJ

Sulfur S:0730

Molecular Formula: S

Synonyms: Brimstone

CAS Registry Number: 7704-34-9; *(alt.)* 12673-82-4; *(alt.)* 12767-24-7; *(alt.)* 56591-09-4; *(alt.)* 56645-30-8; *(alt.)* 57035-13-9; *(alt.)* 63705-05-5

RTECS® Number: WS4250000

UN/NA & ERG Number: UN1350 (solid)/133; UN2448 (molten)/155

EC Number: 231-722-6 [*Annex I Index No.*: 016-094-00-1]

Regulatory Authority and Advisory Bodies

FDA—over-the-counter and proprietary drug.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Hazard Symbol: Xi; Risk phrases: R38; Safety phrases: S2; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent (*metal*); 1—Slightly water polluting (*colloidal*).

Description: Sulfur is a yellow crystalline solid or powder. Often transported in the molten state. Molecular weight = 32.06; 256.5 (S_8); Boiling point = 445°C; Freezing/Melting point = 113−120°C (amorphous); 115°C (β-sulfur); 107°C (r-sulfur); Flash point = 207°C; 160°C (cc); Autoignition temperature = 232°C. Explosive limits: LEL = 35% (1400 g/m^3). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Human Data; Primary Irritant. Widely used in the manufacture of sulfuric acid, carbon bisulfide, drugs, fungicides, gunpowder, wood pulp, rubber, and other products.

Incompatibilities: Combustible solid. Liquid forms sulfur dioxide with air. Violent reaction with strong oxidizers, halogen compounds, phosphorus, sodium, tin, uranium, metal carbides, and other compounds. Forms explosive, shock-sensitive, or pyrophoric mixtures with ammonia, ammonium nitrate, bromates, calcium carbide, charcoal, chlorates, hydrocarbons, iodates, iron. Attacks steel when moist.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.25 mg/m^3
PAC-1: 4 mg/m^3
PAC-2: 30 mg/m^3
PAC-3: 150 mg/m^3

Russia set a MAC of 6.0 mg/m^3 for work-place air of elemental sulfur.

Determination in Air: Filter; Acid; Inductively coupled plasma; NIOSH Analytical Method (IV) #7300, Elements.

Permissible Concentration in Water: Mexico[35] set a MAC of 0.5 mg/L of sulfides in estuaries.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sulfur can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure can cause inflammation of the nose and irritate the lungs.

Long Term Exposure: Repeated exposures may cause chronic bronchitis to develop with cough, phlegm, and/or shortness of breath. Contact can irritate the skin and may cause skin allergy. Repeated exposure to sulfur dust may cause permanent eye damage (clouding of the eye lens and chronic irritation).

Points of Attack: Skin, respiratory tract.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Eye examination. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to sulfur, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store solid sulfur in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); chemically active metals (such as potassium, sodium, lithium, and zinc); charcoal, phosphorus, metal nitrates (such as potassium nitrate), and metal halogenates (such as zinc bromate). Molten sulfur must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), chemically active metals (such as potassium, sodium, lithium, and zinc), and metal carbides (such as calcium carbide), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where sulfur is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Sulfur requires a shipping label of "CLASS 9" (Domestic) or "FLAMMABLE SOLID" (International). It falls in Hazard Class 9 (Domestic) or 4.1 (International) and Packing Group III. Sulfur, molten, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulfur is a combustible solid. Use dry chemical, water spray, or foam extinguishers. Fire may restart after it has been extinguished. Dust or vapor (from molten sulfur) forms explosive mixtures with air. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Salvage for reprocessing or dump to landfill.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 65−68. New York: Van Nostrand Reinhold Co.

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Sulfur*. Trenton, NJ

Sulfur chloride S:0740

Molecular Formula: Cl_2S_2

Common Formula: S_2Cl_2

Synonyms: Chloride of sulfur; Cloruro de azufre (Spanish); Chlorosulfane; Disulfur dichloride; Monocloruro de azufe (Spanish); Sulfur monochloride (di-); Sulfur subchloride; Sulphur chloride (di-); Thiosulfurous dichloride

CAS Registry Number: 10025-67-9

RTECS$^{®}$ Number: WS4300000

UN/NA & ERG Number: UN1828/137

EC Number: 233-036-2 [*Annex I Index No.:* 016-012-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R20; R25; R29; R35; R50; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sulfur chloride is a fuming, oily liquid with a yellowish-red to amber color and a suffocating odor. It has an added hazard since it oxidizes and hydrolyzes to sulfur dioxide and hydrogen chloride. Molecular weight = 135.02; Specific gravity (H_2O:1) = 1.68 at 25°C; Boiling point = 137.8°C; Freezing/Melting point = −77.2°C; Flash point = 118°C (cc).[17] Autoignition temperature = 234°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1₩. Reacts with water (decomposes).

Potential Exposure: Compound Description: Human Data. Sulfur chloride finds use as a chlorinating agent, catalyst, and as an intermediate in the manufacture of organic chemicals, carbon tetrachloride, sulfur dyes, insecticides, synthetic rubber, and pharmaceuticals. Exposure may also occur during the extraction of gold, purification of sugar juice, finishing and dyeing textiles, processing vegetable oils, hardening wood, and vulcanization of rubber. Sulfur chloride has been used as a military poison.

Incompatibilities: Decomposes violently in water, forming hydrochloric acid, sulfur dioxide, sulfur, sulfite, thiosulfate, and hydrogen sulfide. Reacts with oxidizers, strong bases, peroxides, phosphorus oxides, organics, antimony, antimony sulfide, arsenic sulfide, mercury oxide, tin, alkenes, terpenes, unsaturated glycerides, chromyl chloride, methyl sulfoxide, dimethylformamide, acetone, and other compounds, causing fire and explosion hazard. Corrosive to many metals in the presence of water. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor 1 ppm = 5.52 mg/m^3.

OSHA PEL: 1 ppm/6 mg/m^3 TWA.

NIOSH REL: 1 ppm/6 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 1 ppm/5.5 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 5 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.53 ppm

PAC-1: **0.53** ppm

PAC-2: **6.4** ppm

PAC-3: **15** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 1 ppm (6 mg/m^3), 1993; Austria: MAK 1 ppm (6 mg/m^3), 1999; Belgium: STEL 1 ppm (5.5 mg/m^3), 1993; Denmark: TWA 1 ppm (6 mg/m^3), 1999; Finland: TWA 1 ppm (6 mg/m^3); STEL 2 ppm (12 mg/m^3), [skin], 1999; Hungary: STEL 5 mg/m^3, 1993; Japan: 1 ppm (5.5 mg/m^3), 1999; the Netherlands: MAC 6 mg/m^3, 2003; Norway: TWA 1 ppm (6 mg/m^3), 1999; the Philippines: TWA 6 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 15 mg/m^3, 1999; Russia: STEL 1 ppm (0.3 mg/m^3), [skin], 1993; Switzerland: MAK-W 1 ppm (6 mg/m^3), KZG-W 2 ppm (12 mg/m^3), 1999; United Kingdom: STEL 1 ppm (5.6 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1 ppm.

Several states have set guidelines or standards for sulfur monochloride in ambient air[60] ranging from 50.0 μg/m^3 (Virginia) to 60.0 μg/m^3 (North Dakota) to 120.0 μg/m^3 (Connecticut) to 143.0 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Violent reaction.

Routes of Entry: Inhalation of vapor, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A lacrimator and corrosive. Fumes can cause severe irritation to eyes, skin, and mucous membranes of the upper respiratory tract. Contact can cause severe irritation, burns, and permanent eye damage. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposure can cause headache, nausea, and dizziness. Although this compound is capable of producing severe pulmonary irritation, few serious cases of industrial exposure have been reported. This may be due to the pronounced irritant effects of sulfur chloride which serve as an immediate warning signal when concentration of the gas approaches a hazardous level.

Long Term Exposure: May cause lung damage; bronchitis may develop. Repeated exposure can cause drying and cracking of the skin.

Points of Attack: Respiratory system, skin, eyes, lungs.

Medical Surveillance: Preemployment and periodic examinations should give special emphasis to the skin, eyes, and respiratory system. Pulmonary function tests may be useful. Lung function tests. Consider chest X-ray following acute overexposure. Exposures may also include sulfur dioxide and hydrochloric acid. See also these compounds.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Keep containers well closed and upright, away from heat. Do not allow water to get into container as this material reacts violently with water when in a closed vessel. Provisions should be made for washing down spills with large quantities of water. Vapor-tight electrical equipment is recommended to reduce corrosion. Separate from oxidizing materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Sulfur chloride requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid contact with liquid and vapor. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber over clothing (including gloves). Stop discharge if possible to do so without harm. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies. Remove all ignition sources. Ventilate area of spill or leak. The aqueous solution is a strong acid that can be neutralized with lime or soda ash. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day	0.1/0.2
Night	0.1/0.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.8/1.3

When spilled in Water
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.8/1.3

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen chloride, hydrogen sulfide, sulfur oxides, are produced in fire. *Do not use water*. Use chemical extinguishers. Decomposes on contact with water to produce heat and toxic and corrosive fumes. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Wearing protective equipment, spray carefully onto sodium ash/slaked lime mixture. Then spray with water, dilute, neutralize, and flush to drain.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 90−92

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: Sulfur Chloride*. Trenton, NJ

Sulfur dioxide S:0750

Molecular Formula: O_2S
Common Formula: SO_2

Synonyms: Bisulfite; Dioxido de azufe (Spanish); Fermenicide; Schwefelddioxyd (German); Sulfurous acid anhydride; Sulfurous anhydride; Sulfurous oxide; Sulphur dioxide; Sulphurous anhydride; Sulphurous oxide
CAS Registry Number: 7446-09-5; *(alt.)* 8014-94-6; *(alt.)* 12396-99-5; *(alt.)* 83008-56-4; *(alt.)* 89125-89-3
RTECS® Number: WS4550000
UN/NA & ERG Number: UN1079/125
EC Number: 231-195-2 [*Annex I Index No.:* 016-011-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration); *Theft hazard* 500 (≥84.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1992.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Toxic Chemical (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 5000 lb (2270 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23; R34; Safety phrases: S1/2; S9; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sulfur dioxide is a noncombustible colorless gas at ambient temperatures with a characteristic strong suffocating odor. The odor threshold is 1.1 ppm. Shipped as a liquefied compressed gas. Molecular weight = 64.06; Boiling point = −10°C; Freezing/Melting point = −75.6°C; Relative vapor density (air = 1) = 2.26. Vapor pressure = 3.2 atm. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 10%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Sulfur dioxide is used in the manufacture of sodium sulfite, sulfuric acid, sulfuryl chloride, thionyl chloride, organic sulfonates, disinfectants, fumigants, glass, wine, ice, industrial and edible protein, and vapor pressure thermometers. It is also used in the bleaching of beet sugar, flour, fruit, gelatin, glue, grain, oil, straw, textiles, wicker ware; wood pulp; wool; in the tanning of leather; in brewing and preserving; and in the refrigeration industry. Exposure may also occur in various other industrial processes as it is a by-product of ore smelting, coal and fuel oil combustion, paper manufacturing, and petroleum refining.

Incompatibilities: Reacts with water to form sulfurous acid, a medium strong acid. Reacts violently with ammonia, acrolein, acetylene, alkali metals, such as sodium, potassium, magnesium, and zinc, chlorine, ethylene oxide, amines, butadiene. Attacks many metals including aluminum, iron, steel, brass, copper, nickel, especially in the presence of water or steam. Incompatible with halogens. Attacks plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.62 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/13 mg/m^3.

NIOSH REL: 2 ppm/5 mg/m^3 TWA; 5 ppm/13 mg/m^3 STEL.

ACGIH TLV®[1]: 0.25 ppm/0.65 mg/m^3 STEL; not classifiable as a human carcinogen.

NIOSH IDLH: 100 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.2 ppm

PAC-1: 0.2 ppm

PAC-2: 0.75 ppm

PAC-3: 30 ppm

DFG MAK: 0.5 ppm/1.3 mg/m^3 TWA; Peak Limitation Category I(1); a momentary Ceiling Concentration value of 1 mL/m^3/2.7 mg/m^3 should not be exceeded; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 5 ppm (13 mg/m^3), 1993; Australia: TWA 2 ppm (5 mg/m^3); STEL 5 ppm, 1993; Austria: MAK 2 ppm (5 mg/m^3), 1999; Belgium: TWA 2 ppm (5.2 mg/m^3); STEL 5 ppm (13 mg/m^3), 1993; Denmark: TWA 2 ppm (5 mg/m^3), 1999; Finland: TWA 2 ppm (5 mg/m^3); STEL 5 ppm (13 mg/m^3), 1999; France: VME 2 ppm (5 mg/m^3), VLE 5 ppm (10 mg/m^3), 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Japan: 1999; Norway: TWA 2 ppm (5 mg/m^3), 1999; the Philippines: TWA 5 ppm (13 mg/m^3), 1993; Poland: MAC (TWA) 2 mg/m^3; MAC (STEL) 5 mg/m^3, 1999; Russia: STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (5 mg/m^3), TKV 5 ppm (13 mg/m^3), 1999; Switzerland: MAK-W 2 ppm (5 mg/m^3), KZG-W 4 ppm (10 mg/m^3), 1999; Thailand: TWA 5 ppm (13 mg/m^3), 1993; Turkey: TWA 5 ppm (13 mg/m^3), 1993; United Kingdom: TWA 2 ppm (5.3 mg/m^3); STEL 5 ppm (13 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV®: STEL 5 ppm. Russia[43] set a MAC of 0.5 mg/m^3 for ambient air in residential areas on a momentary basis and 0.05 mg/m^3 on a daily average basis. Several states have set guidelines or standards for sulfur dioxide in ambient air[60] ranging from 1.2 μg/m^3 (Tennessee) to 80.0−1300.0 μg/m^3 (Arizona) to 119.0 μg/m^3 (Nevada) to 1300.0 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #6004, Sulfur dioxide; OSHA Analytical Methods ID-200, ID-104 (for impinger).

Routes of Entry: Inhalation of gas, direct contact of gas or liquid phase on skin and mucous membranes.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Causes irritation of the eyes, nose, throat. Nose and throat irritation may occur at 6−12 ppm. Between 10 and 50 ppm for 5−15 min, runny nose (rhinorrhea), difficult breathing, coughing and choking, reflex bronchoconstriction may occur. Levels of 50−100 ppm may only be tolerated for 30−60 min, and 400 ppm and above may immediately cause swelling and accumulation of fluid in throat and lungs (pulmonary edema), breathing stoppage, pneumonia, and death. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Levels of 1% (10,000 ppm) may be irritating to moist skin. Liquid may cause frostbite and chemical burns. *Eyes:* Irritation may occur at 20 ppm and above. Liquid may cause frostbite, and permanent damage leading to blindness. *Ingestion:* Liquid may cause frostbite and chemical burns to mouth.

Long Term Exposure: Repeated or prolonged inhalation exposure may cause asthma. May cause chronic irritation of the eyes and respiratory tract; loss of the sense of smell; burning and dryness. Stomach problems may also occur. May cause permanent lung damage. Repeated exposure to 10 ppm may cause irritation to throat and lungs and an increased occurrence of nosebleeds. There is limited animal evidence that sulfur dioxide causes lung cancer in animals. There is limited evidence that sulfur dioxide may damage the developing fetus.

Note: Persons with asthma, subnormal pulmonary function, or cardiovascular disease are at greater risk. Sulfur dioxide may irritate the eyes and respiratory tract. Signs and symptoms of acute exposure to sulfur dioxide may be severe and include coughing, choking, dyspnea (shortness of breath), sneezing, wheezing, and chest discomfort. Upper airway edema (swelling) or obstruction, bronchoconstriction, pneumonia, pulmonary edema, and respiratory paralysis may occur. Fatigue may be noted. Gastrointestinal effects may include nausea, vomiting, and abdominal pain. Cyanosis (blue tint to skin and mucous membranes) may be noted following exposure to sulfur dioxide. It may cause death or permanent injury after very short exposure to small quantities. 1000 ppm causes death from 10 min to several hours by respiratory depression.

Points of Attack: Respiratory system, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. Preplacement and periodic medical examinations should be concerned especially with the skin, eyes, and respiratory tract. Lung function tests. Examination of the eyes, nose, and throat. Consider chest X-ray following acute overexposure. Pulmonary function should be evaluated, as well as smoking habits, and exposure to other pulmonary irritants.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern] or Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *100 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern] or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and cartridge(s) providing protection against the compound of concern] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Keep below 130°F/54°C, protect containers from damage. Outdoor, ventilated, fireproof storage preferred. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Sulfur dioxide requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3. Sulfurous acid (liquid SO_2) requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with

time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3

Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400

Then: Protect persons downwind (miles/kilometers)

Day 1.3/2.0

Night 3.6/5.7

Fire Extinguishing: Not flammable. Extinguish fires with dry chemical, carbon dioxide, water spry, fog, or foam. Wear self-contained breathing apparatus and full protective clothing. Move container from fire area. Stay away from ends of tanks. Cool containers that are exposed to flames with water from the side until well after the fire is out. Isolate area until gas has dispersed. Keep unnecessary people away. Containers may explode in heat of fire, or they may rupture and release irritating toxic sulfur dioxide. Sulfur dioxide has explosive properties when it comes in contact with sodium hydride; potassium chlorate at elevated temperatures; ethanol; ether; at very cool temperatures (−15°C); fluorine; chlorine trifluoride; and chlorates. It will react with water or steam to produce toxic and corrosive fumes. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pass into soda ash solution, then add calcium hypochlorite, neutralize, and flush to sewer with water (A-38).

References

National Institute for Occupational Safety and Health. (1974). *Criteria for a Recommended Standard: Occupational Exposure to Sulfur Dioxide*, NIOSH Document No. 74-111

World Health Organization. (1979). *Sulfur Oxides and Suspended Particulate Matter*, Environmental Health Criteria No. 8. Geneva, Switzerland

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 78−79

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sulfur Dioxide*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Sulfur Dioxide* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Sulfur Dioxide*. Trenton, NJ

Sulfur hexafluoride S:0760

Molecular Formula: F_6S

Common Formula: SF_6

Synonyms: Hexafluorure de soufre (French); Sulfur fluoride

CAS Registry Number: 2551-62-4

RTECS® Number: WS4900000

UN/NA & ERG Number: UN1080/126

EC Number: Not assigned

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Sulfur hexafluoride is a colorless, odorless gas. Molecular weight = 146.06; Boiling point = (sublimes) − 64°C; Freezing/Melting point = (sublimes) − 51°C; Relative vapor density (air = 1): 5.11; Vapor pressure = 21.5 atm. Shipped as a liquefied compressed gas. Condenses directly to a solid upon cooling. Practically insoluble in water; solubility = 0.003% at 25°C.

Potential Exposure: May contain highly toxic sulfur pentafluoride as an impurity. SF_6 is used in various electric power applications as a gaseous dielectric or insulator. The most extensive use is in high-voltage transformers. SF_6 is also used in waveguides, linear particle accelerators, Van de Graaff generators, chemically pumped continuous-wave lasers, transmission lines, and power distribution substations.

Nonelectrical applications include use as a protective atmosphere for casting of magnesium alloys and use as a leak detector or in tracing moving air masses. Several sources note that vitreous substitution of SF_6 in owl monkeys results in a greater ocular vascular permeability than that caused by saline. This implies that SF_6 could have an important use in retinal surgery.

Incompatibilities: May contain impurities that cause it to hydrolyze on contact with water, forming corrosive and toxic hydrogen fluoride. Vigorous reaction with disilane.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.98 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/6000 mg/m^3 TWA.

NIOSH REL: 1000 ppm/6000 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/5970 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3000 ppm

PAC-2: 5000 ppm

PAC-3: 5000 ppm

DFG MAK: 1000 ppm/6100 mg/m^3 TWA; Peak Limitation Category II(8); Pregnancy Risk Group D.

Australia: TWA 1000 ppm (6000 mg/m^3), 1993; Austria: MAK 1000 ppm (6000 mg/m^3), 1999; Belgium: TWA 1000 ppm (5970 mg/m^3), 1993; Denmark: TWA 1000 ppm (6000 mg/m^3), 1999; Finland: TWA 1000 ppm (6000 mg/m^3); STEL 1250 ppm (7500 mg/m^3), 1999; France: VME 1000 ppm (6000 mg/m^3), 1999; the Netherlands: MAC-TGG 6000 mg/m^3, 2003; the Philippines: TWA 1000 ppm (6000 mg/m^3), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 5000 mg/m^3, 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1000 ppm (6000 mg/m^3), 1999; Turkey: TWA 1000 ppm (6000 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (6070 mg/m^3); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000 ppm. Several states have set guidelines or standards for sulfur hexafluoride in ambient air[60] ranging from 60.0 mg/m^3 (North Dakota) to 100.0 mg/m^3 (Virginia) to 120.0 mg/m^3 (Connecticut) to 142.857 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6602.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.68.

Routes of Entry: Inhalation, skin absorption, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Contact with the liquid may cause frostbite. Symptoms of exposure include asphyxia, increase (d) breathing rate, pulse rate, slight muscle incoordination, emotional upset, fatigue, nausea, vomiting. SF_6 is considered to be physiologically inert in the pure state. In high concentrations, however, pure SF_6 can act as a simple asphyxiant by displacing the necessary oxygen. Ordinarily, however, SF_6 does not exist in the pure state. It contains variable quantities of sulfur fluorides. In the presence of water, these sulfur fluorides can hydrolyze to yield hydrogen fluoride (HF) and oxyfluoride compounds, such as sulfuryl fluoride (SO_2F_2) and thionyl fluoride (SOF_2). These compounds have much more toxic health effects. Sulfur hexafluoride may also be contaminated with more toxic sulfur compounds, such as S_2F_{10}.

Long Term Exposure: Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite, diarrhea, or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Respiratory system, skeleton.

Medical Surveillance: Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *(fluorides) 12.5 mg/m³:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m³:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators.] The following filters may also be used: N99, R99, P99, N100, R100, P100] or SA* (any supplied-air respirator). *62.5 mg/m³:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PAPRDM*† *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 mg/m³:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Sulfur hexafluoride requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Poisonous gases are produced in fire, including sulfur oxides and fluorine compounds. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Seal unused cylinders and return to suppliers.

References

US Environmental Protection Agency. (July 10, 1978). *Chemical Hazard Information Profile: Sulfur Hexafluoride*. Washington, DC

Sulfuric acid S:0770

Molecular Formula: H_2O_4S

Common Formula: H_2SO_4

Synonyms: Acido sulfurico (Spanish); Acide sulfurique (French); BOV; Dihydrogen sulfate; Dipping acid; Hydrogen sulfate; Hydroot; Matting acid; Nordhausen acid; Oil of vitriol; Schwefelsaeureloesungen (German); Spirit of sulfur; Sulphuric acid; Vitriol brown oil; Vitriol, oil of-

CAS Registry Number: 7664-93-9; *(alt.)* 119540-51-1; *(alt.)* 127529-01-5; 8014-95-7 (fuming sulfuric acid; Oleum)

RTECS® Number: WS5600000; WS5605000 (fuming)

UN/NA & ERG Number: UN1830/137; UN1831 (fuming)/137; UN1832 (spent)/137

EC Number: 231-639-5

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). (*Oleum*).

Carcinogenicity (*strong inorganic acid mists of sulfuric acid*): IARC: Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1992; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 (acid aerosols including mists, vapors, gas, fog, and other airborne species of any particle size) Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer (Strong inorganic acid mists containing sulfuric acid) 4/14/03.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sulfuric acid is a colorless to dark-brown, odorless, oily liquid which is commercially sold at 93−98% H_2SO_4, the remainder being water. Molecular weight = 98.08; Specific gravity (H_2O:1) = 1.8 at 25°C; Boiling point = (decomposes) 340°C; Freezing/Melting point = 10.6°C; Vapor pressure = 0.001 mmHg. Fuming sulfuric acid (oleum) gives off free SO_2. Soluble in water; violent reaction.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Used as a chemical feedstock in the manufacture of acetic acid, hydrochloric acid, citric acid, phosphoric acid, aluminum sulfate, ammonium sulfate, barium sulfate, copper sulfate, phenol, superphosphates, titanium dioxide, as well as synthetic fertilizers, nitrate explosives, artificial fibers, dyes, pharmaceuticals, detergents, glue, paint, and paper. It finds use as a dehydrating agent for esters and ethers due to its high affinity for water; as an electrolyte in storage batteries; for the hydrolysis of cellulose to obtain glucose; in the refining of mineral and vegetable oil; and in the leather industry. Other uses include fur and food processing; carbonization of wool fabrics; gas drying; uranium extraction from pitchblende; and laboratory analysis. Sulfuric acid is among the highest volume produced chemical in the United States.

Incompatibilities: A strong acid and oxidizer. Reacts violently with water with dangerous spattering and evolution of heat. Reacts violently with combustible and reducing materials, bases, organic materials, chlorates, carbides, picrates, fulminates, water, powdered metals. Corrosive to most common metals, forming explosive hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.2 mg/m^3 (measured as thoracic fraction of the aerosol) TWA; Suspected Human Carcinogen; H_2SO_4 contained in strong inorganic acid mists.

NIOSH IDLH: 15 mg/m^3.

Protective Action Criteria (PAC)*

Includes oleum

TEEL-0: 0.2 mg/m^3

PAC-1: **0.20** mg/m^3

PAC-2: **8.7** mg/m^3

PAC-3: **160** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 0.1 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(1), a momentary Ceiling value of 0.2 mg/m^3 should not be exceeded; Carcinogen Category 4; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 1 mg/m^3, 1993; Australia: TWA 1 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3; STEL 3 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3; STEL 3 mg/m^3, [skin], 1999; France: VME 1 mg/m^3, VLE 3 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Japan: 1 mg/m^3, 1999; Norway: TWA 1 mg/m^3, 1999; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993; Sweden: NGV 1 mg/m^3, TKV 3 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, KZG-W 2 mg/m^3, 1999; Thailand: TWA 1 mg/m^3, 1993; Turkey: TWA 1 mg/m^3, 1993; United Kingdom: TWA 1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 mg/m^3. Several states have set guidelines or standards for sulfuric acid in ambient air[60] ranging from 2.381 μg/m^3 (Kansas) to 10.0 μg/m^3 (South Carolina) to 14.0 μg/m^3 (Massachusetts) to 16.0 μg/m^3 (Virginia) to 12.0−100.0 μg/m^3 (North Carolina) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7903, Inorganic Acids; OSHA Analytical Method ID-113.

Permissible Concentration in Water: A guideline of 250 μg/L of sulfate has been recommended for drinking water by the EEC[35] and the state of Kansas.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation of nose and throat at levels of 5 mg/m^3. Swelling of the throat and lungs and inflammation of the bronchial membranes may occur at levels of 12−35 mg/m^3. A few drops in the lung air passages may be fatal. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* May cause severe irritation, burns, and ulceration. *Eyes:* May cause severe irritation, damage to the cornea, and blindness. *Ingestion:* May cause damage to teeth; burning of the mouth, throat, and stomach; nausea, vomiting of blood and eroded tissue; holes in the stomach and intestines; shock; and kidney damage. Death may occur from as little as 1 oz. Signs and symptoms of acute ingestion of sulfuric acid may be severe and include salivation, intense thirst, difficulty in swallowing, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of sulfuric acid. Acute inhalation exposure may result in sneezing, hoarseness, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation, and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, pulmonary edema, chronic bronchitis, and pneumonia may also occur. If the eyes have come in contact with sulfuric acid, irritation, pain, swelling, corneal erosion, and blindness may result. Dermal exposure may result in severe burns, pain, and dermatitis (red, inflamed skin).

Long Term Exposure: Can cause chronic runny nose, tearing of the eyes, nose bleeding, and stomach upset. Risk of tooth erosion and pitting from repeated or prolonged exposure to the aerosol. Lungs may be affected by repeated or prolonged exposure to the aerosol; bronchitis may develop. Exposure to amounts greater than 3.0 mg/m^3 may cause all of the above symptoms in greater severity.

Points of Attack: Eyes, skin, respiratory system, teeth.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Examination of the teeth. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene, Teflon™, Saranex®, Neoprene™/natural rubber, Viton are among the recommended protective materials for *sulfuric acid solution of more than 70%*. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For engineering controls see NIOSH Criteria Document #74-128, *Exposure to Sulfuric Acid.*

Respirator Selection*: Up to 15 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprAgHie (APF = 25) (APF = 25)* (any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter) or CcrFAg100 (APF = 50) [any chemical cartridge respirator with a full face-piece and acid gas cartridge(s) in combination with an N100, R100, or P100 filter] or GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF; Pd,Pp (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Sulfuric acid must be stored to avoid contact with water, chlorates, chromates, carbides, fulminates, nitrates, picrates, and powdered metals, since violent reactions occur. Store in tightly closed containers in a cool, dry well-ventilated area away from sunlight and in an area with an acid-resistant cement floor. Sources of ignition, such as smoking and open flames, are prohibited where sulfuric acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Always add acid to water, never the reverse. Sulfuric acid is extremely corrosive; handle with care and use proper equipment and practices. Wherever sulfuric acid is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Contact of sulfuric acid with metal drums may cause the release of flammable, explosive hydrogen gas; therefore, storage drums should be coated with acid-resistant material.

Shipping: Sulfuric acid with >51% acid or sulfuric acid with not >51% acid requires a shipping label of "CORROSIVE." They fall in Hazard Class 8 and Packing Group II.

Sulfuric acid, fuming, with 30% or more free sulfur trioxide requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I.

Sulfuric acid, fuming, with <30% free sulfur trioxide, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group I.

Sulfuric acid, spent, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Extremely hazardous to health; areas may be entered with extreme care. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. No skin surface should be exposed. Keep all sources of ignition away from containers because explosive mixtures of hydrogen may be produced during storage. Ventilate area of spill or leak. *Small spills:* cover area with sodium bicarbonate or soda ash/slaked lime. Shovel neutralized residues into containers for disposal, or (if not available) cover area with sand or earth and shovel into disposal containers. Other neutralizing agents are calcinated dolomite, calcium oxide and hydroxide, sodium carbonate. Place sulfuric acid absorbed in vermiculite in sealed containers. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Notify proper authorities in case of water pollution. Do not touch spilled material. Use water spray to reduce vapor; do not get water inside container. Dike for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Sulfuric acid, fuming; Sulfuric acid, fuming, with not less than 30% free Sulfur trioxide

Small spills (*From a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 200/60

Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3

Night 0.6/1.4

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300

Then: Protect persons downwind (miles/kilometers)

Day 1.8/2.9

Night 3.6/5.7

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur oxides, are produced in fire or on contact with water. Contact with metal releases flammable and explosive hydrogen gas. Use carbon dioxide or dry chemical. Use water on combustibles burning in vicinity of this material, but use extreme care as water applied directly to this acid results in generation of heat and causes splattering. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to solution of soda ash and slaked lime with stirring; flush to drain with large volumes of water. Recovery and reuse of spent sulfuric acid may be a viable alternative to disposal, and processes are available.

References

National Institute for Occupational Safety and Health. (1974). *Criteria for a Recommended Standard: Occupational Exposure to Sulfuric Acid*, NIOSH Document No. 74-128

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 80−83 (1981) and 5, No. 3, 70−74 (1985)

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sulfuric Acid*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1988). *Chemical Fact Sheet: Sulfuric Acid* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

Fuming sulfuric acid or oleum

New Jersey Department of Health and Senior Services. (January 1986). *Hazardous Substances Fact Sheet: Sulfuric Acid Fuming*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Sulfuric Acid Fuming*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2002). *Hazardous Substances Fact Sheet: Sulfuric Acid*. Trenton, NJ

Sulfurous acid 2-(*p-tert*-butylphenoxy)-1-methylethyl-2-chloroethyl ester S:0780

Molecular Formula: $C_{15}H_{23}ClO_4S$

Common Formula: $(CH_3)_3C-C_6H_4-OCH_2CH(CH_3)OSO_2-(CH_2)_2Cl$

Synonyms: 88-R; Acaracide; Aracide; Aramite®; Araramite-15W®; Aratron®; 2-(*p*-Butylphenoxy)isopropyl 2-chloroethyl sulfite; 2-(4-*tert*-Butylphenoxy)isopropyl-2-chloroethyl sulfite; Butylphenoxyisopropyl chloroethyl sulfite; 2-(*p*,*tert*-Butylphenoxy)isopropyl 2′-chloroethyl sulphite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl 2-chloroethyl ester of sulphurous acid; 2-(*p*-Butylphenoxy)-1-methylethyl 2-chloroethyl sulfite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl-2-chloroethyl sulfite ester; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl 2′-chloroethyl sulphite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl sulphite of 2-chloroethanol; 1-(*p*,*tert*-Butylphenoxy)-2-propanol-2-chloroethyl sulfite; CES; 2-Chloroethanol-2-(*p*,*tert*-butylphenoxy)-1-methylethyl sulfite; 2-Chloroethanol ester with 2-(*p*,*tert*-butylphenoxy)-1-methylethyl sulfite; β-Chloroethyl-b′-(*p*,*tert*-butylphenoxy)-a′-methylethyl sulfite; β-Chloroethyl-β-(*p*,*tert*-butylphenoxy)-α-methylethyl sulphite; 2-Chloroethyl 1-methyl-2-(*p*, *tert*-butylphenoxy)ethyl sulphite; 2-Chloroethylsulfurous acid 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester; 2-Chloroethyl sulphite of 1-(*p*,*tert*-Butylphenoxy)-2-propanol; Compound 88R; ENT 16,519; *o*-Mite; Niagaramite

CAS Registry Number: 140-57-8

RTECS® Number: WT2975000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Sufficient Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Hazardous Waste Constituent (EPA/RCRA).[5]

California Proposition 65 Chemical: Cancer 7/1/87.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Aramite® is a heavy, dark-amber liquid. Molecular weight = 334.89; Boiling point = 175°C at 0.1 mmHg; Freezing/Melting point = −32°C; Vapor pressure = 9 mmHg at 25°C. Practically insoluble in water.

Potential Exposure: Aramite® is a miticide and antimicrobial agent. Aramite is regulated by EPA under the Federal Insecticide, Fungicide, and Rodenticide Act and the Resource Conservation and Recovery Act. The significant regulatory action was a voluntary cancellation of the active ingredient registration by the sole producer in 1975.

Incompatibilities: Incompatible with alkaline material, such as lime or Bordeaux mixture (slaked lime and copper sulfate solution).

Permissible Exposure Limits in Air

No TEEL available.

A limit on Aramite® in ambient air has been set in Pennsylvania[60] at 18.07 $\mu g/m^3$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is slightly toxic (LD_{50} value for rats is 3900 mg/kg) but it is carcinogenic to animals.

Long Term Exposure: Aramite® is carcinogenic in the rat and dog following its oral administration. It produced liver tumors in the rat and carcinomas of the gall bladder and biliary ducts in the dog. Aramite® was tested in two strains of mice by the oral route and produced a significant increase of hepatomas in males of one strain.

Points of Attack: See above.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis, nitrates, and heat. This material may be thermally unstable (Verschueren). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Pesticides, liquid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1 and Packing Group I to III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including chlorine and sulfur oxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Acid or alkaline hydrolysis followed by flushing to sewer.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 79−80

Sulfur pentafluoride S:0790

Molecular Formula: $F_{10}S_2$

Common Formula: S_2F_{10}

Synonyms: Suflur decafluoride; Disulfur decafluoride; Disulphur decafluoride

CAS Registry Number: 5714-22-7

RTECS® Number: WS4480000

UN/NA & ERG Number: Not regulated

EC Number: 227-204-4 (disulphur decafluoride)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sulfur pentafluoride is a colorless liquid or gas (above 29°C) with an odor like sulfur dioxide. Noncombustible liquid and nonflammable gas. Molecular weight = 254.12; Boiling point = 28.9°C; Freezing/Melting point = −92.2°C; Relative vapor density (air = 1) = 8.77; Specific gravity (H_2O:1) = 2.08 at 0°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Sulfur pentafluoride is encountered as a by-product in the manufacture of sulfur hexafluoride, which is made by the direct fluorination of sulfur or sulfur dioxide.

Incompatibilities: Fluorides form explosive and toxic gases on contact with strong acids and acid fumes. Reacts with strong caustics. Decomposed in temperatures above 400°C forming toxic and corrosive fumes of sulfur oxides and sulfur fluorides; and as this chemical decomposes, it acts as both a strong oxidizer and a fluorinating agent.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.39 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.025 ppm/0.25 mg/m^3 TWA.

NIOSH REL: 0.01 ppm/0.1 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.01 ppm/0.10 mg/m^3 Ceiling Concentration.
Protective Action Criteria (PAC)
TEEL-0: 0.01 ppm
PAC-1: 0.01 ppm
PAC-2: 0.01 ppm
PAC-3: 1 ppm
DFG MAK: No numerical value established. Data may be available.
NIOSH IDLH: 1 ppm.
Australia: TWA 0.01 ppm (0.1 mg/m^3), 1993; Austria: MAK 0.025 ppm (0.25 mg/m^3), 1999; Belgium: STEL 0.01 ppm (0.1 mg/m^3), 1993; Denmark: TWA 0.01 ppm (0.1 mg/m^3), 1999; Finland: TWA 0.025 ppm, STEL 0.075 ppm, [skin], 1999; Norway: TWA 0.01 ppm (0.1 mg/m^3), 1999; the Philippines: TWA 0.025 ppm (0.25 mg/m^3), 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 0.01 ppm (0.1 mg/m^3), KZG-W 0.02 ppm (0.2 mg/m^3), 1999; Turkey: TWA 0.025 ppm (0.25 mg/m^3), 1993; United Kingdom: TWA 0.025 ppm (0.26 mg/m^3), STEL 0.075 ppm, 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.01 ppm. Several states have set guidelines or standards for sulfur pentafluoride in ambient air[60] ranging from 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (North Dakota) to 5.0 μg/m^3 (Connecticut) to 6.0 μg/m^3 (Nevada).

Determination in Air: Gaseous fluorides collected by impinger using caustic; particulates by filter. Analysis is by ion-specific electrode per NIOSH Analytical Method 7902.[18]

Permissible Concentration in Water: The EPA has set a standard of 4 mg/L for fluoride[61] and the state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Fluorides can irritate and may damage the eyes. Skin contact can cause irritation, rash, or burning sensation. High repeated exposure can cause nausea, vomiting, loss of appetite, and bone and teeth changes. Extremely high levels could be fatal. Breathing can irritate the nose and throat, and cause nausea, headaches, and nosebleeds. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Very high exposure can cause fluoride poisoning with stomach pain, weakness, convulsions, collapse, and death. These effects do not occur at the level of fluorides used in water for preventing cavities in teeth. In animals: pulmonary edema, hemorrhage.

Long Term Exposure: Repeated high exposures can cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth. May cause kidney damage.

Points of Attack: Respiratory system, central nervous system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; electrocardiogram; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; white blood cell count/differential. Also consider kidney function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.1 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 1 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Fluorides must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Fluorides form explosive gases on contact with nitric acid. Store in tightly closed containers in a cool, well-ventilated area away from water. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Gas:* If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156

Sulfur tetrafluoride S:0800

Molecular Formula: F_4S

Common Formula: SF_4

Synonyms: Sulfur fluoride (SF_4),(*t*-4)-; Sulphur fluoride; Sulphur tetrafluoride; Tetraflurosulfurane; Tetrafluoruro de azufre (Spanish); Tétrafluorure de soufre (French)

CAS Registry Number: 7783-60-0

RTECS® Number: WT4800000

UN/NA & ERG Number: UN2418/125

EC Number: 232-013-4

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (≥1.00% concentration); *Theft hazard* 15 (≥1.33% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Sulfur tetrafluoride is a colorless gas with an odor like sulfur dioxide. Shipped as a liquefied compressed gas. Molecular weight = 108.06; Specific gravity (H_2O:1) = 10.5 at 21°C; Boiling point = −40°C; Freezing/Melting point = −120°C; Relative vapor density (air = 1) = 3.78; Vapor pressure = 10.5 atm at 25°C. Reacts with water; highly soluble.

Potential Exposure: Sulfur tetrafluoride is used as a selective fluorinating agent in making water-repellent and oil-repellent materials and lubricity improvers. It is also used as a pesticide intermediate.

Incompatibilities: Moisture, concentrated sulfuric acid, dioxygen difluoride. Readily hydrolyzed by moisture, forming hydrofluoric acid and thionyl fluoride.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.42 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 0.1 ppm/0.4 mg/m^3 Ceiling Concentration.
ACGIH TLV®[1]: 0.1 ppm/0.44 mg/m^3 Ceiling Concentration.
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.3 ppm
PAC-2: 2.08 ppm
PAC-3: 2.08 ppm

Australia: TWA 0.1 ppm (0.4 mg/m^3), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: STEL 0.1 ppm (0.44 mg/m^3), 1993; Denmark: TWA 0.1 ppm (0.4 mg/m^3), 1999; Finland: TWA 0.1 ppm (0.4 mg/m^3), STEL 0.3 ppm, [skin], 1999; Norway: TWA 0.1 ppm (0.4 mg/m^3), 1999; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 2 mg[HF]/m^3, 1999; the Netherlands: MAC 0.4 mg/m^3, 2003; United Kingdom: TWA 0.1 ppm (0.45 mg/m^3), STEL 0.3 ppm (1.3 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV®: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for sulfur tetrafluoride in ambient air[60] ranging from 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Connecticut) to 10.0 μg/m^3 (Nevada).

Determination in Air: Bubbler; Sodium hydroxide; Ion-specific electrode; OSHA Analytical Method. #ID11.

Permissible Concentration in Water: No criteria set. (SF_4 reacts violently with water to give SO_2 and HF).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure can severely irritate the nose, throat, and lungs. May cause skin burns (from SF_4 releasing hydrofluoric acid on exposure to moisture). High levels can cause a buildup of fluid in the lungs (pulmonary edema) with cough and shortness of breath. This can lead to death. Contact with liquid may cause frostbite. Sulfur tetrafluoride is about as toxic as phosgene. It is a strong irritant. The toxic effects are attributed largely to fluorine which is released upon hydrolysis. In animals: dyspnea (breathing difficulty), weakness, rhinorrhea (discharge of thin nasal mucous).

Long Term Exposure: May cause lung damage. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth. May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Urine test for fluoride level (should not be above 4 mg/L). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Fluorides: 12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PAPRDM*† *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 mg/m^3*: HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAF

(APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Sulfur tetrafluoride must be stored to avoid contact with water, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, or acids to avoid the production of toxic fumes. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Sulfur tetrafluoride requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.6/2.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 2.9/4.7
Night 6.4/10.3

Fire Extinguishing: This chemical is a nonflammable gas. Poisonous gases, including sulfur dioxide and hydrogen fluoride, are produced in fire. *Do not use water*. For small fires, use dry chemical or carbon dioxide. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sulfur Tetrafluoride*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Sulfur Tetrafluoride*. Trenton, NJ

Sulfur trioxide S:0810

Molecular Formula: O_3S
Common Formula: SO_3
Synonyms: Sulfan; Sulfuric anhydride; Sulfuric oxide; Sulfur trioxide, stabilized; Sulphur trioxide; Trioxido de azufre (Spanish); Trioxyde de soufre (French)
CAS Registry Number: 7446-11-9
RTECS® Number: WT4830000
UN/NA & ERG Number: UN1829/137
EC Number: 231-197-3
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; IARC: Human Sufficient Evidence*, carcinogenic to humans*, Group 1, 1992.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).
Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg). This material is a reactive solid. The TPQ does not default to 10,000 pounds for nonpowder, nonmolten, nonsolution form.
Reportable Quantity (RQ): 100 lb (45.4 kg).
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sulfur trioxide is a crystalline solid which has 3 forms: *alpha-, beta-*, and *gamma-*; and can also exist as a gas or liquid. Molecular weight = 80.06; Boiling point = 45°C (all forms); Freezing/Melting point = 17°C (*gamma-*); 32.5°C (*beta-*); 62°C (*alpha-*); Vapor pressure = 433 mmHg at 250°C. An explosive increase in vapor pressure occurs when the *alpha*-form melts. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Reacts with water. Combustible and Corrosive.

Potential Exposure: Compound Description: Tumorigen; Human Data. Sulfur trioxide is used as a sulfating and sulfonating agent for detergent, lubricating oil additives, and other organic compounds; in solar energy collectors. It is also used as an intermediate in sulfuric acid manufacture and in making explosives.

Incompatibilities: Reacts violently with water, steam, or moisture, releasing corrosive hydrosulfuric acid. Violent reactions occur on contact with strong bases, strong acids, chemically active metals, reducing agents, cyanides, nitrates, picrates, fulminates, chlorates, sulfides, carbides, phosphorus, dioxygen difluoride, barium oxide, lead oxide, diphenyl mercury, alcohols, nitryl chloride, acetonitrile, dioxane, tetrafluoroethylene.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)*
TEEL-0: 0.06 mg/m^3
PAC-1: **0.20** mg/m^3
PAC-2: **8.7** mg/m^3
PAC-3: **160** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
Finland: STEL 1 ppm (3 mg/m^3), [skin], 1999; Hungary: STEL 1 mg/m^3, 1993; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Russia: STEL 1 mg/m^3, [skin], 1993.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: This material is highly toxic and corrosive. Contact can severely irritate and burn the skin and eyes with possible permanent eye damage. It is an irritant and corrosive to mucous membranes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Poisonous if inhaled or swallowed. Contact causes severe burns to skin and eyes. This material may cause coughing, choking, and severe discomfort at a concentration of 1 ppm.
Long Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture and incompatible materials listed above. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group I. A plus (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Avoid inhalation. Do not touch spilled material. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Dike spill for later disposal; do not apply water unless directed to so. Clean up only under supervision of an expert. Remove all ignition sources. *Solid:* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate and wash area after cleanup is complete. *Gas:* Ventilate area of leak to disperse gas. Stop flow of gas if it can be done without harm to personnel. If the source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Sulfur trioxide, used as a weapon—not listed in current DOT tables.

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.6/1.4

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.8/2.9
Night 3.6/5.7

Fire Extinguishing: Sulfur trioxide may burn but does not easily ignite. *Do not use water*. Use dry chemical or carbon dioxide extinguishers. *Small fires:* dry chemical or carbon dioxide. Spray cooling water on containers that are exposed to flames until well after fire is out. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 83−84

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Sulfur Trioxide*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (September 1999). *Hazardous Substances Fact Sheet: Sulfur Trioxide*. Trenton, NJ

Sulfuryl fluoride S:0820

Molecular Formula: F_2O_2S
Common Formula: SO_2F_2
Synonyms: Fluorure de sulfuryle (French); Fluoruro de sulfurilo (Spanish); Sulfonyl fluoride; Sulfur difluoride dioxide; Sulfuric oxyfluoride; Sulphuryl fluoride; Sulphuryl difluoride; Vikane; Vikane fumigant
CAS Registry Number: 2699-79-8
RTECS® Number: WT5075000
UN/NA & ERG Number: UN2191/123
EC Number: 220-281-5 [*Annex I Index No.:* 009-015-00-7]
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
US EPA, FIFRA 1998 Status of Pesticides: RED completed.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT 49CFR172.101, Inhalation Hazardous Chemical.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R23; R48/20; R50; Safety phrases: S1/2; S45; S630; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Sulfuryl fluoride is a colorless, poisonous gas. Odorless. Molecular weight = 102.06; Boiling point = −55.6°C; Freezing/Melting point = −135.6°C; Relative vapor density (air = 1) = 3.72; Vapor pressure = 15.2 atm at 25°C. Slightly soluble in water; solubility = 0.2 at 0°C. Water and air reactive.
Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. Sulfuryl fluoride is used an insecticidal fumigant. It is also used in organic synthesis of drugs and dyes.
Incompatibilities: Can react with water, steam. Fluorides form explosive gases on contact with strong acids or acid fumes.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.18 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 5 ppm/20 mg/m^3 TWA.
NIOSH REL: 5 ppm/20 mg/m^3 TWA; 10 ppm/42 mg/m^3 STEL.
ACGIH TLV®[1]: 5 ppm/21 mg/m^3 TWA; 10 ppm/40 mg/m^3 STEL.
NIOSH IDLH: 200 ppm.
Protective Action Criteria (PAC)
TEEL-0: 5 ppm
PAC-1: 10 ppm
PAC-2: 21 ppm
PAC-3: 64 ppm
Australia: TWA 5 ppm (20 mg/m^3), STEL 10 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: TWA 5 ppm (21 mg/m^3), STEL 10 ppm (42 mg/m^3), 1993; Denmark: TWA 5 ppm (20 mg/m^3), 1999; Finland: TWA 5 ppm (20 mg/m^3), STEL 10 ppm (40 mg/m^3), 1999; France: VME 5 ppm (20 mg/m^3), 1999; Norway: TWA 5 ppm (20 mg/m^3), 1999; the Netherlands: MAC-TGG 20 mg/m^3, 2003; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 5 ppm (20 mg/m^3), 1999; United Kingdom: TWA 5 ppm (21 mg/m^3), STEL 10 ppm (42 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 ppm. Several states have set guidelines or standards for sulfuryl fluoride in ambient air[60] ranging from 200−400 μg/m^3 (North Dakota) to 350 μg/m^3 (Virginia) to 400 μg/m^3 (Connecticut) to 476 μg/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (IV) #6012, Sulfuryl fluoride.
Routes of Entry: Inhalation, eye and/or skin contact (liquid).
Harmful Effects and Symptoms
Short Term Exposure: May cause conjunctivitis, rhinitis, pharyngitis, paresthesia. Contact with the liquid may cause frostbite. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Overexposure can cause nausea, vomiting, itching, muscle twitching, tremors, and seizures.
Long Term Exposure: May cause kidney damage. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth.
Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. The fluoride level in urine (for fluoride in urine use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests, examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush

them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50 ppm:* Sa* (APF = 10) (any supplied-air respirator). *Up to 125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 200 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison gas. Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and strong acids. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Sulfuryl fluoride requires a shipping label of "POISON GAS." It falls in Hazard Class 2.3. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 3.1/4.9

Fire Extinguishing: This chemical is a nonflammable gas. Poisonous gases, including sulfur dioxide and hydrogen fluoride, are produced in fire. For small fires, use dry chemical or carbon dioxide extinguishers. Gas is heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Addition of soda ash−slaked lime solution to form the corresponding sodium and calcium salt solution. This solution can be safely discharged after dilution. The precipitated calcium fluoride may be buried or added to a landfill. Small amounts could also be released directly to the atmosphere without serious harm.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Sulfuryl Fluoride*. Trenton, NJ

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Sulphamic acid S:0830

Molecular Formula: H_3NO_3S

Common Formula: H_2NSO_3H

Synonyms: Amidosulfonic acid; Amidosulfuric acid; Aminosulfonic acid; Sulfamic acid; Sulfamidic acid

CAS Registry Number: 5329-14-6

RTECS® Number: WO5950000

UN/NA & ERG Number: UN2967/154

EC Number: 226-218-8 [*Annex I Index No.:* 016-026-00-0]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA, 1998 Status of Pesticides: Unsupported.

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

European/International Regulations: Hazard Symbol: Xi, N; Risk phrases: R36/38; R52/53; Safety phrases: S2; S26; S28; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Sulphamic acid is a white crystalline solid. Molecular weight = 97.10; Freezing/Melting point = about 205°C (decomposition). Soluble in water; slowly reactive.

Potential Exposure: Compound Description: Agricultural Chemical; Primary Irritant. Sulphamic acid is used in metal and ceramic cleaning, bleaching paper pulp, and textiles; in acid cleaning; as a stabilizing agent for chlorine and hypochlorite in swimming pools; cooling towers; and paper mills.

Incompatibilities: The aqueous solution is a strong acid. Reacts violently with strong acids (especially fuming nitric acid), bases, chlorine. Reacts slowly with water, forming ammonium bisulfate. Incompatible with ammonia, amines, isocyanates, alkylene oxides, epichlorohydrin, oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 12.5 mg/m^3

PAC-1: 40 mg/m^3

PAC-2: 250 mg/m^3

PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Sulphamic acid can affect you when breathed in. Contact can burn the skin and eyes. Breathing the dust (crystals) or vapor can irritate the nose, mouth, and lower airways; and may cause cough with phlegm. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May cause dermatitis and skin allergy. Some closely related sulfonates cause skin allergy. May affect the lungs.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to sulphamic acid, use a NIOSH/MSHA- or European Standard EN149-approved full face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Sulphamic acid must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from chlorine and nitric acid.

Shipping: Sulfamic acid requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulphamic acid may burn, but does not readily ignite. Use dry chemical, CO_2, dry sand. *Do not use water* directly on material. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog. Poisonous gases, including oxides of sulfur and nitrogen, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Sulphamic Acid*. Trenton, NJ

Sulprofos S:0840

Molecular Formula: $C_{12}H_{19}O_2PS_3$

Common Formula: $CH_3S-C_6H_4-OP(S)(SC_3H_7)(OCH_2CH_3)$

Synonyms: AI3-29149; Bayer NTN 9306; Bay-NTN-9306; Bolstar (Bayer); *o*-Ethyl *o*-[4-(methylmercapto)phenyl]-*S*-*n*-propylphosphorothionothiolate; *o*-Ethyl *o*-[4-(methylthio) phenyl]phosphorodithioic acid *S*-propyl ester; *o*-Ethyl *o*-[4-(methylthio)phenyl]phosphorodithioic acid *S*-propyl ester; *o*-Ethyl *o*-(4-methylthiophenyl) *S*-propyl dithiophosphate; *o*-Ethyl *o*-[4-(methylthio)phenyl] *S*-propyl phosphorodithioate; Helothion; Mercaprofos; Mercaprophos; Phosphorodithioic acid, *o*-ethyl *o*-[4-(methylthio)phenyl] *S*-propyl ester; Phosphorothioic acid, *o*-Ethyl *o*-[4-(methylthio)phenyl] *S*-propyl ester

CAS Registry Number: 35400-43-2

RTECS® Number: TE4165000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 252-545-0

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (Germany, Malaysia) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Sulprofos is a tan colored liquid. Molecular weight = 322.46; Specific gravity (H_2O:1) = 1.20 at 25°C; Boiling point = 155−158°C at 0.1 mmHg; Vapor pressure = 63 mmHg at 20°C. Poor solubility in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector. Those involved in the manufacture, formulation, and application of this insecticide that is used for control of certain lepidopterous, dipterous, and hemipterous insects on cotton, etc.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 1 mg/m^3 TWA.

ACGIH TLV®[1]: 0.008 ppm/0.1 mg/m^3 measured as inhalable fraction and vapor TWA; not classifiable as a human

carcinogen; BEI_A issued for acetylcholinesterase inhibiting pesticides.
No TEEL available.
Australia: TWA 1 mg/m^3, 1993; Belgium: TWA 1 mg/m^3, 1993; France: VME 1 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines of standards for sulprofos in ambient air[60] ranging from 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada) to 100.0 μg/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; OSHA Analytical Method PV-2037, Sulprofos.

Determination in Water: Fish Tox = 63.99264000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: May affect the nervous system, causing convulsions and respiratory failure. Shows typical anticholinesterase effects. Sulprofos can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is an organophosphate pesticide. Exposure can cause rapid severe poisoning with headaches, sweating, nausea and vomiting, diarrhea, loss of coordination, convulsions, respiratory failure, and death. This is considered a moderately toxic compound (LD_{50} for rats is 65 mg/kg).

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Human Tox = 21.00000 ppb (INTERMEDIATE).

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA

1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 12,000 (Estimate).

Fire Extinguishing: Sulprofos may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including oxides of sulfur and phosphorus, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency or by contacting your regional EPA office.

References

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Sulprofos*. Trenton, NJ

T

2,4,5-T T:0100

Molecular Formula: $C_8H_5Cl_3O_3$
Common Formula: $Cl_3C_6H_2OCH_2COOH$
Synonyms: Acetic acid, (2,4,5-T)-; Acetic acid, (2,4,5-trichlorophenoxy)-; Acide 2,4,5-trichlorophenoxyacetique (French); Acido 2,4,5-triclorofenoxiacetico (Spanish); Amine; BCF-Bushkiller; Brush-Off 445 low-volatile brush killer; Brush rhap; Brushtox; Dacamine; Debroussaillant concentre; Debroussaillant super concentre; Decamine 4T; Ded-weed brush killer; Ded-weed LV-6 brush kill; Dinoxol; Envert-T; Estercide T-2 and T-245; Esteron; Esteron 245; Esteron brush killer; Fence rider; Forron; Forst U 46; Fortex; Fruitone A; Inverton 245; Line rider; Phortox; Reddon; Reddox; Spontox; Super D weedone; 2,4,5-T; T-5 brush kil; Tippon; T-Nox; Tormona; Transamine; Tributon; 2,4,5-Trichlorophenoxyacetic acid; (2,4,5-Trichlor-phenoxy)-essigsaeure (German); Trinoxol; Trioxal; Trioxon; Trioxone; Veon; Veon 245; Verton 2T; Visko rhap low-volatile ester; Weedar; Weedone
CAS Registry Number: 93-76-5
RTECS® Number: AJ8400000
UN/NA & ERG Number: UN3345/153
EC Number: 202-273-3 [*Annex I Index No.:* 607-041-00-9]

Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.
US EPA Gene-Tox Program, Positive: *D. melanogaster* sex-linked lethal; *S. cerevisiae*—reversion; Positive/dose response: *In vivo* cytogenetics—nonhuman bone marrow; Negative: *D. melanogaster*—whole sex chromosome loss; Negative: *D. melanogaster*—nondisjunction; Inconclusive: Host-mediated assay; Mammalian micronucleus.
Banned or Severely Restricted (many countries) (UN).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
US EPA Hazardous Waste Number (RCRA No.): U232.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.72; Nonwastewater (mg/kg), 7.9.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (2).
Safe Drinking Water Act: Priority List (55FR1470).
Reportable Quantity (RQ): 1000 lb (454 kg).
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as 2,4,5-T and its salts and esters).
European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R2; R36/37/38; R50/53; Safety phrases: S2; S24; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 2,4,5-T acid is an odorless, colorless to tan crystalline solid. Molecular weight = 255.48; Specific gravity (H_2O:1) = 1.80 at 25°C; Boiling point = (decomposes); Freezing/Melting point = 152.8°C; Vapor pressure = 1×10^{-7} mmHg. Slightly soluble in water; solubility = 0.03% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector. Those engaged in the manufacture, formulation, and application of this herbicide used to control woody and herbaceous weeds. The EPA has issued a rebuttable presumption against registration of 2,4,5-T for pesticide uses, however. The Vietnam war era defoliant, Agent Orange, was a mixture of 2,4,5-T and 2,4-D.

Incompatibilities: The aqueous solution is a weak acid. Incompatible with sulfuric acid, bases, ammonia, aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin; strong oxidizers, such as chlorine, bromine, fluorine, and strong bases.

Permissible Exposure Limits in Air
OSHA PEL: 10 mg/m^3 TWA
NIOSH REL: 10 mg/m^3 TWA
ACGIH TLV®[1]: 10 mg/m^3; Not classifiable as a human carcinogen
NIOSH IDLH: 250 mg/m^3
Protective Action Criteria (PAC)
TEEL-0: 10 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 10 mg/m^3
PAC-3: 250 mg/m^3
DFG MAK: 10 mg/m^3, inhalable fraction [skin]; Peak Limitation Category II(2); Pregnancy Risk Group C
Australia: TWA 10 mg/m^3, 1993; Austria: MAK 10 mg/m^3 [skin], 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 5 mg/m^3 [skin], 1999; France: VME 10 mg/m^3, 1993; Hungary: TWA 1 mg/m^3, STEL 2 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 10 mg/m^3, 2003; the Philippines: TWA 10 mg/m^3, 1993; Switzerland: MAK-W 10 mg/m^3, STEL 50 mg/m^3 [skin], 1999; Thailand: TWA 10 mg/m^3, 1993; United Kingdom: TWA 10 mg/m^3, STEL 20 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Not classifiable as a human carcinogen. Several states have set guidelines or standards for 2,4,5-T in ambient air[60] ranging from 1.0 $\mu g/m^3$ (Pennsylvania) to 100.0 $\mu g/m^3$ (North Dakota) to 160 $\mu g/m^3$ (Virginia) to 238.0 $\mu g/m^3$ (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5001, 2,4,5-T.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00019-9

Permissible Concentration in Water: The EPA (see "References" below) has set a lifetime health advisory of 21.0 μg/L. Mexico[35] has set limits of 100 μg/L in estuaries and 10 μg/L in coastal waters. The state of Kansas[61] has set a guideline for drinking water of 700.0 μg/L.

Determination in Water: Liquid−liquid extraction and gas chromatography (see EPA reference below). Fish Tox = 79154.36150000 ppb (VERY LOW). Octanol−water coefficient: Log $K_{ow} = 3.99$.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* Increasingly severe symptoms may include nose and throat irritation; weakness, tiredness, metallic taste in mouth; loss of appetite; diarrhea, heart problems; heart failure and death. *Skin:* Reddening and itching may develop. Absorption is slow, but may contribute significantly to total exposure. *Eyes:* Irritation may develop. *Ingestion:* 350 mg (0.01 oz) produces only a metallic taste in the mouth, lasting about 2 h. Approximately 4 teaspoonfuls (150-lb man) may cause weakness, tiredness, loss of appetite; diarrhea, heart problems, heart failure; and death.

Note: Reported effects of 2,4,5-T are due to accidental exposures, often at unknown levels or duration. In addition, 2,4,5-T may be contaminated with very small amounts of another more toxic compound 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD, Dioxin). Therefore, some of the symptoms of exposure to 2,4,5,-T may be due to contaminants.

Long Term Exposure: Levels above the standard may produce skin irritation, acne-like skin sores; loss of skin coloration in small patches; GI tract ulcer; and nerve disorders resulting in difficulty controlling muscles. Animal studies also indicate the possibility of an increased susceptibility to infection. Changes in generic material and birth defects have been reported in laboratory studies and may be due to 2,4,5-T or its contaminant. Whether these effects are produced in humans is unknown. In animals: ataxia, skin irritation; acne-like rash; liver damage. Human Tox = 70.00000 ppb (LOW).

Points of Attack: Skin, liver, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: blood plasma; urine (chemical/metabolite); urine (chemical/metabolite), 24-h collection. If symptoms develop or overexposure is suspected, liver or kidney function tests may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: If ingested, remove by lavage or emesis. Use general supportive measures for CNS depression. Use quinidine for myotonia.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m³:* Qm (APF = 25) (any quarter-mask respirator). *100 mg/m³:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *250 mg/m³:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, such as chlorine, bromine, fluorine, and strong bases. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This material falls under "Phenoxy pesticides, solid, toxic, n.o.s." This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 80.

Fire Extinguishing: 2,4,5-T Acid may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including phosgene, hydrogen chloride, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Two disposal procedures have been discussed for 2,4,5-T: (1) Mix with excess sodium carbonate, add water and let stand for 24 h before flushing down the drain with excess water; and (2) pour onto vermiculite and incinerate with wood, paper, and waste alcohol.[22] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (August 1987). *Health Advisory: 2,4,5-Trichlorphenoxy-Acetic Acid*. Washington, DC: Office of Drinking Water

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 20−21

New York State Department of Health. (March 1980). *Chemical Fact Sheet: 2,4,5-T*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2001). *Hazardous Substances Fact Sheet: 2,4,5-(Trichlorophenoxy) Acetic Acid*. Trenton, NJ

Tabun (Agent GA, WMD) T:0110

Molecular Formula: $C_5H_{11}N_2O_2P$

Common Formula: $(CH_3)_2NPO(OC_2H_5)CN$

Synonyms: Dimethylamidoethoxyphosphotyl cyanide; Dimethylaminocyanphosphorsaeureaethylester (German); Dimethylphosphoramidocyanidic acid, ethyl ester; Ethyl dimethylamidocyanophosphate; Ethyl *N*,*N*-dimethyl-aminocyanophosphate; Ethyl *N*,*N*-dimethyl-phosphoramidocyanidate; Ethyl dimethyl-phosphoramidocyanidate; GA (military designation); Gelan 1; LE-100; MCE; Phosphoramidocyanidic acid, dimethyl-, ethyl ester; T-2104; Taboon A; TL 1578

CAS Registry Number: 77-81-6

RTECS® Number: TB4550000

UN/NA & ERG Number: UN2810/153

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Carcinogenicty: GA is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical.

Note: Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions.

Canada, National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tabun (GA), an organophosphorous compound, is a nerve agent, and among the most toxic of the known chemical warfare agents. Exposure to tabun can cause death in minutes. A fraction of an ounce (1−10 mL) of tabun on the skin can be fatal. GA is a clear, colorless to brownish, oily liquid, with a slight fruity odor, like almonds. No odor when pure. *Warning:* Odor is not a reliable indicator of the presence of toxic amounts of tabun. It is tasteless. Molecular weight = 162.12; Specific gravity (H_2O:1) = 1.07 at 25°C; Boiling point = 230°C (decomposition); Freezing/Melting point = −50°C; Vapor density (air = 1) = 5.6; Vapor pressure = 0.057 mmHg at 25°C/0.07 at 24°C; Volatility = 490 mg/m^3 at 25°C; Flash point = 78°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Soluble in water; readily hydrolyzed forming hydrogen cyanide; solubility = 9.8% at 25°C/7.2 at 20°C. It is chemically similar to malathion or parathion, and other organophosphates.

Potential Exposure: GA is a highly persistent (may remain as liquid for more than 24 h) chemical warfare agent; military nerve gas. Nerve agents are more toxic and potent than insecticides. *Note:* If used as a weapon, notify US Department of Defense: Army. Damage and/or death may occur before chemical detection can take place. Use M8 paper if available (Detection: yellow) or M256-A1 Detector Kit (Detection limit: 0.005 mg/m^3).

Persistence of Chemical Agent: Tabun (GA): Summer: 10 min to 24 h; Winter: 2 h to 3 days.

Incompatibilities: Tabun (GA) decomposes slowly in water. Under acid conditions, GA hydrolyzes to form hydrofluoric acid (HF). Raising the pH increases the rate of decomposition significantly. Rapidly hydrolyzed in basic solutions (Na_2CO_3, NaOH, or KOH) with a half-life of 1.5 min at pH 11 at 25°C. GA and its hydrolysis products exhibit no significant phototransformations in sunlight. Tabun and its hydrolysis products are thermally stable at temperatures less than 49°C. Contact with metals may evolve flammable hydrogen gas. Reacts with oxidizing materials. Tabun is destroyed by bleaching powder, but the reaction produces cyanogen chloride (CNCl). Decomposes within 6 months at 60°C. Complete decomposition in 3.5 h at 150°C. May produce hydrogen cyanide, oxides of nitrogen; oxides of phosphorus; carbon monoxide; and hydrogen cyanide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) GA*
TEEL-0: 0.000125 ppm
PAC-1: 0.00042 ppm
PAC-2: **0.0053** ppm
PAC-3: **0.039** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

STEL: **0.0001** mg/m^3

The suggested permissible airborne exposure concentration for GA for an 8-h workday or a 40-h workweek is an 8 h time weight average (TWA) of 0.0001 mg/m^3 (2×10^{-5} ppm). This value is based on the TWA of GA as proposed in the USAEHA Technical Guide 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents, GA, GB, GD, and VX.*

WPL (Worker population limit): 0.00003 mg/m^3.

GPL (General population limit): 0.000001 mg/m^3.

Determination in Air: Military chemical agent detection papers and kits (M18A2 for liquid; M256A1, M8A1, M18A2, ICAD, CAM for vapor). M8, M9 paper will quickly detect the presence of a nerve agent but will not identify the type of agent being used. Also, the following may be helpful: "Accuro®" or "Accuro® 2000" (Draeger®) Air Sampling/Gas (Vapor) System; or use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; NIOSH Analytical Method #7904, Cyanides.

Determination in Water: Log K_{ow} = (estimated) 0.29; also listed at 1.4. Tabun dissolves in water and remains very dangerous. To prevent anyone from drinking water mixed with tabun, notify local health and pollution control officials. Also, notify operators of nearby water intakes and advise shutting water intakes. Use M272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Also, for cyanides, distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). If used as a weapon, utilize an M272 Water Detection Kit (Detection limit: 0.02 mg/L). Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. This material will be broken down in water quickly, but small amounts may evaporate. This material will be broken down in moist soil quickly. Small amounts may evaporate into the air or travel below the soil surface and contaminate groundwater. Persists 1½ to 2 days in soil. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride (CAS: 506-77-4). See table of contents or name index for location of entry for cyanogen chloride.

Routes of Entry: Skin absorption, absorption through eyes; and inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Tabun is a nerve agent; it acts as a cholinesterase inhibitor. The median lethal dosage (vapor/respiratory) LCt_{50} = 400 mg-min/m^3 for humans; the median incapacitating dosage is 300 mg-min/m^3. Respiratory lethal dosages kill in 1−10 min; liquid in the eye kills nearly as rapidly. The LD_{50} (skin) = 1.0g/70 kg/156.8 lb [human] (*Medical Aspects of Chemical and Biological Warfare, Part I*, Walter Reed Medical Center, 1997). Skin absorption great enough to cause death may occur in 1−2 min, but may be delayed for 1−2 h. Nerve agent symptoms include difficulty in breathing; drooling, nausea, vomiting, cramps, involuntary defecation and urination; twitching, jerking, staggering, headache, confusion, drowsiness, coma, and convulsions. Inhalation causes dimness of vision and pinpointing of the pupils. GA is an anticholinesterase agent similar in action to GB (sarin). Although only about half as toxic as GB (sarin) by inhalation, GA in low concentrations, is more irritating to the eyes than GB (sarin). The number and severity of symptoms which appear are dependent on the quantity, and rate of entry of the nerve agent which is introduced into the body (very small skin dosages sometimes cause local sweating and tremors with few other effects). Individuals poisoned by GA display approximately the same sequence of symptoms regardless of the route by which the poison enters the body (whether by inhalation, absorption, or ingestion). These symptoms, in normal order of appearance, runny nose; tightness of chest; dimness of vision and pinpointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea, vomiting, cramps; and involuntary defecation and urination; twitching, jerking, staggering, headaches, confusion, drowsiness, coma, and convulsions. These symptoms are followed by cessation of breathing and death. Onset Time of Symptoms: Symptoms appear much more slowly from skin dosage than from respiratory dosage. Although skin absorption great enough to cause death may occur in 1–2 min, death may be delayed for 1–2 h. Respiratory lethal dosages kill in 1–10 min, and liquid in the eye kills almost as rapidly. Median Lethal Dosage, animals: LD_{50} (monkey, percutaneous) = 9.3 mg/kg (shaved skin); LCt_{50} (monkey, inhalation) = 187 mg-min/m^3 ($t = 10$); Median Lethal Dosage, Man: LCt_{50} (man, inhalation) = 135 mg-min/m^3 ($t = 0.5–2$ min) at RMV (Respiratory Minute Volume) of 15 l/min; 200 mg-min/m^3 at RMV of 10 l/min.

GA is not listed by the International Agency for Research on Cancer (IARC); American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase. Liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG.

First Aid: *Inhalation:* Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil construction, a lack of coordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5- to 20-min intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *immediately*.

Eye contact: immediately flush eyes with water for 10–15 min then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken immediately to the medical treatment facility for observation.

Skin contact: Don respiratory protection mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminate. Use M258A1 and/or M291 kit for skin decontamination. Speed in removing material from skin is of extreme importance. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention *immediately*.

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. *Immediately* administer 2 mg intramuscular injection of the MARK I kit auto-injectors. Seek medical attention *immediately*.

Medical treatment: Electrocardiogram (ECG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5–10 mg in adults and 0.2–0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6–12 h to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination*:* This is very important. The rapid physical removal of a chemical agent is essential. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim canmot move, decontaminate without touching and without entering the hot or the warm zone. Nerve gases stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash–strip–wash–evacuate upwind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild-to-moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Remember that the water you use to decontaminate the victims is dangerous. Be sure you've decontaminated the victims as much as you can before they are released from the area, so they do not spread the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

*The following can be used in addition to household bleach: (1) solids, powders and solutions containing various types of bleach ($NaOCl$ or $Ca(OCl)_2$); (2) DS2 (2% $NaOH$, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide ($NaOH$) dissolved in water, phenol, ethanol, and ammonia.

Note: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes, and other items.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber gloves and Tyvek® "F" decontamination suits provide barrier protection against chemical warfare agents. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. The M40 Series mask (which replaced the M17A1 protective mask) provides respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen-deficient environment and is *not approved for civilian use*. It does not afford protection against industrial toxics, such as ammonia and carbon monoxide.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic, liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone A] require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10% wt.). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10% wt. sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% $NaOH$, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate and Supertropical

Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

GA, when used as a weapon

Small spills (From a small package or a small leak from a large package).

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages).

First: Isolate in all directions (feet/meters) 300/100.
Then: Protect persons downwind (miles/kilometers).
Day 0.4/0.6
Night 0.4/0.6

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (½ mile) in all directions; also, consider initial evacuation for 800 m (½ mile) in all directions.

Fire Extinguishing: Tabun is a combustible liquid. When heated, vapors may form explosive mixtures with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Water, fog, foam, carbon dioxide—avoid using extinguishing methods that will cause splashing or spreading of the GA. Poisonous gases, including hydrogen cyanide, oxides of nitrogen, oxides of phosphorus; carbon monoxide; and hydrogen cyanide may be produced in fire. Respiratory protection is required. Positive pressure, full face-piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Complete protection required; have decontaminants available (bleach, alkali) and atropine. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: A minimum of 56 g of decontamination solution is required for each gram of GA. The decontamination solution is agitated while GA is added and the agitation is maintained for at least 1 h. The resulting solution is allowed to react for 24 h. At the end of 24 h, the solution must be titrated to a pH between 10 and 12. After completion of the 24-h period, the decontamination solution must be treated with excess bleach (2.5 mole OCl-/mole GA) to destroy the CN formed during hydrolysis. Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents with additional bleach before affixing the drum head. All contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW, state, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, state, EPA, and DOT regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

References

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New Jersey Department of Health and Senior Services. (April 2004). *Hazardous Substances Fact Sheet: Tabun*. Trenton, NJ

Schneider, A. L., (Ed.) (2007). *CHRIS + CD-ROM Version 2.0 (United States Coast Guard Chemical Hazard Response Information System (COMDTINST 16465.12C)*. Washington, DC: United States Coast Guard and the Department of Homeland Security

Talc (no asbestos and less than 1% quartz) T:0120

Molecular Formula: $H_2Mg_3O_{12}Si$

Common Formula: $Mg_3SiO_{10}(OH)_2$

Synonyms: Agalite; Alpine talc; Asbestine; C.I. 77718; Desertalc 57; Emtal 596; Fibrene C 400; French chalk; Hydrous magnesium silicate; Lo micron talc 1; Metro talc; Mistron; Mistron star; Mistron super frost; Mistron vapor; MP-12-50; MP 25-38; NCI-C06008; Nonasbestiform talc; Nonfibrous talc; Nytal; OOS; OXO; Puretalc USP; Seawhite; Sierra C-400; Snowgoose; Steatite talc; Supreme dense; Talc (nonasbestos form); Talcum

CAS Registry Number: 14807-96-6; *(alt.)* 11119-41-8; *(alt.)* 12420-12-1; *(alt.)* 37232-12-5; *(alt.)* 99638-63-8; *(alt.)* 110540-41-5

RTECS® Number: VV8790000

EC Number: 238-877-9

Regulatory Authority and Advisory Bodies

Carcinogencity: IARC: Sufficient (*for talc containing asbestiform fibers*) Group 1; Human Inadequate Evidence (*talc not containing asbestiform fibers*) group 3; NTP (*for talc containing asbestiform fibers*): Known to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; no evidence: mouse.

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer (*talc containing asbestiform fibers*) 4/1/90

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Talc is an odorless solid which exists in both a nonasbestos form and a fibrous form. This entry will be concerned with the nonfibrous form. Molecular weight = 96.33; Freezing/Melting point = 900°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Natural Product; Primary Irritant. Talc is used in the ceramics, paint, roofing, insecticide, paper, cosmetics, lubricant, pharmaceutical, and rubber industries; electrical insulation.

Incompatibilities: None reported.

Permissible Exposure Limits in Air

For talc containing asbestos fibers: See Asbestos.

The following is for talc containing NO asbestos fibers.

OSHA PEL (*containing less than 1% quartz*): 20 mppcf TWA.

NIOSH REL: 2 mg/m^3 TWA, respirable dust.

ACGIH TLV®[1]: 2 mg/m^3 TWA (respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica); not classifiable as a human carcinogen.

NIOSH IDLH: 1000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 75 mg/m^3

PAC-3: 500 mg/m^3

Australia: TWA 2.5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 2 mg/m^3, 1993; Finland: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3 (respirable dust), 1999; United Kingdom: TWA 1 mg/m^3, respirable dust, 2000; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Determination in Air: Use NIOSH (III) P&CAM, Method #355.

Routes of Entry: Inhalation of dust, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Talc can affect you when breathed in. Can cause eye and lung irritation.

Long Term Exposure: May affect the lungs, causing talc fibrotic pneumoconiosis. Repeated high exposure can cause scarring of the lungs. Symptoms of shortness of breath and cough can develop. This disease can be disabling and fatal. Talc can cause the chest X-ray to become abnormal. Contact can cause eye irritation, and may lead to a reaction causing serious eye damage.

Points of Attack: Eyes, respiratory system; cardiovascular system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Chest X-ray every 1−3 years, after five or more years of heavy exposure should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 10 mg/m³:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m³:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 50 mg/m³:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 100 mg/m³:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); SaF (any supplied-air respirator with a full face-piece). *Up to 1000 mg/m³:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue (*only for talc containing asbestiform fibers*): Health Hazard/Poison: Store in a secure poison location. Color Code—Green (*talc powder or tablets*): General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Talc itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Talc*, Report PB-276, 678. Rockville, MD, pp. 51−53

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Talc*. Trenton, NJ

Tantalum & tantalum oxide dusts T:0130

Molecular Formula: Ta; O_5Ta_2 (oxide)

Synonyms: *Metal:* Elemental tantalum; Tantalum 181; Tantalum metal

Oxide: Tantalic acid anhydride; Tantalum(V) oxide; Tantalum pentaoxide; Tantalum pentoxide

CAS Registry Number: 7440-25-7 (elemental); 1314-61-0 (oxide)

RTECS® Number: WW5505000 (elemental)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric. UN3089 (metal powder, flammable, n.o.s.)/170

EC Number: 231-135-5; 215-238-2 (pentoxide)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent (*metal and oxide*).

Description: Tantalum is a refractory metal in Group V-B of the periodic table. The pure metal is ductile, steel-blue to gray solid or black, odorless powder. Molecular weight = 180.95; Specific gravity (H_2O:1) = 16.65 (*metal*); 14.40 (powder) at 25°C; Boiling point = 5425°C; Freezing/Melting point = 2996°C; 1872 (oxide); Maximum Explosive concentration (MEC) = <200 g/m^3. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen. Tantalum metal is used in electronic components: electric capacitors; rectifiers, in chemical equipment; in nuclear reactor components; in chemical equipment; body implants. Tantalum carbide is used in metal cutting tools and wear-resistant parts. Some tantalum salts are used in catalysts.

Incompatibilities: A combustible solid; the dry powder ignites spontaneously in air. Incompatible with lead chromate, strong oxidizers; bromine trifluoride; fluorine. Tantalum metal is attacked by hydrogen fluoride, fused alkalis, fuming sulfuric acid.

Permissible Exposure Limits in Air

(*metal, oxides, and dusts*)

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA; 10 mg[Ta]/m^3 STEL.

ACGIH TLV®[1]: Withdrawn due to insufficient data.

NIOSH IDLH: 2500 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK (*metal*): 1.5 mg/m^3, respirable fraction (previously "fine dust"); 4 mg[Ta]/m^3, inhalable fraction (previously "total dust"); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 mg/m^3, 1993; Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3, 1999; Russia: STEL 10 mg/m^3, 1993; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg. Several states have set guidelines or standards for tantalum in ambient air[60] ranging from 50−100 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: No criteria set. Insoluble.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. In animals: pulmonary irritation.

Long Term Exposure: May be a systemic poison.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 50 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or PaprTHie

(APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 2,500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red (*pyrophoric powder*): Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage.

Sipping: Metal powder, in bulk, may be pyrophoric. Flammable powder requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill if necessary; recover if possible because of economic value. Technology exists for tantalum recovery from spent catalysts, for example.

TDE T:0140

Molecular Formula: $C_{14}H_{10}Cl_4$

Common Formula: $ClC_6H_4CH(CHCl_2)C_6H_4Cl$

Synonyms: Benzene, 1,1′-(2,2-dichloroethylidene)bis(4-chloro-); 1,1-Bis(*p*-chlorophenyl)-2,2-dichloroethane; 1,1-Bis (4-chlorophenyl)-2,2-dichloroethane; 2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane; 2,2-Bis(4-chlorophenyl)-1,1-dichloroethane; DDD; *p,p*′-DDD (EPA); 1,1-Dichlor-2,2-bis(4-chlor-phenyl)-aethan (German); 1,1-Dichloro-2,2-bis(*p*-chlorophenyl) ethane; 1,1-Dichloro-2,2-bis(4-chlorophenyl)ethane; 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane; 1,1-Dichloro-2,2-di(4-chlorophenyl)ethane; *p*-,*p*-'-Dichlorodiphenyldichloroethane; Dichlorodiphenyldichloroethane; Diclorodifeniltricloroetano (Spanish); Dilene; ENT 4,225; ME-1700; NCI-C00475; Rhothane; Rhothane D-3; Rothane; *p*-,*p*-'-TDE; Tetrachlorodiphenylethane

CAS Registry Number: 72-54-8

RTECS® Number: KI070000

UN/NA & ERG Number: UN2761/151

EC Number: 200-783-0

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: rat; no evidence: mouse.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U060.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.087.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8270 (10).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 1/1/89.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: TDE is a colorless, combustible, crystalline compound. Molecular weight = 320.04; Vapor pressure = 1×10^{-6} mmHg at 20°C; Freezing/Melting point = 109−110°C. Insoluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide. In an action of March 18, 1971, EPA canceled all pesticide uses of this product which is a metabolite of DDT. Hence it is no longer manufactured commercially.

Incompatibilities: Incompatible with alkalis, strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 35 mg/m^3
PAC-3: 500 mg/m^3

Permissible Concentration in Water: For the protection of freshwater aquatic life, the value is 0.6 μg/L, based on acute toxicity. For saltwater aquatic life, the value is 3.6 μg/L, based on acute toxicity. For the protection of human health, with respect to TDE, see criteria proposed for DDT, since TDE is a metabolite of DDT. Mexico[35] has set a limit of 30 μg/L in estuaries and 3 μg/L in coastal waters. Russia set a MAC of zero in surface water used for fishery purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen-specific detection (EPA Method #608) or gas chromatography plus mass spectrometry (EPA Method #625). Fish Tox = 0.59514000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Since DDD is a metabolite of DDT, as well as a contaminant of commercial preparations of DDT, many of the effects of DDT could be mediated through DDD. Irritates the eyes, skin, and respiratory tract. May affect the central nervous system, causing convulsions and respiratory failure. Exposure may result in death. Symptoms of exposure include lethargy, anorexia, nausea, vomiting, diarrhea, paresthesia of tongue, lips, face; tremor, apprehension, dizziness, confusion, malaise (vague feeling of discomfort), headache, fatigue; convulsions; paresis of hands.

Long Term Exposure: Based on DDT, the chemical may affect the central nervous system. May damage the liver. A Suspected Human Carcinogen; there is some evidence that DDD is carcinogenic in mice; however, in other species, it appears to be noncarcinogenic. DDD has been shown to be mutagenic in drosophila, but not in yeast or bacteria. In cell culture, DDD causes chromosomal breaks.

Points of Attack: Eyes, skin, central nervous system; kidneys, liver, peripheral nervous system.

Medical Surveillance: Kidney and liver function tests. Examination of the nervous system.

First Aid: *Skin Contact*[52]*:* Flood all areas of the body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. Medical observation is recommended following acute overexposure.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Organochlorine pesticides, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC

MATERIALS." This material falls in DOT Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Dampen spilled material with acetone to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10,000.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen chloride and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit operating above 850°C equipped with HCl scrubber. Incineration above 1200°C for 1−2 s is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency. (April 30, 1980). *DDD, Health and Environmental Effects Profile No. 58*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (1980). *DDT—Ambient Water Quality Criteria*. Washington, DC

Tellurium T:0150

Molecular Formula: Te

Synonyms: Aurum paradoxum; Elemental tellurium; Metallum problematum; Telloy; Telurio (Spanish); Tellurium elemental

CAS Registry Number: 13494-80-9; *(alt.)* 137322-20-4

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

RTECS® Number: WY2625000 (elemental)

UN/NA & ERG Number: Available for Te compounds only: 3284 (tellurium compound, n.o.s.)/151

EC Number: 236-813-4

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tellurium is a grayish or silvery white, lustrous, crystalline, semimetallic element. It may exist in a hexagonal crystalline form or an amorphous powder. It is found in sulfide ores and is produced as a by-product of copper or bismuth refining. Molecular weight = 127.60; Specific gravity (H_2O:1) = 6.24 at 25°C; Boiling point = 990°C; Freezing/Melting point = 450°C; Autoignition temperature = 340°C. Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Human Data. The primary use of tellurium is in the vulcanization of rubber and as an additive in ferritic steel production. It is also used as a carbide stabilizer in cast iron, a chemical catalyst; a coloring agent in glazes and glass; a thermocoupling material in refrigerating equipment; as an additive to selenium rectifiers; in alloys of lead, copper, steel, and tin for increased resistance to corrosion and stress, workability, machinability, and creep strength; and in certain culture media in bacteriology. Since tellurium is present in silver, copper, lead, and bismuth ores, exposure may occur during purification of these ores.

Incompatibilities: Finely divided powder or dust may be flammable and explosive. Violent reaction with halogens, interhalogens, zinc and lithium silicide; with incandescence. Incompatible with oxidizers, cadmium; strong bases; chemically active metals; silver bromate; nitric acid.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Te]/m^3 TWA.

NIOSH REL: 0.1 mg[Te]/m^3 TWA, *except tellurium hexafluoride and bismuth telluride*.

ACGIH TLV®[1]: 0.1 mg[Te]/m^3 TWA, *except hydrogen telluride*.

NIOSH IDLH: 25 mg[Te]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 25 mg/m^3

Australia: TWA 0.1 mg/m^3, 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA

0.1 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg[Te]/m^3, 2003; the Philippines: TWA 0.1 mg/m^3, 1993; Poland: MAC (TWA) 0.01 mg/m^3; MAC (STEL) 0.03 mg/m^3, 1999; Sweden: NGV 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.5 mg/m^3, 1999; Turkey: TWA 0.1 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Te]/m^3. Several states have set guidelines or standards for tellurium in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7900. See also #7300, Elements: #7301; #7303; #9102; OSHA Analytical Method ID-121.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[43] set a MAC for tellurium in water bodies used for domestic purposes of 0.01 mg/L.

Routes of Entry: Inhalation of dust or fume; percutaneous absorption from dust, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Causes central nervous system depression. Moderate skin and eye irritant. Tellurium is capable of doing harm within the body by replacing the essential element sulfur. Signs and symptoms of acute exposure to tellurium may include garlicky breath, metallic taste; sweating; dry mouth; drowsiness, no sweating headache; drowsiness, malaise, fatigue, lassitude, weakness, and dizziness. Gastrointestinal symptoms may include nausea, vomiting, anorexia, and constipation. High levels of the dust or fume may cause bronchitis or pneumonia to develop. In animals: central nervous system; red blood cell changes.

Long Term Exposure: Repeated exposure can cause garlic odor on the breath, nausea, vomiting, anorexia, metallic taste, and irritability. Kidney damage, liver injury, and pulmonary effects may also occur. Dermal exposure may result in dermatitis; red, inflamed skin; drying and cracking. At doses which are severely toxic to the mother, tellurium produces teratogenic effects. May damage the unborn fetus. High exposures may cause damage to the nervous system.

Points of Attack: Skin, central nervous system; kidneys, liver.

Medical Surveillance: Oral hygiene and the respiratory tract should receive special attention in preplacement or periodic examinations. Liver and kidney function tests. Blood tests for liver and kidney function. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Give a slurry of activated charcoal in water to drink. Seek medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from tellurium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1* mg/*m^3:* 95QX [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 25 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, chlorine, cadmium. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic solid, inorganic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use water spray. Tellurium will burn only slowly in air. Straight water streams will scatter molten tellurium oxide. Wear goggles, rubber gloves, and proper respirator with filter. Poisonous gases, including tellurium, are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Tellurium*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tellurium*. Washington, DC: Chemical Emergency Preparedness Program

Tellurium hexafluoride T:0160

Molecular Formula: F_6Te

Common Formula: TeF_6

Synonyms: Tellurium fluoride

CAS Registry Number: 7783-80-4

RTECS® Number: WY2800000

UN/NA & ERG Number: UN2195/125

EC Number: 232-027-0

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥0.83.00% concentration).

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (454 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tellurium hexafluoride is a colorless gas with a repulsive odor. Molecular weight = 241.60; Boiling point = (sublimes before reaching its BP) −39°C; Freezing/Melting point = (sublimes) −38°C; Relative vapor density (air = 1) = 8.34. Decomposes in water.

Potential Exposure: Tellurium hexafluoride is stated to be a by-product of ore refining.

Incompatibilities: Hydrolyzes slowly in water to telluric acid. Emits highly toxic fumes when heated or on contact with acid or acid fumes.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.88 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.02 ppm/0.2 mg/m^3 TWA.
NIOSH REL: 0.02 ppm/0.2 mg/m^3 TWA.
ACGIH TLV®[1]: 0.02 ppm/0.2 mg/m^3 TWA.
NIOSH IDLH: 1 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 0.018 ppm
PAC-1: 0.018 ppm
PAC-2: **0.018** ppm
PAC-3: **0.053** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: 0.1 mg[Te]/m^3, inhalable fraction, as Te and its compounds.
The following is for reference and consideration in that this compound is also a fluoride compound and some foreign countries use the fluoride standard.
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration.
ACGIH TLV®[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.
NIOSH IDLH: 250 mg[F]/m^3.
Australia: TWA 0.02 ppm (0.2 mg/m^3), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Austria: MAK 0.1 mg[Te]/m^3, 1999; Belgium: TWA 0.02 ppm (0.1 mg/m^3), 1993; Denmark: TWA 0.02 ppm (0.2 mg/m^3), 1999; Finland: TWA 0.02 ppm (0.2 mg/m^3), STEL 0.06 ppm (0.6 mg/m^3), 1999; France: VME 0.02 ppm (0.2 mg/m^3), 1999; the Netherlands: MAC-TGG 0.2 mg/m^3, 2003; the Philippines: TWA 0.02 ppm (0.2 mg/m^3), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Poland: MAC (TWA) 0.01 mg[Te]/m^3; MAC (STEL) 0.03 mg[Te]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Sweden: NGV 0.1 mg[Te]/m^3, 1999; Switzerland: MAK-W 0.02 ppm (0.2 mg/m^3), 1999; United Kingdom: TWA 2.5 mg[F]/m^3; TWA 0.1 mg[Te]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.02 ppm. Several states have set guidelines or standards for TeF_6 in ambient air[60] ranging from 2.0 μg/m^3 (North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II (3), Method #S-187.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Capable of causing death or permanent injury. *Acute*: the material is highly toxic by inhalation exposure and a strong irritant to skin, eyes, lungs, throat, and stomach. Death can occur from filling of the lungs with fluid (pulmonary edema) or from asphyxiation due to spasm of the throat (larynx), or bronchi. Signs and symptoms of acute exposure to tellurium hexafluoride may include drowsiness, malaise, lassitude, weakness, and dizziness.

Long Term Exposure: Dermal exposure may result in dermatitis; red, inflamed skin; drying and cracking. May cause kidney and liver injury. A metallic taste; garlicky breath; and profuse sweating may develop. Gastrointestinal effects may include nausea, vomiting, anorexia, and constipation.

Points of Attack: Respiratory system, liver, and kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from tellurium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.2 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 1 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA

(APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Poison gas. Color Code—White Stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Color Code—Blue: Health Hazard/ Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water.

Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Tellurium hexafluoride requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3 and Packing Group I. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse vapors. Stop the flow of the leak. Remove the leaking container to a safe place in the open air and allow the leak to disperse. Use water spray to reduce vapor but do not put water on leak or spill area. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Do not get water inside container. Isolate area until gas has dispersed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 600/200.
Then: Protect persons downwind (miles/kilometers).
Day 0.8/1.2
Night 2.7/4.3/4.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000.
Then: Protect persons downwind (miles/kilometers).
Day 5.9/9.4
Night 7.0 + /11.0+

Fire Extinguishing: This chemical is a nonflammable gas. *Small fires:* dry chemical or carbon dioxide. *Large fires:* water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and full protective clothing. Do not get water inside container. Move container from fire area if you can do so without risk. Stay away from ends of tanks. Spray cooling water on containers that are exposed to flames until well after fire is out. Isolate area until gas has dispersed. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tellurium Hexafluoride*. Washington, DC: Chemical Emergency Preparedness Program

Temephos T:0170

Molecular Formula: $C_{16}H_{20}O_6P_2S_3$

Synonyms: 27165; Abat; Abate; Abathion; AC 52160; AI3-27165; American Cyanamid AC-52,160; American Cyanamid CL-52160; American Cyanamid E.I. 52,160; Biothion; Bis- *p*-(*O*,*O*-dimethyl *O*-phenylphosphorothioate) sulfide; Bithion; Cl 52160; Difenphos; Difenthos; Difos; *O*, *O*-Dimethyl phosphorothioate *O*,*O*-diester with 4,4′-thiodiphenol; Diphos; Ecopro; Ecopro 1707; EI 52160; ENT 27,165; Nephis; Nephis 1G; Nimitex; Nimitox; Phenol,4,4′-thiodi-, *O*,*O*-diester with *O*,*O*-dimethyl phosphorothioate; Phosphorothioic acid, *O*,*O*′-dimethyl ester, *O*,*O*-diester with

4,4′-thiodiphenol; Phosphorothioic acid, *O,O*′-(thiodi-*p*-phenylene) *O,O,O*′,*O*′-tetramethyl ester; Phosphorothioic acid, *O,O*′-(thiodi-4,1-phenylene) *O,O,O*′,*O*′-tetramethyl ester; Swebate; Temefos (Spanish); Temophos; Tetrafenphos; *O*, *O,O*′,*O*′-Tetramethyl *O,O*′-thiodi-*p*-phenylene bis(phosphorothioate); *O,O,O*′,*O*′-Tetramethyl *O,O*′-thiodi-*p*-phenylene phosphorothioate; Tetramethyl *O,O*′-thiodi-*p*-phenylene phosphorothioate; *O,O*′-(Thiodi-4,1-phenylene) bis(*O,O*-dimethyl phosphorothioate); *O,O*′-(Thiodi-4,1-phenylene) phosphorothioic acid *O,O,O*′,*O*′-tetramethyl ester; *O,O*′-(Thiodi-*p*-phenylene) *O,O,O*′,*O*′-tetramethyl bis(phosphorothioate)

CAS Registry Number: 3383-96-8

RTECS® Number: TF6890000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 222-191-1 [015-025-00-2]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Temephos is a crystalline solid. The technical product is a brown viscous liquid. Molecular weight = 466.48; Boiling point = 120−125°C; Freezing/Melting point = 30.6°C; Vapor pressure = 7×10^{-8} mmHg at 25°C. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Primary Irritant. Those involved in the manufacture, formulation, and application of this insecticide which is used as a mosquito, black fly, and midge larvicide.

Incompatibilities: Strong acids; bases.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA, total dust; 5 mg/m^3 TWA respirable fraction.

NIOSH REL: 10 mg/m^3 TWA, total dust; 5 mg/m^3 TWA respirable fraction.

ACGIH TLV®[1]: 1 mg/m^3 TWA, inhalable fraction and vapors [skin]; not classifiable as a human carcinogen; BEI$_A$ issued for acetylcholinesterase inhibiting pesticides.

No Teel available.

Australia: TWA 10 mg/m^3, 1993; Belgium: TWA 10 mg/m^3, 1993; France: VME 10 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3 [skin], 1993; Switzerland: MAK-W 10 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 10 mg/m^3. Several states have set guidelines or standards for temephos in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #0500, #0600; NIOSH Analytical Method PV-2056.

Permissible Concentration in Water: No criteria set. Experience in the field for a period of more than 1 year has shown, however, that 1 mg/L in drinking water is without effect.

Determination in Water: Techniques used for residue determination include colorimetry and gas liquid chromatography, and may be applicable to water analysis. Fish Tox = 16.53952000 ppb (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 5.96.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Temephos can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic organophosphate chemical. Exposure can cause rapid severe poisoning with headache, sweating, nausea, and vomiting; diarrhea, loss of coordination; and death.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 3.50000 ppb (HIGH).

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Shampoo hair promptly if contaminated. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with the crystals, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a pesticide cartridge. Increased protection is obtained from full-face-piece air-purifying respirators. Where there is potential for exposure *over 10 mg/m*^{3} as liquid temephos or for high exposures, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids and bases. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur and phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Essentially complete, hydrolysis occurs upon heating in concentrated KOH for 20 min.[22] Incineration is recommended for large quantities. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Temephos*. Trenton, NJ

TEPP T:0180

Molecular Formula: $C_8H_{20}O_7P_2$

Synonyms: Bis-*O*,*O*-diethylphosphoric anhydride; Bladan; Bladon; Diphosphoric acid, Tetraethyl ester; ENT 18,771; Ethyl pyrophosphate, *tetra*-; Fosvex; Grisol; HEPT; Hexamite; Killax; Kilmite 40; Lethalaire G-52; Lirohex; Mortopal; Motopal; Nifos; Nifos T; Nifrost; Phosphoric acid, tetraethyl ester; Pyrophosphate de tetraethyle

(French); TEP; *O,O,O,O*-Tetraaethyl-diphosphat, bis(*O,O*-diaethylphosphorsaeure-anhydrid (German); Tetraethyl pyrophosphate; Tetraethyl pyrophosphate, liquid; Tetrastigmine; Tetron; Tetron-100; Vapotone

CAS Registry Number: 107-49-3

RTECS® Number: UX6825000

UN/NA & ERG Number: UN3018 (liquid)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 203-495-3 [*Annex I Index No.:* 015-025-00-2]

Regulatory Authority and Advisory Bodies: Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P111.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50; Safety phrases: S1/2; S36/37/39; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: TEPP is a colorless to amber liquid with a faint, fruity odor. Molecular weight = 290.22; Specific gravity (H_2O:1) = 1.19 at 25°C; Boiling point = Decomposes below BP at 170°C; 138°C under 2.3 mmHg; Freezing/Melting point = 0°C; Vapor pressure = 2×10^{-4} mmHg at 25°C. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug; Human Data. Those engaged in the manufacture, formulation, and application of this aphicide and acaricide; used as an insecticide to control aphids, thrips, and mites; as an anticholinesterase.

Incompatibilities: Strong oxidizers, alkalis, water. Hydrolyzes quickly in water to form pyrophosphoric acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 11.87 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.05 mg/m^3 TWA [skin].

NIOSH REL: 0.05 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.01 mg/m^3, measured as inhalable fraction and vapor TWA [skin]; BEI$_A$ issued for acetylcholinesterase inhibiting pesticides.

NIOSH IDLH: 5 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.01 mg/m^3

PAC-1: 0.15 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 5 mg/m^3

DFG MAK: 0.005 ppm/0.06 mg/m^3; Peak Limitation Category II(2) [skin].

Arab Republic of Egypt: TWA 0.004 ppm (0.05 mg/m^3) [skin], 1993; Australia: TWA 0.004 ppm (0.05 mg/m^3) [skin], 1993; Austria: MAK 0.005 ppm (0.05 mg/m^3) [skin], 1999; Belgium: TWA 0.004 ppm (0.047 mg/m^3) [skin], 1993; Denmark: TWA 0.004 ppm (0.05 mg/m^3) [skin], 1999; France: VME 0.004 ppm (0.05 mg/m^3) [skin], 1999; the Netherlands: MAC-TGG 0.05 mg/m^3 [skin], 2003; the Philippines: TWA 0.05 mg/m^3 [skin], 1993; Switzerland: MAK-W 0.005 ppm (0.05 mg/m^3) [skin], 1999; Turkey: TWA 0.05 mg/m^3 [skin], 1993 Occupational Exposure Limit United Kingdom: TWA 0.004 ppm (0.05 mg/m^3), STEL 0.1 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.05 mg/m^3 (skin).

Several states have set guidelines or standards for TEPP in ambient air[60] ranging from 1.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (North Dakota) to 80,000 μg/m^3 (Virginia) to a much higher value for Nevada.

Determination in Air: Use NIOSH Analytical Method (IV) #2504, Tetraethyl Pyrophosphate; see also NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Symptoms of exposure include eye pain; blurred vision; lacrimation (discharge of tears); rhinorrhea (discharge of thin nasal mucous); headache, chest tightness; cyanosis, anorexia, nausea, vomiting, diarrhea, weakness, twitching, paralysis, Cheyne−Stokes respiration, convulsions, low blood pressure; cardiac irregular/irregularities; sweating. TEPP is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg (a taste) for a 150 lb person. A small drop in the eye may cause death. Small doses at frequent intervals are additive. Poisonings always develop at a rapid rate. It is a cholinesterase inhibitor.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Eyes, respiratory system; central nervous system; cardiovascular system, gastrointestinal tract; blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink. *Do NOT* induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 0.5 mg/m^3: Sa (APF = 10) (any supplied-air respirator). 1.25 mg/m^3: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 2.5 mg/m^3: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 5 mg/m^3: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Organophosphorus pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid that may be formulated with a flammable substance. Poisonous gases, including oxides of sulfur; oxides of phosphorus; and phosphoric acid, are produced in fire. Use dry chemical, carbon dioxide; or foam extinguishers if formulated with a flammable substance. Vapors are heavier than air and will collect in low areas. Vapors from a flammable carrier may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be

trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. TEPP is 50% hydrolyzed in water in 6.8 h at 25°C, and 3.3 h at 38°C; 99% hydrolysis requires 45.2 h at 25°C, or 21.9 h at 38°C. Hydrolysis of TEPP yields nontoxic products. Incineration is, however, an option for TEPP disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: TEPP*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: TEPP*. Trenton, NJ

Terbufos T:0190

Molecular Formula: $C_9H_{21}O_2PS_3$

Common Formula: $(C_2H_5O)_2PSSCH_2SC(CH_3)_3$

Synonyms: AC 921000; Counter; Counter 15G soil insecticide; Counter 15G soil insecticide-nematicide; *S*-([(1,1-Dimethylethyl)thio]methyl) *O*,*O*-diethyl phosphorodithioate; Phosphorodithioic acid, *S*-([(1,1-dimethylethyl)thio] methyl), *O*,*O*-diethyl ester; Phosphorodithioic acid, *S*-[(*tert*-butylthio)methyl], *O*,*O*-diethyl ester; *S*-[(*tert*-Butylthio) methyl] *O*,*O*-diethyl phosphorodithioate

CAS Registry Number: 13071-79-9

RTECS® Number: TD7200000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 235-963-8 [*Annex I Index No.:* 015-139-00-2]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S36/37; S45; S60. S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Terbufos is a colorless to pale yellow liquid. Molecular weight = 288.45; Boiling point = 70°C at 0.01 mm; Freezing/Melting point = −29°C; Vapor pressure = 3×10^{-4} mmHg at 20°C; Flash point = 88°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, or application of this soil insecticide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 0.01 mg/m^3 TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued (1999).

Protective Action Criteria (PAC)

TEEL-0: 0.01 mg/m^3

PAC-1: 0.03 mg/m^3

PAC-2: 1 mg/m^3

PAC-3: 1 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: The EPA (see "References" below) has developed a lifetime health advisory of 0.18 μg/L.

Determination in Water: Analysis of terbufos is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen−phosphorus containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen−phosphorus detector. Fish Tox = 0.04733000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This material may be fatal if swallowed, inhaled, or absorbed through the skin. Repeated inhalation or skin contact may progressively increase susceptibility to poisoning. Acute exposure to terbufos may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may be noted, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous

system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox: 0.90000 ppb (EXTRA HIGH).

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health-care facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organophosphorus pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." Terbufos falls in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: This is a liquid organophosphorus pesticide. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 500.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including sulfur and phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency, Office of Drinking Water. (August 1987). *Health Advisory: Terbufos*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Terbufos*. Washington, DC: Chemical Emergency Preparedness Program

Terephthalic acid T:0200

Molecular Formula: $C_8H_6O_4$

Common Formula: $HOOCC_6H_4COOH$

Synonyms: Acide terephthalique (French); *p*-Benzenedicarboxylic acid; 1,4-Benzenedicarboxylic acid; *p*-Phthalic acid; Phthalic acid, *p*-isomer; TA 12; TA

CAS Registry Number: 100-21-0

RTECS® Number: WZ0875000

EC Number: 202-830-0

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: TPA is a white crystalline solid. Molecular weight = 166.14; Specific gravity (H_2O:1) = 1.51 at 25°C; Sublimation point ≥400°C; Flash point = 260°C; Autoignition temperature = 495°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Drug, Mutagen, Primary Irritant. TPA is used primarily in the production of polyethylene terephthalate polymer for the fabrication of polyester fibers and films. A high-volume production chemical in the US.

Incompatibilities: Dust may form an explosive mixture with air. May react with strong oxidizers, such as chlorine or permanganate, and may form explosive compounds when exposed to nitric acid.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 10 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 0.1 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

The Netherlands: MAC-TGG 10 mg/m^3, 2003. Russia[43] set a MAC in work-place air of 0.1 mg/m^3. Kansas[60] has set a guideline for ambient air of 556 μg/m^3.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.96.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to mouth, nose, or throat. *Skin:* May cause irritation, especially in open cuts or sores. *Eyes:* Can cause irritation. *Ingestion:* Mildly toxic.

Long Term Exposure: No information found.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: May require supportive measures for allergic reaction. Urinary excretion is rapid.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wear a dust mask. Where there is potential for overexposure to this chemical, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in detached units of noncombustible construction. As far as possible use dust-tight equipment and vacuum cleaning.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Fine dust may form explosive mixture with air and produce a severe hazard. Use carbon dioxide, dry chemical, or water. Wear a self-contained breathing apparatus when fighting a fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (December 1979). *Information Profile on Potential Occupational Hazards—Single Chemicals: Terephthalic Acid*, Report TR 79-607. Rockville, MD, pp. 115−119

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Terephthalic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (April 2000). *Hazardous Substances Fact Sheet: Terephthalic Acid*. Trenton, NJ

Terphenyls T:0210

Molecular Formula: $C_{18}H_{14}$

Common Formula: $C_6H_5{-}C_6H_4{-}C_6H_5$

Synonyms: *ortho-isomer:* *o*-Diphenylbenzene; 1,2-Diphenylbenzene; 2-Phenylbiphenyl; *o*-Terphenyl; 1,2-Terphenyl; *o*-Triphenyl

para-isomer: *p*-Diphenylbenzene; 1,4-Diphenylbenzene; 4-Phenylbiphenyl; *p*-Terphenyl; 1,4-Terphenyl; *p*-Triphenyl

meta-isomer*:* *m*-Diphenylbenzene; 1,3-Diphenylbenzene; Isodiphenylbenzene; 3-Phenylbiphenyl; *m*-Terphenyl; 1,3-Terphenyl; *m*-Triphenyl

Hydrogenated: Hydrogenated terphenyls

Mixed isomers: Delowas S; Delowax OM; Diphenylbenzene; Gilotherm OM 2; Terbenzene; Triphenyl

CAS Registry Number: 92-06-8 (*m*-isomer); 84-15-1 (*o*-isomer); 92-94-4 (*p*-isomer); 26140-60-3 (*mixed isomers*); 61788-32-7 (hydrogenated)

RTECS® Number: WZ6470000 (*m*-isomer); WZ6472000 (*o*-isomer); WX6475000 (*p*-isomer); WZ6535000 (hydrogenated)

EC Number: 202-122-1 (*m*-); 201-517-6 (*o*-); 202-205-2 (*p*-); 247-477-3 (*mixed isomers*); 262-967-7 (hydrogenated)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*m-, o-, p*-isomers).

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: There are three isomeric terphenyls, all having the formula $C_6H_5{-}C_6H_4{-}C_6H_5$. Pure terphenyl is a white, crystalline solid. The commercial grades are light yellow. All three isomers are unusually stable toward heat. Molecular weight = 230.32 (*m-, o-, p-isomers*). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. All are insoluble in water.

The properties of the terphenyls are:

m-isomer

Specific gravity (H_2O:1) = 1.23 at 25°C; Boiling point = 365°C; Freezing/Melting point = 89°C; Vapor pressure = 0.01 mmHg at 93°C; Flash point = 191°C.

o-isomer

Specific gravity (H_2O:1) = 1.10 at 25°C; Boiling point = 332°C; Freezing/Melting point = 58°C; Vapor pressure = 0.09 mmHg at 93°C; Flash point = 163°C.

p-isomer

Specific gravity (H_2O:1) = 1.23 at 25°C; Boiling point = 405°C; Freezing/Melting point = 212.8°C; Vapor pressure = 1.23 mmHg at 93°C; Flash point = 207°C.

Potential Exposure: Compound Description (*p*-isomer): Agricultural Chemical. Terphenyl is used primarily as a heat storage and heat transfer agent. It is also used as a high-temperature lubricant; a constituent of waxes and polishes; and as a plasticizer for resin-bodied paints; as a coolant and heat storage agent.

Incompatibilities: Materials are combustible. Avoid contact with strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.57 mg/m^3 (*m- and p*-isomers); 1 ppm = 9.42 mg/m^3 at 25°C & 1 atm (*o*-isomer).

All isomers

OSHA PEL: 1 ppm/9 mg/m^3 Ceiling Concentration.

NIOSH REL: 0.5 ppm/5 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 0.53 ppm/5 mg/m^3 Ceiling Concentration.

NIOSH IDLH: 500 mg/m^3.

Protective Action Criteria (PAC)

European/International Regulations: Not listed in Annex I.

p- and *mixed isomers*

TEEL-0: 0.4 mg/m^3

PAC-1: 1.25 mg/m^3

PAC-2: 9 mg/m^3

PAC-3: 500 mg/m^3

Denmark: Ceiling Concentration 0.5 ppm (5 mg/m^3), 1999; Switzerland: MAK-W 0.5 ppm (5 mg/m^3), 1999; United Kingdom: STEL 0.5 ppm (4.8 mg/m^3), 2000.

Terphenyls, hydrogenated

Australia: Ceiling Concentration 0.5 ppm (5 mg/m^3), 1993; Belgium: Ceiling Concentration 0.5 ppm (4.9 mg/m^3), 1993; Denmark: Ceiling Concentration 0.4 ppm (4.4 mg/m^3), 1999; France: VME 0.5 ppm (5 mg/m^3), 1999; Russia: STEL 5 mg/m^3, 1993; Switzerland: MAK-W 0.5 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.5 ppm.

Russia: MAC 5 mg/m^3. Several states have set guidelines or standards for terphenyls in ambient air[60] ranging from 40 μg/m^3 (Virginia) to 50 μg/m^3 (North Dakota) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5021, *o*-terphenyl.

Routes of Entry: Inhalation of dusts and mists, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritation of eyes, skin, and respiratory tract. Skin or eye contact may cause thermal burns. Inhalation can cause lung irritation with coughing, wheezing, and/or shortness of breath. Symptoms of exposure include headache, sore throat.

Long Term Exposure: May affect the liver and kidneys. Repeated skin contact can cause dermatitis; drying and cracking. In animals: liver, kidney damage.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 25 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 50 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Terphenyls are combustible solid, but do not easily ignite. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Terphenyls*. Trenton, NJ

Testosterone T:0220

Molecular Formula: $C_{19}H_{28}O_2$

Synonyms: Androlin; Andronaq; Androst-4-en-17(β)-ol-3-one; Androst-4-en-3-one, 17-β-hydroxy-; Androst-4-en-3-one, 17-hydroxy-, (17-β)-; Andrusol; Cristerone T; Geno-cristaux gremy; Homosteron; Homosterone; 17-β-Hydroxy-4-androsten-3-one; 17-β-Hydroxyandrost-4-en-3-one; 7-β-Hydroxyandrost-4-en-3-one; Malestrone (AMPS); Mertestate; Neo-testis; Oreton; Oreton-F; Orquisteron; Perandren; Percutacrine androgenique; Primotest; Primoteston; Sustanone; Synandrol F; Teslen; Testandrone; Testiculosterone; Testobase; Testopropon; Testosteroid; Testosteron; Testosterone hydrate; Testostosterone; Testoviron schering; Testoviron T; Testrone; Testryl; Virormone; Virosterone

CAS Registry Number: 58-22-0; 57-85-2 (testosterone propionate)

RTECS® Number: XA3030000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-370-5; 200-351-1 (testosterone propionate)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, 1979.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer (testosterone and its esters) 1/1/88.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Testosterone is an odorless, white or slight cream-colored crystals or crystalline powder. Molecular weight = 288.47; Freezing/Melting point = 155°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Used as an androgenic, anabolic, and estrogenic hormone for both males and females.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

No TEEL available.

Russia[43] set a MAC in work-place air of 0.005 mg/m^3 (5 $\mu g/m^3$).

Harmful Effects and Symptoms

Short Term Exposure: Testosterone can affect you when breathed in and by passing through your skin. Testosterone is a teratogen. Handle with extreme caution. Exposure can cause nausea, upset stomach; acne, and fluid and salt retention in body tissues.

Long Term Exposure: Women can also develop male features, baldness, increased body hair; deep voice and menstrual changes. Men can have lower sperm production, painful enlarged breasts; enlarged prostate; and excess of red blood cells. Repeated exposure can cause women to develop male characteristics including face and body hair, baldness, deepened voice, and enlarged female genitalia (clitoris). Higher levels can cause irregular menstrual cycles, lighter periods, and smaller breasts. If carried home (clothing, etc.) children in the home may have stunted growth, premature puberty in boys, and masculine appearance and abnormal genitals in girls.

Points of Attack: Blood cells, sex organs.

Medical Surveillance: Frequent exams (at least monthly) are recommended to evaluate for any signs or symptoms of exposure. If exposure is suspected, the following are recommended: red blood cell count (in men). Urine test for androsterone and/or etiocholanolone. (The more common 17-ketosteroid test is not sufficiently sensitive for such exposures).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to testosterone, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Medicine, solid, toxic, n.o.s., requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Testosterone may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray; or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 81−82

New Jersey Department of Health and Senior Services. (February 17, 1987). *Hazardous Substances Fact Sheet: Testosterone*. Trenton, NJ

Tetrachloro-dibenzo-*p*-dioxin T:0230

Molecular Formula: $C_{12}H_4Cl_4O_2$

Synonyms: Dibenzo(b,e)-1,4-dioxin, 2,3,7,8-tetrachloro-; Dibenzo-*p*-dioxin, 2,3,7,8-tetrachloro-; Dioxine; Dioxin (herbicide contaminant); NCI-CO3714; TCDBD; 2,3,7,8-TCDD; TCDD; 2,3,7,8-Tetrachlorodibenzo(b,e)(1,4)dioxan; 2,3,6,7-Tetrachlorodibenzo-*p*-dioxin; 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin; 2,3,7,8-Tetrachlorodibenzo-1,4-dioxin; Tetrachlorodibenzodioxin; Tetradioxin

CAS Registry Number: 1746-01-6; *(alt.)* 56795-67-6

RTECS® Number: HP3500000

UN/NA & ERG Number: UN2811/154

EC Number: 217-122-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Limited Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; Carcinogenesis studies; on test (2-year study), October, 2000; Carcinogenesis studies; on test (prechronic studies), October, 2000; Carcinogenesis studies; test completed (peer review), October, 2000; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat;

(dermal); clear evidence: mouse; NIOSH: Potential occupational carciogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Negative: Rodent dominant lethal.

Banned or Severely Restricted (UN).[13]

Persistent Organic Pollutants (UN) *as polychlorinated dibenzo-p-dioxins*.

Very Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Safe Drinking Water Act: MCL, 0.000000003 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.000063; Nonwastewater (mg/kg), 0.001.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8250 (0.005).

Reportable Quantity (RQ): 1 lb (0.454 kg).

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 4/1/91.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

List of Stockholm Convention POPs: Annex C (Unintentional production and release) as *polychlorinated dibenzo-p-dioxins (PCDD)*.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetrachlorodibenzo-*p*-dioxin is a white, needle-shaped, crystalline solid. Molecular weight = 321.96; Boiling point = (decomposition); Freezing/Melting point = 305°C; Vapor pressure = 2×10^{-6} mmHg at 25°C. Decomposition begins at 500°C and is virtually complete within 21 s at 800°C. Very slightly soluble in water; solubility = 0.00000002%. Polychlorinated dibenzo-*p*-dioxins are formed in the manufacturing process of all chlorophenols. However, the amount formed is dependent on the degree to which the temperature and pressure are controlled during production. An especially toxic dioxin, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), is formed during the production of 2,4,5,-TCP (trichlorophenol) by the alkaline hydrolysis of 1,2,4,5-tetrachlorobenzene.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. TCDD has no uses except as a research chemical. As noted above, TCDD is an inadvertent contaminant in herbicide precursors and thus in the herbicides themselves. It is also formed during various combustion processes including the incineration of chemical wastes (chlorophenols, chlorinated benzenes, and biphenyl ethers). It may be found in flue gases, fly ash, and soot particles. It is highly persistent in soil, and contamination may be retained for years. TCDD is the most toxic of all the dioxins, and has the potential for bioaccumulation in animals. Thus, it is applied in herbicide formulations, but is not used *per se*. It has been estimated that approximately 2 million acres in the United States have been treated for weed control on one or more occasions with approximately 15 million pounds of TCDD contaminated 2,4,5,-T, 2,4,-D, or combinations of the two.

Incompatibilities: Decomposes in UV light.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: Carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

Protective Action Criteria (PAC)

TEEL-0: 0.00000001 mg/m^3

PAC-1: 0.0015 mg/m^3

PAC-2: 0.0075 mg/m^3

PAC-3: 0.0075 mg/m^3

DFG MAK: 1.0×10^{-8}, inhalable fraction Peak Limitation Category II(8) [skin]; Carcinogen Category 4; Pregnancy Risk Group C.

Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Switzerland: carcinogen, 1999. Several states have set guidelines or standards for TCDD in ambient air[60] ranging from zero (North Dakota and South Carolina) to 1.1 pg/m^3 (Massachusetts) to 0.003 ng/m^3 (North Carolina) to 0.0001 μg/m^3 (Pennsylvania) to 3.0 μg/m^3 (Virginia) to 450.0 μg/m^3 (Indiana).

Determination in Air: No method available.

Permissible Concentration in Water: There is insufficient data to permit the development of criteria for the protection of freshwater or saltwater aquatic life. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed at a concentration of 4.55×10^{-7} μg/L as of 1979. A concentration of 0.0039 μg/L was estimated to limit cancer risk to one in a million by EPA in 1980. States which have set guidelines for TCDD in drinking water include Maine at 2×10^{-4} μg/L and Minnesota at 2×10^{-6} μg/L.[61]

Determination in Water: Methylene chloride extraction followed by transfer to benzene and capillary column gas chromatography/mass spectrometry with electron impact ionization (EPA Method #613); or gas chromatography plus mass spectrometry (EPA Method #625).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Note:* 2,3,7,8-TCDD is one of the most toxic synthetic chemicals, and the most toxic of the 75 dioxins. LD_{50} = (oral-rat) 0.05 mg/kg. Exposure can cause headache, weakness, and digestive disturbances. Most symptoms develop slowly, over many days. Inhalation can cause burning sensation in nose and throat, headache, dizziness, nausea, vomiting, pain in the joints; tiredness, emotional disorders; blurred vision; muscle pain; nervousness, irritability, and intolerance to cold. Itching, swelling, and redness, followed by acne-like eruptions of the skin known as chloracne commonly occur. Symptoms of chloracne may appear weeks or months after initial exposure and may last a few months or up to 15 years. Can cause abnormalities of liver, pancreas, circulatory system, respiratory system, and death. Skin contact with very small amounts can cause chloracne. Eye contact can cause burning and irritation. Animal studies suggest that daily exposure to amounts smaller than one grain of salt may cause severe symptoms and death within a few weeks.

Long Term Exposure: Can cause effects under inhalation, especially chloracne (an acne-like skin rash), as well as numbness and tingling in arms and legs. Can cause allergic dermatitis porphyria; gastrointestinal disturbance; possible reproductive problems. A blood abnormality may occur which may include light sensitive skin, blisters, dark skin coloration; excessive hair growth and dark red urine. Reproductive problems and an increased susceptibility to infection may occur. TCDD is considered a potential occupational carcinogen because extremely low levels cause cancer and birth defects in animals. May cause liver, kidney damage. May be a teratogen. May decrease fertility in males and females.

Points of Attack: Eyes, skin, liver, kidneys, reproductive system, liver, and kidneys. Cancer site in animals: tumors at many sites; liver, lung, mouth, tongue, skin cancer. Causes lymphomas in humans.

Medical Surveillance: In short, contact with TCDD should be avoided but obviously careful preplacement and regular physical exams should be carried out in those cases where worker exposure cannot be avoided, with emphasis on liver and kidney function studies. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Liver and nerve function screening tests should be performed. Also monitor serum triglycerides and cholesterol.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Use in isolated area with adequate ventilation, preferably a hood; segregated glassware and tools; and plastic-backed absorbent. Thoroughly wash hands and forearms after each manipulation and before leaving work area. Use the same precautions required for radioactive work.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Warn other workers of spill. Wear protective clothing, collect powdered material in the most convenient and safe manner and deposit in sealed containers. Rinse area with 1,1,1-trichloroethane, then wash with detergent and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (1979). *2,3,7,8-Tetrachlorodibenzo-p-Dioxin: Ambient Water Quality Criteria*. Washington, DC

US Public Health Service. (November 1987). *Toxicological Profile for 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin*. Atlanta, GA: Agency for Toxic Substance & Disease Registry

US Environmental Protection Agency. (April 30, 1980). *TCDD, Health and Environmental Effects Profile No. 155*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 63−64

National Institute for Occupational Safety and Health. (January 23, 1984). *2,3,7,8-Tetrachlorodiabenzop-dioxin*. Current Intelligence Bulletin 40, DHHS (NIOSH), Publication No. 84-104. Cincinnati, OH

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 2,3,7,8-TCDD (Dioxin)*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (September, 2002). *Hazardous Substances Fact Sheet: 2,3,7,8-Tetrachlorodibenzo-p-dioxin*. Trenton, NJ.

Tetrachlorodifluoroethanes T:0240

Molecular Formula: $C_2Cl_4F_2$

Common Formula: Cl_2FCCl_2F; CCl_3CF_2Cl

Synonyms: *1,1,1,2-:* 1,2-Difluoro-1,1,2,2-tetrachloroethane; Ethane, 1,1,2,2-tetrachloro-1,2-difluoro-; F-112; Freon 112; Genetron 112; Halocarbon 112; Refrigerant 111; *sym*-Tetrachloro-1,2-difluoroethane; 1,1,2,2-Tetrachloro-1,2-difluoroethane; Tetrachloro-1,2-difluoroethane

1,1,2,2-: 1,1-Difluoroperchloroethane; 2,2-Difluoro-1,1,1,2-tetrachlorethane; Ethane, 1,1,1,2-Tetrachloro-2,2-difluoro-; Halocarbon 112A; Refrigerant 112A; 1,1,1,2-Tetrachloro-2,2-difluoroethane

CAS Registry Number: 76-11-9 (1,1,1,2-T-2,2,-D); 76-12-0 (1,1,2,2-T-1,2,-D)

RTECS® Number: KI1420000 (1,1,2,2-T-1,2,-D); KI1425000 (1,1,1,2-T-2,2,-D)

UN/NA & ERG Number: Not regulated.

EC Number: 200-934-0 (1,1,1,2-T-2,2,-D); 200-935-6 (1,1,2,2-T-1,2,-D)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned (both CAS numbers).

Description: 1,1,2,2-tetrachloro-1,2-difluoroethane, CCl_2-$FCCl_2F$, and 1,1,1,2-tetrachloro-2,2-difluoroethane, CCl_3-CF_2Cl, are both colorless liquids or solids with slight ether-like odor. Molecular weight = 203.82 (either compound); Specific gravity (H_2O:1) = 1.65 at 25°C (both); Boiling point 93°C (1,1,2,2-) and 91.7°C (1,1,1,2-); Freezing/Melting point = 25°C (1,1,2,2-) and 41°C (1,1,1,2-); Vapor pressure = 40 mmHg at 25°C (both); 40 mmHg at 20°C[NIOSH]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Both are practically insoluble in water; solubility = 0.01%.

Potential Exposure: Compound Description (1,1,2,2-): Tumorigen, Primary Irritant. 1,1,1,2- is used as a refrigerant, corrosion inhibitor, and blowing agent; making plastics. 1,1,2,2- is used as a refrigerant, a solvent extractant; and in the dry cleaning industry.

Incompatibilities: Acids and chemically active metals, such as potassium, beryllium, powdered aluminum; zinc, calcium, magnesium, and sodium.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 8.34 mg/m^3 (both) at 25°C & 1 atm.

(1,1,1,2-)

OSHA PEL: 500 ppm/4170 mg/m^3 TWA.

NIOSH REL: 500 ppm/4170 mg/m^3 TWA.

ACGIH TLV®[1]: 100 ppm/834 mg/m^3 TWA.

NIOSH IDLH: 2000 ppm.

DFG MAK: 200 ppm/1700 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Australia: TWA 500 ppm (4170 mg/m^3), 1993; Austria: MAK 500 ppm (4179 mg/m^3), 1999; Belgium: TWA 500 ppm (4170 mg/m^3), 1993; Denmark: TWA 500 ppm (4170 mg/m^3), 1999; Finland: TWA 500 ppm (4170 mg/m^3), STEL 625 ppm (5215 mg/m^3), 1999; France: VME 500 ppm (4170 mg/m^3), 1999; the Netherlands: MAC-TGG 4170 mg/m^3, 2003; Switzerland: MAK-W 500 ppm (4200 mg/m^3), 1999; United Kingdom: TWA 100 ppm (847 mg/m^3), STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 500 ppm.

(1,1,2,2-)

OSHA PEL: 500 ppm/4170 mg/m^3 TWA.

NIOSH REL: 500 ppm/4170 mg/m^3 TWA.

ACGIH TLV®[1]: 500 TWA.

NIOSH IDLH: 2000 ppm

Protective Action Criteria (PAC)

1,1,2,2-T-1,2,-D (76-12-0)

TEEL-0: 50 ppm

PAC-1: 150 ppm

PAC-2: 2000 ppm

PAC-3: 2000 ppm

DFG MAK: 200 ppm/1700 mg/m^3; Pregnancy Risk Group D.

Australia: TWA 500 ppm (4170 mg/m^3), 1993; Austria: MAK 200 ppm (1690 mg/m^3), 1999; Belgium: TWA 500 ppm (4170 mg/m^3), 1993; Denmark: TWA 200 ppm (1665 mg/m^3), 1999; Finland: TWA 500 ppm (4170 mg/m^3), STEL 625 ppm (5215 mg/m^3), 1999; France: VME 500 ppm (4170 mg/m^3), 1999; the Netherlands: MAC-TGG 850 mg/m^3, 2003; the Philippines: TWA 500 ppm (4170 mg/m^3), 1993; Switzerland: MAK-W 500 ppm (4200 mg/m^3), STEL 1000 ppm, 1999; United Kingdom: TWA 100 ppm (847 mg/m^3), STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 500 ppm. Several states have set guidelines or standards for these compounds in ambient air[60] ranging from 0.57 mg/m^3 (Massachusetts) to 41.7 mg/m^3 (North Dakota) to 51.7 mg/m^3 (North Carolina) to 70.0 mg/m^3 (Virginia) to 83.4 mg/m^3 (Connecticut) to 99.296 mg/m^3 (Nevada).

Determination in Air: NIOSH Analytical Method (IV) #1016; OSHA Analytical Method #7.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact with either chemical can irritate the eyes and the skin, causing a rash or a burning feeling. 1,1,1,2-Tetrachloro-2,2-difluoroethane can affect you when breathed in. May cause central nervous system depression. High levels may irritate the lungs, causing coughing, shortness of breath; drowsiness, dyspnea (breathing difficulty). Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. 1,1,2,2,-Tetrachloro-1,2-difluoroethane can affect you when breathed in. Exposure can cause you to become dizzy, lightheaded, and to pass out. Very high exposures could cause death. May affect the heart, causing an irregular rhythm. Exposure can cause you to become dizzy and lightheaded. Extremely high levels could cause you to pass out and even die. It can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Either compound may cause liver damage. Repeated exposure to either compound may reduce the number of white blood cells.

Points of Attack: Eyes, skin, respiratory system; central nervous system; heart.

Medical Surveillance: *For the 1,1,1,2-compound:* For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24-h EKG to look for irregular heart rhythms). Consider chest X-ray after acute overexposure. Liver function tests. Complete blood count (CBC). For the *1,1,2,2-compound:* If symptoms develop or overexposure has occurred, blood tests for liver function, a complete blood count (CBC) and lung function tests may be useful. If heart rhythm symptoms are occurring, special 24-h EKG test might be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. (This is particularly true of the 1,1,1,2-compound).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Barrier® and Viton gloves; Tychem® BR, Tychem® TK, Responder®, and Trellchem suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or dust-proof goggles and face shield when working with powders or dusts, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2000 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or

SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Tetrachlorodifluoroethanes must be stored to avoid contact with chemically active metals (such as sodium, potassium, beryllium, zinc, powdered aluminum, or magnesium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.
Shipping: Not regulated.
Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid in vermiculite, dry sand; earth, or similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Tetrachloro-difluoroethanes do not burn. Poisonous gases are produced in fire, including hydrogen chloride, hydrogen fluoride, and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (September 2002). *Hazardous Substances Fact Sheet: 1,1,1,2-Tetrachloro-2,2-Difluoroethane*. Trenton, NJ

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: 1,1,2,2-Tetrachloro-1,2-Difluoroethane*. Trenton, NJ

1,1,1,2-Tetrachloroethane T:0250

Molecular Formula: $C_2H_2Cl_4$
Common Formula: Cl_3CCH_2Cl
Synonyms: Ethane, 1,1,1,2-tetrachloro-; NCI-C52459; 1,1,1,2-Tetracloroetano (Spanish)
CAS Registry Number: 630-20-6
RTECS$^{®}$ Number: KI8450000
UN/NA & ERG Number: UN1702/151
EC Number: 211-135-1
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat.

NTP: Toxicity studies, RPT#TOX-45, October 2000.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U208.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5).

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1,1,1,2-Tetrachloroethane is a colorless to yellowish-red liquid. Molecular weight = 167.84; Specific gravity (H_2O:1) = 1.54 at 25°C; Boiling point = 135.6°C; Freezing/Melting point = −70°C; Vapor pressure = 14 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.1%.
Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. 1,1,1,2-Tetrachloroethane is used as a solvent and in manufacture of insecticides, herbicides, soil fumigants; blanches, paints, and a number of widely used products; as are the other chloroethanes.
Incompatibilities: Oxidizers, strong bases; dinitrogen tetraoxide, metal caustics, hot iron, potassium hydroxide, nitrogen tetroxide; 2,4-dinitrophenyl disulfide, chemically active metals: potassium, sodium, magnesium, and zinc.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: No numerical value but users are cautioned to handle with caution in the workplace. See *NIOSH Pocket Guide*, Appendix C.
Protective Action Criteria (PAC)
TEEL-0: 3 ppm

PAC-1: 7.5 ppm
PAC-2: 30 ppm
PAC-3: 30 ppm

Brazil[35] 4 ppm (27 mg/m^3) for work-place air over a 48-h week. Russia[43] set a MAC for tetrachloroethanes (no isomer indicated) of 5 mg/m^3 in work-place air.

Determination in Air: No method available.

Permissible Concentration in Water: For 1,1,1,2-tetrachoroethane the criterion to protect freshwater aquatic life is 9320 μg/L based on acute toxicity data. For saltwater aquatic life, no criterion for 1,1,1,2-tetrachloroethane can be derived using the guidelines, and there is insufficient data to estimate a criterion using other procedures. For the protection of human health, there is insufficient data to derive criteria for 1,1,1,2-tetrachloroethane.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.4$.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Contact irritates the eyes and skin. Inhalation can irritate the respiratory tract causing coughing, wheezing, and/or shortness of breath. Can cause headache, nausea and vomiting. May cause central nervous system depression. Symptoms of exposure include weakness, restlessness, tremor, dizziness, drowsiness, irregular/irregularities of respiration; decreased muscle coordination; coma.

Long Term Exposure: There is limited evidence that this chemical causes liver cancer in animals. Can cause dermatitis; drying and cracking. May affect the liver and nervous system.

Points of Attack: Eyes, skin, central nervous system; liver.

Medical Surveillance: Liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from potassium, sodium, dinitrogen tetraoxide; potassium hydroxide; nitrogen tetroxide; sodium potassium alloy; 2,4-dinitrophenyl disulfide. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded.

Shipping: Tetrachloroethane requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Poisonous gases, including chlorine and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 30, 1980). *1,1,1,2-Tetrachloroethane, Health and Environmental Effects Profile No. 156*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (1980). *Chlorinated Ethanes: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 93−95

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: 1,1,1,2-Tetrachloroethane*. Trenton, NJ

1,1,2,2-Tetrachloroethane T:0260

Molecular Formula: $C_2H_2Cl_4$

Common Formula: $CHCl_2CHCl_2$

Synonyms: Acetylene tetrachloride; Bonoform; Cellon; 1,1-Dichloro-2,2-dichloroethane; Ethane,1,1,2,2-tetrachloro-; NCI-C03554; *sym*-Tetrachloroethane; TCE; 1,1,2,2-Tetrachloraethan (German); 1,1,2,2-Tetrachlorethane (French); Tetrachlorethane; 1,1,2,2-Tetrachloro-; Tetrachlorure d'acetylene (French); Westron

CAS Registry Number: 79-34-5

RTECS® Number: KI8575000

UN/NA & ERG Number: UN1702/151

EC Number: 201-197-8 [*Annex I Index No.:* 602-015-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse; equivocal evidence: rat; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: *E. coli* polA without S9; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*—homozygosis; *S. cerevisiae*—reversion; Positive/limited: Carcinogenicity—mouse/rat.

NTP: Toxicity studies, RPT-TOX-45, October 2000.

Banned or Severely Restricted (UK, Belgium) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U209.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List.

Suggested methods (PQL μg/L): 8010 (0.5); 8240 (5).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0.

Safe Drinking Water Act: Priority List (55 FR 1470).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

California Proposition 65 Chemical: Cancer 1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R26/27; R51/53; Safety phrases: S1/2; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Tetrachloroethane is a heavy, volatile colorless to light yellow liquid. It has a sweetish, chloroform-like odor. The odor threshold is 0.5 ppm in water and 1.5 ppm in air. Molecular weight = 146.3; Specific gravity (H_2O:1) = 1.59 at 25°C; Boiling point = 146.7°C; Freezing/Melting point = −36.1°C; Vapor pressure = 5.8 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.29% at 20°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Human Data. Tetrachloroethane is used as an intermediate in the trichloroethylene production from acetylene and as a solvent; as a dry cleaning agent; as a fumigant; in cement; and in lacquers. It is used in the manufacture of artificial silk, artificial leather, and artificial pearls. Recently, its use as a solvent has declined due to replacement by less toxic compounds. It is also used in the estimation of water content in tobacco and many drugs, and as a solvent for chromium chloride impregnation of furs.

Incompatibilities: Violent reaction with chemically active metals; strong caustics; strong acids; especially fuming sulfuric acid. Degrades slowly when exposed to air. Attacks plastic and rubber.

Permissible Exposure Limits in Air

OSHA PEL: 5 ppm/35 mg/m^3 TWA [skin].

NIOSH REL: 1 ppm/7 mg/m^3 TWA [skin]; potential occupational carcinogen; See *NIOSH Pocket Guide*, Appendix A and C (chloroethanes).

ACGIH TLV®[1]: 1 ppm/6.9 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: potential occupational carcinogen 100 ppm.
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 3 ppm
PAC-2: 20 ppm
PAC-3: 100 ppm
DFG MAK: 1 ppm/7.0 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B; Pregnancy Risk Group D.
Australia: TWA 1 ppm (7 mg/m^3) [skin], 1993; Austria: MAK 1 ppm (7 mg/m^3) [skin], Suspected: carcinogen, 1993; Belgium: TWA 1 ppm (6.9 mg/m^3) [skin], 1993; Denmark: TWA 1 ppm (7 mg/m^3) [skin], 1999; Finland: TWA 1 ppm (7 mg/m^3), STEL 3 ppm (21 mg/m^3) [skin], 1999; France: VME 1 ppm (7 mg/m^3), VLE 5 ppm (35 mg/m^3), 1999; Japan: 1 ppm (6.9 mg/m^3) [skin], 1999; the Netherlands: MAC-TGG 7 mg/m^3 [skin], 2003; Norway: TWA 1 ppm (7 mg/m^3), 1999; the Philippines: TWA 5 ppm (35 mg/m^3) [skin], 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 35 mg/m^3, 1999; Russia: TWA 1 ppm, 1993; Switzerland: MAK-W 1 ppm (7 mg/m^3) [skin], 1999; Turkey: TWA 5 ppm (35 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC for ambient air in residential areas[35] of 60 μg/m^3 on a once-daily basis. Several states have set guidelines or standards for 1,1,2,2-tetrachloroethane in ambient air[60] ranging from zero (North Carolina) to 1.2 μg/m^3 (Massachusetts) to 16.667 μg/m^3 (Kansas) to 23.3 μg/m^3 (New York) to 34.4 μg/m^3 (Connecticut) to 167.0 μg/m^3 (Pennsylvania).

Determination in Air: Adsorption on charcoal, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1019.[18]

Permissible Concentration in Water: *To protect freshwater aquatic life:* 9320 μg/L on an acute toxicity basis and 2400 μg/L on a chronic basis. *To protect saltwater aquatic life:* 9020 μg/L on an acute toxicity basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 1.7 μg/L. Russia[43] set a MAC in water bodies used for domestic purposes of 200 μg/L for tetrachloroethanes in general. Several states have set guidelines for 1,1,2,2-tetrachloroethane in drinking water[61] ranging from 0.5 μg/L (Arizona) to 1.7 μg/L (Kansas and Vermont) to 1.75 μg/L (Minnesota). New Mexico has set a standards of 10.0 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method #601) or gas chromatography plus mass spectrometry (EPA Method #624).

Routes of Entry: Inhalation of vapor and absorption of liquid through the skin (there is some evidence that tetrachloroethane absorbed through the skin affects the central nervous system only), ingestion, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A central nervous system depressant. Symptoms may include nervousness, loss of appetite; constipation, tremors, fatigue, dizziness, nausea, vomiting, and headache. May cause liver and kidney damage. These symptoms have been reported after prolonged exposure to 75 ppm. *Inhalation:* Exposure of 116 ppm for 20 min has caused dizziness and vomiting. At 260 ppm for 10 min, irritation of nose and throat were felt also. At 335 ppm for 10 min, rapid fatigue was also experienced. These symptoms generally disappear when exposure stops. Large accidental exposures have resulted in death. *Skin:* Causes skin irritation. Absorption through skin is possible. Significant skin absorption may occur to produce toxic effects. Earliest and most common symptom is tremors of hands, followed by skin irritation, numbness, and effects listed above. Death has occurred from a combination of inhalation and skin absorption. *Eyes:* Causes irritation and tearing. *Ingestion:* Abdominal pain; nausea, and vomiting followed by similar symptoms as *inhalation.* As little as 3 mL (1/10 liquid oz) may cause unconsciousness. LD_{50} = (oral-rat) 25 mg/kg.

Long Term Exposure: Repeated exposure may cause dermatitis, drying and cracking. May damage the blood forming organs, causing monocytosis (increased blood monocytes). May affect the central nervous system causing tremors, weakness, dizziness, decreased coordination; and even unconsciousness and death. May cause kidney and liver damage; jaundice, hepatitis, liver tenderness. Tetrachloroethane is a mutagen and a potential occupational carcinogen. There is limited evidence that this chemical is a teratogen in animals.

Points of Attack: Skin, liver, kidneys, central nervous system; gastrointestinal tract. Cancer site in animals: liver tumors.

Medical Surveillance: NIOSH lists the following tests: Blood Urea Nitrogen; liver function tests; urinalysis (routine). Preplacement and periodic examination should be comprehensive because of the possible involvement of many systems. Special attention should be given to liver, kidney, and bone marrow function, as well as to the central and peripheral nervous system. Alcoholism may be a predisposing factor.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact.

Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™, Viton™, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. 1,1,2,2-Tetrachloroethane must be stored to avoid contact with chemically active metals (such as potassium, powdered aluminum; sodium, magnesium, and zinc) or strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Tetrachloroethane requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. 1,1,2,2-Tetrachloroethane itself does not burn. Poisonous gases, including phosgene, chlorine, and hydrogen chloride, are produced in fire. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to 1,1,2,2-Tetrachoroethane*. NIOSH Document No. 77-121. Washington, DC

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: 1,1,2,2-Tetrachloroethane*. Washington, DC

US Environmental Protection Agency. (1980). *Chlorinated Ethanes: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *1,1,2,2-Tetrachloroethane, Health and Environmental Effects Profile No. 157*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 84−85 (1981); 2, No. 6, 79−83 (1982); and 3, No. 2, 60−64 (1983)

US Public Health Service. (December 1988). *Toxicological Profile for 1,1,2,2-Tetrachloroethane*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (October 1999). *Hazardous Substances Fact Sheet: 1,1,2,2-Tetrachloroethane*. Trenton, NJ

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 1,1,2,2-Tetrachloroethane*. Albany, NY: Bureau of Toxic Substance Assessment (Version 3)

Tetrachloroethylene T:0270

Molecular Formula: C_2Cl_4
Common Formula: $Cl_2C{=}CCl_2$
Synonyms: Ankilostin; Antisal 1; Carbon bichloride; Carbon dichloride; Didakene; Dilatin PT; Dowper; ENT 1,860; Ethene, tetrachloro-; Ethylene tetrachloride; Ethylene tetrachloro-; Fedal-UN; Freon 1110; NCI-C04580; Nema; PER; Perawin; PERC; Perchlor; Perchloraethylen, per (German); Perchlorethylene; Perchlorethylene, per (French); Perclene; Percloroetileno (Spanish); Percosolve; PERK; Perklone; Persec; Tetlen; Tetracap; Tetrachloraethen (German); 1,1,2,2-Tetrachloroethene; Tetrachloroethene; 1,1,2,2,-Tetrachloroethylene; Tetrachloroethylene; Tetracloroetileno (Spanish); Tetraleno; Tetralex; Tetravec; Tetroguer; Tetropil
CAS Registry Number: 127-18-4
RTECS® Number: KX3850000
UN/NA & ERG Number: UN1897
EC Number: 204-825-9
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, Limited Evidence, Group 2A, 1995; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; Carcinogenesis Bioassay (gavage); inadequate studies: rat; NTP: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NIOSH: Potential occupational carcinogen.
US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; Positive/limited: Carcinogenicity—mouse/rat; Negative: Cell transform.—SA7/SHE.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Banned or Severely Restricted (Japan) (UN).[13]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); 40CFR401.15 Section 307 Toxic Pollutants.
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.
US EPA Hazardous Waste Number (RCRA No.): U210.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 6.0.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5).
Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Chemical: Cancer 4/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.
Description: Tetrachloroethylene is a clear, colorless, nonflammable liquid with a characteristic odor. The odor is noticeable at 47 ppm, though after a short period it may become inconspicuous, thereby becoming an unreliable warning signal. The odor threshold is variously given as 5 ppm[41] to 6.17 (3M). Molecular weight = 165.82; Specific gravity (H_2O:1) = 1.62 at 25°C; Boiling point = 121.1°C; Freezing/Melting point = −18.9°C; Vapor pressure = 14 mmHg at 25°C. Slightly soluble in water; solubility = 0.02%.
Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Tetrachloroethylene is used in the textile industry and as a chemical intermediate or a heat-exchange fluid; a widely used solvent with particular use as a dry cleaning agent; a degreaser; a fumigant, and medically as an anthelmintic.
Incompatibilities: Violent reaction with strong oxidizers; powdered, chemically active metals, such as aluminum, lithium, beryllium, and barium; caustic soda; sodium hydroxide; potash. Tetrachloroethylene is quite stable. However, it reacts violently with concentrated nitric acid to give carbon dioxide as a primary product. Slowly decomposes on contact with moisture producing trichloroacetic acid and hydrochloric acid. Decomposes in UV light and in temperatures above 150°C, forming hydrochloric acid and phosgene.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 6.78 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 300 ppm (5-min maximum peak in any 3 h).
NIOSH REL: Potential occupational carcinogen; limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 25 ppm/170 mg/m^3 TWA; 100 ppm/685 mg/m^3 STEL, animal carcinogen with unknown relevance to humans; BEI issued.
NIOSH IDLH: potential occupational carcinogen 150 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 25 ppm
PAC-1: **35** ppm
PAC-2: **230** ppm
PAC-3: **1200** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
DFG MAK: [skin]; Carcinogen Category 3B; BAT: 1 mg [tetrachloroethylene]/L in blood at the beginning of the next shift.

Arab Republic of Egypt: TWA 5 ppm (35 mg/m^3) [skin], 1993; Australia: TWA 50 ppm (335 mg/m^3), STEL 150 ppm, carcinogen, 1993; Austria: MAK 50 ppm (345 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (339 mg/m^3), STEL 200 ppm (1368 mg/m^3), 1993; Denmark: TWA 10 ppm (70 mg/m^3) [skin], 1999; Finland: TWA 50 ppm (335 mg/m^3), STEL 75 ppm (520 mg/m^3) [skin], 1999; France: VME 50 ppm (335 mg/m^3), carcinogen, 1999; the Netherlands: MAC-TGG 240 mg/m^3 [skin], 2003; Japan: 50 ppm (340 mg/m^3), 2B carcinogen, 1999; Norway: TWA 20 ppm (130 mg/m^3), 1999; the Philippines: TWA 100 ppm (670 mg/m^3), 1993; Poland: MAC (TWA) 60 mg/m^3; MAC (STEL) 480 mg/m^3, 1999; Russia: TWA 50 ppm, STEL 10 mg/m^3, 1993; Sweden: NGV 10 ppm (70 mg/m^3), KTV 25 ppm (170 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 50 ppm (345 mg/m^3), STEL 100 ppm [skin], 1999; Thailand: TWA 100 ppm, STEL 200 ppm, 1993; United Kingdom: TWA 50 ppm (345 mg/m^3), STEL 199 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm. Limits in ambient air in residential areas have been set by The Czech Republic[35] at 1.0 mg/m^3 on a daily average basis and 4.0 mg/m^3 on a half-hour basis as well as by Russia at 0.06 mg/m^3 on a daily average basis and 0.5 mg/m^3 on a once-daily basis. Several states have set guidelines or standards for tetrachloroethylene in ambient air[60] ranging from 0.05 μg/m^3 (Rhode Island) to 0.18 μg/m^3 (Massachusetts) to 1.7 μg/m^3 (Michigan) to 5.882 μg/m^3 (Kansas) to 21.0 μg/m^3 (North Carolina) to 1116.0 μg/m^3 (New York) to 1700.0 μg/m^3 (Connecticut) to 3350.0 μg/m^3 (Indiana, South Carolina, South Dakota) to 3350−13,400 μg/m^3 (North Dakota) to 5600 μg/m^3 (Virginia) to 7976.0 μg/m^3 (Nevada) to 8040 μg/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated[18]; #2549, Volatile organic compounds; OSHA Analytical Method #1001.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 5,280 μg/L on an acute toxicity basis and 840 μg/L on a chronic toxicity basis. *To protect saltwater aquatic life:* 10,200 μg/L on an acute toxicity basis and 450 μg/L on a chronic toxicity basis. *To protect human health:* preferably 0. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 8.0 μg/L.[6] A lifetime health advisory of 10 μg/L has been suggested by EPA.[48] A drinking water maximum of 5 μg/L has more recently been suggested by EPA.[62] WHO[35] has set 10 μg/L as a guideline for drinking water as has Japan. Several states have set guidelines for PCE in drinking water[61] ranging from 0.67 μg/L (New Hampshire) to 1.0 μg/L (Arizona) to 4.0 μg/L (California) to 5.0 μg/L (Colorado) to 7.0 μg/L (Kansas and Vermont) to 20.0 μg/L (Connecticut, Massachusetts and Wisconsin) to 35.0 μg/L (Maine). Standards have been set at 1.0 μg/L (New Jersey) to 3.0 μg/L (Florida) to 20.0 μg/L (New Mexico).

Determination in Water: Inert gas purge followed by gas chromatography with halide-specific detection (EPA Method #601); or gas chromatography plus mass spectrometry (EPA Method #624). Octanol−water coefficient: Log K_{ow} = 2.9.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Irritates the eyes and respiratory tract causing coughing and/or shortness of breath. High exposure can cause headache, dizziness, lightheadedness, nausea, vomiting, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Exposures of 200 ppm for 1 h can cause irritation of the nose, mouth and throat; dizziness, headaches and lightheadedness; exposures of 1000 ppm for 30 min can cause difficult breathing; weakness, loss of muscle control; irritability, tremors, convulsions, paralysis, coma, heart irregularities and death. *Skin:* Contact can cause irritation and burns. Can cause dry, scaly skin; a mild-to-moderate burning sensation; redness and inflammation. *Eyes:* Can cause burning and irritation. *Ingestion:* Can cause nausea, vomiting, diarrhea, bloody stool; a reddening of face and neck; weakness and loss of muscle control.

Long Term Exposure: May affect the liver, kidneys, and nervous system. Exposures *over 200 ppm* during weeks or months can cause irritation of the respiratory tract, nausea, headache, sleeplessness, abdominal pain; constipation, dizziness, increased perspiration; fatigue, skin infection; kidney and liver damage; fluid in the lungs and coma. Long term exposure can cause dermatitis; drying and cracking of the skin. Tetrachloroethylene has caused liver cancer and birth defects in mice. Whether it causes cancer in humans is unknown. May damage the developing fetus.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: urinalysis. Liver function tests. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Special 24-h EKG (Holter monitor) to look for irregular hearth beat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Exposure to tetrachloroethylene should not be controlled with the use of respirators except: during the time period necessary to install or implement engineering or work practice controls; in work situations in which engineering and work practice controls are technically not feasible; to supplement engineering and work practice controls when such controls fail to adequately control exposure to tetrachloroethylene; for operations which require entry into tanks or closed vessels; or in emergencies.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Tetrachloroethylene must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and chlorine dioxide; chemically active metals, such as barium, lithium, and beryllium; and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Tetrachloroethylene requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Tetrachloroethylene itself does not burn. Poisonous gases, including hydrogen chloride, phosgene, and chlorine are produced in fire or heat above 150°C. Vapors are heavier than air and will collect in low areas. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Alternatively, PCE may be recovered from waste gases and reused.

References

National Institute for Occupational Safety and Health. (1986). *Criteria for a Recommended Standard: Occupational Exposure to Tetrachloroethylene*. NIOSH Document 76-185

National Institute for Occupational Safety and Health. (January 20, 1978). *Current Intelligence Bulletin No. 20: Tetrachloroethylene*. Washington, DC

US Public Health Service. (December 1987). *Toxicological Profile for Tetrachloroethylene*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

US Environmental Protection Agency. (1980). *Tetrachloroethylene: Ambient Water Quality Criteria*. Washington, DC

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US Environmental Protection Agency. (April 30, 1980). *Tetrachloroethylene, Health and Environmental Effects Profile No. 158*. Washington, DC: Office of Solid Waste

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Tetrachloroethylene*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Tetrachloroethylene*. Trenton, NJ

Tetracycline T:0280

Molecular Formula: $C_{22}H_{24}N_2O_8$

Synonyms: Abramycin; Abricycline; Achromycin; Agromicina; Ambramicina; Ambramycin; Bio-tetra; Bristaciclin; Bristacycline; Cefracycline suspension; Criseocicline; Cyclomycin; Democracin; Deschlorobiomycin; Hostacyclin; Liquamycin; 6-Methyl-1,11-dioxy-2-naphthacenecarboxamide; Neocycline; Oletetrin; Panmycin; Polycycline; Purocyclina; Robitet; Sanclomycine; Sigmamycin; SK-Tetracycline; Steclin; T-125; Tetrabon; Tetracycline I; Tetracyn; Tetradecin; Tetraverine; Tsiklomitsin; ω-Mycin

Hydrochloride: Achro; Achromycin; Achromycin hydrochloride; Achromycin V; AI3-50120; Amycin, hydrochloride; Artomycin; Bristacycline; Cefracycline tablets; Chlorhydrate de tetracycline (French); Diacycine; 4-(Dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6,10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-2-naphthacenecarboxamide monohydrochloride; Dumocycin; Medamycin; Mephacyclin; 2-Naphthacenecarbo xamide, 4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6,10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-, monohydrochloride; 2-Naphthacenecarbo xamide,4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6, 10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-, monohydrochloride [4s-(4a,4a.a,5aa,6b,12aa)]-; NCI-C55561; Neocyclin; Paltet; Panmycin hydrochloride; Polycycline hydrochloride; Qidtet; Quadracycline; Remicyclin; Ricycline; RO-Cycline; SK-Tetracycline; Steclin hydrochloride; Stilciclina; Subamycin; Supramycin; Sustamycin; T-250 Capsules; TC Hydrochloride; Tefilin; Teline; Telotrex; TET-CY; Tetrabakat; Tetrablet; Tetracaps; Tetrachel; Tetracompren; Tetracycline chloride; Tetracyn hydrochloride; Tetra-D; Tetralution; Tetramavan; Tetramycin; Tetrasure; Tetra-Wedel; Tetrosol; Topicycline; Totomycin; Triphacyclin; U-5965; Unicin; Unimycin; Vetquamycin-324

CAS Registry Number: 60-54-8; 64-75-5 (hydrochloride)

RTECS® Number: QI8750000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-481-9; 200-593-8 (hydrochloride)

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (several countries) (UN).[13]

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Hydrochloride:

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin [Tetracycline (internal use)] 10/1/92; [Tetracycline hydrochloride (internal use)] 1/1/91.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetracycline trihydrate is a white crystalline substance. Molecular weight = 444.48; Freezing/Melting point = 170−175°C (decomposition). It is commonly employed as the *hydrochloride*; Molecular weight = 480.94; Freezing/Melting point = 214°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Tetracycline is slightly soluble in water; the hydrochloride is highly soluble in water.

Potential Exposure: Tetracycline is an antibiotic medicine used as capsules, tablets, or intravenous injections against certain infections in humans and animals.

Incompatibilities: Although no dangerous incompatibilities are reported, the potency of this medicine is reduced by heat, sunlight, and solutions with pH <2; and destroyed by caustic hydroxide solutions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.75 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

Russia[43] set a MAC in work-place air of 0.1 mg/m^3 and also MAC values for ambient air in residential areas of 0.01 mg/m^3 on a momentary basis and 0.006 mg/m^3 on a daily average basis.

Determination in Air: No method available.

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Tetracycline can affect you when breathed in. Exposure can cause sneezing, itching of the nose; stomach upset; vomiting and diarrhea.

Long Term Exposure: Tetracycline can cause an allergic skin rash to develop. If skin allergy develops, sunlight may exacerbate the reaction. May cause stomach upset with nausea, vomiting, and diarrhea. Tetracycline is used as a medical drug. Used that way, it may cause liver and kidney damage. It is not known if this can occur with occupational exposure. May cause mutations. Whether it poses a cancer risk requires more study. Handle with extreme caution. It may also damage the developing fetus.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sunlight, heat, and caustic materials.

Shipping: Medicine, solid, toxic, n.o.s., requires a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any agent suitable for surrounding fires. Poisonous gases are produced in fire, including nitrogen oxides (and in the case of the *hydrochloride:* hydrogen chloride). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (February 1986). *Hazardous Substances Fact Sheet: Tetracycline*. Trenton, NJ

Tetraethylenepentamine T:0290

Molecular Formula: $C_8H_{23}N_5$

Common Formula: $H_2N(C_2H_4NH)_3C_2H_4NH_2$

Synonyms: *N*-(2-Aminoethyl)-*N*-(2-[(2-aminoethyl) amino] ethyl-1,2-ethanediamine); Amino ethyl-1,2-ethanediamine; D.E.H. 26; 1,2-Ethanediamine, *N*-(2-aminoethyl)-*N*′-(2-aminoethyl) aminoethyl-; 1,2-Ethanediamine, *N*-(2-aminoethyl)-*N*′-[2-(2-aminoethyl)ethyl]-; 1,4,7,10,13-Pentaazatridecane

CAS Registry Number: 112-57-2

RTECS® Number: KH8585000

UN/NA & ERG Number: UN2320/153

EC Number: 203-986-2 [*Annex I Index No.:* 612-060-00-0]

Regulatory Authority and Advisory Bodies

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R21/22; R34; R43; R51/53; Safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Tetraethylenepentamine is a yellow, viscous liquid. Molecular weight = 189.36; Boiling point = 333−340°C; Freezing/Melting point = −40 to −30°C; Flash point = 163−185°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Tetraethylenepentamine is used as a solvent for resins and dyes, in manufacture of synthetic rubber; and intermediate for oil additives; in papermaking.

Incompatibilities: Violent reaction with strong oxidizers. This chemical is strongly alkaline; reacts with acids.

Permissible Exposure Limits in Air

AIHA WEEL: 5 mg/m^3 TWA [skin]; Potential for dermal sensitization.

Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 50 mg/m^3
PAC-2: 350 mg/m^3
PAC-3: 500 mg/m^3

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Tetraethylenepentamine can affect you when breathed in and by passing through your skin. Tetraethylenepentamine is a corrosive chemical, and skin or eye contact can cause burns. The vapor is strongly irritating to the nose, throat, and bronchial tubes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure may damage the liver, kidneys, heart muscle, and/or brain; impairing thinking, reasoning, and concentration. Some related chemicals can cause a skin or lung allergy to develop. It is not known whether this chemical can cause the same allergies.

Points of Attack: Lungs, liver, kidneys, heart, brain.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Exam of central nervous system. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer 50/50 solution of vinegar/water, water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to tetraethylenepentamine, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Tetraethylenepentamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where tetraethylenepentamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Tetraethylenepentamine requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides; are produced in fire. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (February 2000). *Hazardous Substances Fact Sheet: Tetraethylenepentamine*. Trenton, NJ

Tetraethyl lead T:0300

Molecular Formula: $C_8H_{20}Pb$

Common Formula: $Pb(C_2H_5)_4$

Synonyms: Lead, tetraethyl-; Motor fuel antiknock compound; NCI-C54988; NSC-22314; Piombo tetra-etile; Plumbane, tetraethyl-; TEL; Tetraethylolovo; Tetraethylplumbane; Tetraethylplumbium

CAS Registry Number: 78-00-2

RTECS® Number: TP4550000

UN/NA & ERG Number: UN1649/131

EC Number: 201-075-4; Listed in part 3 of Annex I to Regulation (EC) 689/2008; HS 2931.00.

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE.

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P110.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (liquid).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: listed in Annex 1, Part 3 without Index Number.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Tetraethyl lead is a colorless oily liquid with a sweet, slight musty odor. In commerce it is usually dyed red, orange, or blue. Tetraethyl lead will decompose in bright sunlight yielding needle-like crystals of tri-, di-, and mono-ethyl lead compounds, which have a garlic odor. Molecular weight = 323.47; Specific gravity (H_2O:1) = 1.65 at 25°C; Boiling point = (decomposes) 118.9°C; Freezing/Melting point = −130°C; Vapor pressure = 0.2 mmHg at 25°C; Flash point = 93°C; Autoignition temperature ≥110°C. Explosive limits: LEL = 1.8%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 3. Practically insoluble in water; solubility = 0.00002%.

Potential Exposure: Compound Description: Tumorigen, Organometallic, Mutagen; Reproductive Effector; Human Data. Tetraethyl lead is used as a component of antiknock mixes for gas and as an intermediate in making fungicides; Tetraethyl lead (used as an antiknock compound in gasoline) can also contain impurities, such as *ethylene dibromide* and *ethylene dichloride*.

Incompatibilities: Violent reaction with strong oxidizers, sulfuryl chloride; halogens, oils and fats; rust, potassium permanganate. Decomposes slowly in light and at room temperature, and more rapidly at temperatures above 110°C. Attacks rubber and some plastics and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 0.075 mg[Pb]/m^3 TWA [skin].

NIOSH REL: 0.075 mg[Pb]/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg[Pb]/m^3 [skin]; not classifiable as a human carcinogen.

NIOSH IDLH: 40 mg[Pb]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1170 mg/m^3

PAC-1: 0.468 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 62.4 mg/m^3

DFG MAK: 0.05 mg[Pb]/m^3; Peak Limitation Category II (2) [skin]; Pregnancy Risk Group B.

Arab Republic of Egypt: TWA 0.1 mg/m^3, 1993; Australia: TWA 0.1 mg/m^3 [skin], 1993; Austria: MAK 0.1 ppm (0.075 mg/m^3) [skin], 1999; Belgium: TWA 0.1 mg/m^3 [skin], 1993; Denmark: TWA 0.007 ppm (0.05 mg/m^3) [skin], 1999; France: VME 0.10 mg/m^3 [skin], 1999; Hungary: TWA 0.005 mg/m^3, STEL 0.01 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 0.05 mg/m^3 [skin], 2003; Norway: TWA 0.001 ppm (0.075 mg/m^3), 1999; the Philippines: TWA 0.075 mg/m^3 [skin], 1993; Poland: MAC (TWA) 0.05 mg/m^3; MAC (STEL) 0.1 mg/m^3, 1999; Russia: STEL 0.005 mg/m^3 [skin], 1993; Sweden: NGV 0.05 mg/m^3, ktv 0.2 mg/m^3 [skin], 1999; Switzerland: MAK-W 0.01 ppm (0.075 mg/m^3), KZG-W 0.02 ppm [skin], 1999; Thailand: TWA 0.075 mg/m^3, 1993; United Kingdom: LTEL 0.10 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for TEL in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 1.5 μg/m^3 (Connecticut) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2533, Tetraethyl lead (as Pb).

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[35,43] set a MAC of zero in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.15$. See also "Lead" entry.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Tetraethyl lead is extremely poisonous; may be fatal if inhaled, swallowed, or absorbed through the skin. Irritates the moist eyes, skin, and respiratory tract. Contact may cause burns to skin and eyes; causing permanent loss of vision. Most symptoms of poisoning are due to the effects of tetraethyl lead on the nervous system. Signs and symptoms of acute exposure to tetraethyl lead may be severe and include intoxication, anxiety, irritability, insomnia, violent/frightening, strange dreams; headache, disorientation, hyperexcitability, delusions, reduced memory; hallucinations, personality changes; tremors, convulsions, and death. Muscular weakness, ataxia, tremors, convulsions, cerebral edema; and coma may occur. A metallic taste may be noted. Sneezing, bronchitis, and pneumonia may be observed. Bradycardia (slow heart rate), hypotension (low blood pressure), hypothermia, and pallor may also occur. Gastrointestinal symptoms include vomiting and diarrhea.

Long Term Exposure: May be a reproductive toxin; may damage the developing fetus. There is limited evidence that this chemical causes cancer in animals. High levels can cause muscle and joint pains, weakness, muscle cramps; and easy fatigue. Repeated exposure may cause lead to accumulate in the body. May cause kidney and brain damage, and damage to the blood cells; causing anemia.

Points of Attack: Central nervous system; cardiovascular system, kidneys, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite): blood urea nitrogen, calcium, carbon dioxide; Sugar/Glucose; Biologic Monitoring of Urine every 3 months; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urinalysis (routine). If symptoms develop or overexposure is suspected, the following may be useful: Urine test for lead (levels of 0.1 mg/L of urine indicate increased exposure. Such levels increase risk from further exposure). Blood lead tests are not usually accurate with exposure to tetraethyl lead. Kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.75 ppm:* Sa (APF = 10) (any supplied-air respirator). *1.875 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *3.75 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *40 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetraethyl lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where tetraethyl lead is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of tetraethyl lead. Wherever tetraethyl lead is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Motor fuel antiknock mixtures require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including lead and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide; mist and foam. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use water from unmanned monitors and hose-holders to keep fire-exposed containers cool. When stopping leak, use water spray to protect firefighters from a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration with scrubbing for collection of lead oxides which may be recycled or landfilled. It is also possible to recover alkyl lead compound from wastewaters as an alternative to disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tetraethyl Lead*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Tetraethyl Lead*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Tetraethyl Lead*. Trenton, NJ

Tetraethyltin T:0310

Molecular Formula: $C_8H_{20}Sn$

Synonyms: Stannane, tetraethyl-; TET; Tetraethylstannane; Tetraethyltin; Tin, tetraethyl-

CAS Registry Number: 597-64-8

RTECS® Number: WH8625000

UN/NA & ERG Number: UN2788/153

EC Number: 209-906-2

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetraethyltin is a colorless liquid. Molecular weight = 234.97; Boiling point = 181°C; Freezing/Melting point = −112°C; Flash point = 53°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Used as biocide, bactericide, fungicide and insecticide; preservative for wood, textile, paper, and leather. Not registered as a pesticide in the US.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Sn]/m^3 TWA.

NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin].

NIOSH IDLH: 25 mg[Sn]/m^3 [skin].

Protective Action Criteria (PAC)

TEEL-0: 0.198 mg/m^3

PAC-1: 0.396 mg/m^3

PAC-2: 7 mg/m^3

PAC-3: 49.5 mg/m^3

DFG MAK: 0.1 mg[Sn]/m^3 inhalable fraction [skin]; Pregnancy Risk Group D.

Determination in Air: Use NIOSH Analytical Method (IV) #5504, Organotin.

Permissible Concentration in Water: A MAC in water bodies used for domestic purposes of 0.2 μg/L has been set by Russia joint project.[43]

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact may cause skin burns. Inhalation can cause coughing, wheezing, and/or shortness of breath. Toxic hazard rating is high for oral, intravenous, intraperitoneal administration. This material causes swelling of the brain and spinal cord. Exposure may result in muscular weakness and paralysis, leading to respiratory failure; convulsive movements; closure of eyelids and sensitivity to light; headaches, EEG changes; dizziness, psychological and neurological disturbances; vertigo (an illusion of movement), sore throat; cough, abdominal pain; nausea, vomiting, diarrhea, urine retention; paresis, focal anesthesia; pruritus. Higher levels can cause unconsciousness, collapse, and death.

Long Term Exposure: Repeated or prolonged contact can cause dermatitis; dry and cracked skin. May cause brain damage, hepatic necrosis; kidney damage.

Points of Attack: Skin, brain, kidneys.

Medical Surveillance: NIOSH lists the following tests: Glaucoma; kidney function tests; liver function tests; urine (chemical/metabolite); urinalysis (routine). Also consider, psychological testing; examination of the nervous system; EEG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 mg/m^3:* CcrOvDM [any chemical cartridge respirator with organic vapor cartridge (s) in combination with a dust and mist filter]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 mg/m^3:* CcrFOv100 (APF = 50) (any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter); or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 25 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Organotin compounds, liquid, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wearing protective equipment, absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Ventilate and wash area after cleanup is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a flammable liquid. Extinguish small fires with dry chemical, carbon dioxide; water spray or foam. For large fires, use water spray, fog, or foam. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tetraethyltin.* Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (November 1999). *Hazardous Substances Fact Sheet: Tetraethyltin.* Trenton, NJ

Tetrafluoroethylene T:0320

Molecular Formula: C_2F_4

Synonyms: Ethene, tetrafluoro-; Ethylene, tetrafluoro-; Fluroplast 4; Perfluoroethene; Perfluoroethylene; Teflon 1,1,2,2-Tetrafluoroethylene; Tetrafluoroethylene, Inhibited; Tetrafluoroethene; TFE

CAS Registry Number: 116-14-3

RTECS® Number: KX4000000

UN/NA & ERG Number: UN1081 (stabilized)/116P

EC Number: 204-126-9

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NTP: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical: Cancer 5/1/97.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: TFE is a colorless, flammable gas. Molecular weight = 100.02; Melting point = −143°C; Boiling point = −76°C; Flash point ≤0°C; Autoignition temperature = 188°C. Its flammable limits in air are LEL = 10%; UEL = 50%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: Those involved in the production of TFE and the manufacture of fluorocarbon polymers.

Incompatibilities: Reacts with air. Hazardous polymerization may occur unless inhibited. Will explode at pressures above 2.7 bar if terpene inhibitor is not added. Inhibited monomer can decompose explosively in fire, under pressure, or upon contact with materials with which it can react exothermically. Violent reaction with oxygen, oxidizers, sulfur trioxide; halogen compounds.

Permissible Exposure Limits in Air

ACGIH TLV®[1]: 2 ppm/8.2 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **220** ppm

PAC-2: **550** ppm

PAC-3: **3300** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 2.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Tetrafluoroethylene can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Very high exposures can displace the oxygen in the air, causing lightheadedness, dizziness, poor coordination, and unconsciousness. High levels may also damage the liver and/or kidneys and irritate the lungs. Contact with liquefied gas may cause frostbite.

Long Term Exposure: May cause lung irritation; bronchitis may develop. May cause kidney and liver damage.

Points of Attack: Lungs, kidneys, liver.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, Viton™, butyl rubber; and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Combustion by-products include hydrogen fluoride and carbonyl fluoride. The respiratory recommendations for *fluorides* has been included for reference: NIOSH: *(fluorides) 12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or SA* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM*† *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 mg/m^3:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF† (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Check that oxygen content is at least 19% before entering storage or spill area. Prior to working with this chemical you should be trained on its proper handling and storage. Tetrafluoroethylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilate area. Protect storage against physical damage. Will explode at pressures above 2.7 bar if terpene inhibitor is not added. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Tetrafluoroethylene, inhibited, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases, including hydrogen fluoride and carbonyl fluoride, are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (May 2004). *Hazardous Substances Fact Sheet: Tetrafluoroethylene*. Trenton, NJ

Tetrafluoromethane T:0330

Molecular Formula: CF_4

Synonyms: Arcton O; Carbon fluoride; Carbon tetrafluoride; F 14; FC 14; Freon 14; Halocarbon 14; Halon 14; Methane, tetrafluoro-; Perfluoromethane; R 14

CAS Registry Number: 75-73-0

RTECS® Number: FG4920000

UN/NA & ERG Number: UN1982/126

Ec Number: 200-896-5

Regulatory Authority and Advisory Bodies

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetrafluoromethane is a colorless, odorless gas. Molecular weight = 88.01; Boiling point = −128°C; Freezing/Melting point = −183.6°C; Autoignition temperature ≥1100°C. Insoluble in water.

Potential Exposure: Tetrafluoromethane is used in fire extinguishers and as a low temperature refrigerant.

Incompatibilities: Forms hydrogen fluoride and fluorides on decomposition with hot surfaces above 125°F/52°C or open flame. Incompatible with powdered metals; including aluminum, zinc, and beryllium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 200 ppm
PAC-1: 600 ppm
PAC-2: 5000 ppm
PAC-3: 25,000 ppm

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Tetrafluoromethane can affect you when breathed in. High levels can cause you to feel dizzy, lightheadedness, and to pass out. Very high levels could cause death. Similar chemicals can affect the cardiovascular system, causing irregular heartbeat, which could lead to death. Contact with the liquefied gas could cause frostbite. Exposure at high levels can cause depletion of oxygen, causing unconsciousness and death by suffocation.

Long Term Exposure: Unknown at this time.

Points of Attack: Cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heart beat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles unless full-face-piece respiratory protections is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to tetrafluoromethane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from powdered metals; including aluminum, zinc, and beryllium; and from open flames or temperatures above 125°F/51.6°C. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Tetrafluoromethane, compressed, requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tetrafluoromethane may burn, but does not readily ignite. Use dry chemical or carbon dioxide extinguishers. Poisonous gases are produced in fire, including fluorides, such as hydrogen fluoride. Containers may explode in fire. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Tetrafluoromethane*. Trenton, NJ

Tetrahydrofuran T:0340

Molecular Formula: C_4H_8O

Synonyms: Butane, 1,4-epoxy-; Butylene oxide; Cyclotetramethylene oxide; Diethylene oxide; 1,4-Epoxybutane; Furanidine; Furan, tetrahydro-; Hydrofuran; NCI-C60560; Oxacyclopentane; Oxolane; Tetrahydrofuranne (French); Tetramethylene oxide; THF

CAS Registry Number: 109-99-9
RTECS® Number: LU5950000
UN/NA & ERG Number: UN2056/127
EC Number: 203-726-8 [*Annex I Index No.*: 603-025-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis Studies (inhalation): some evidence: rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U213.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 1000 lb (454 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xi; Risk phrases: R11; R19; R36/37; Safety phrases: S2; S16; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Tetrahydrofuran is a colorless liquid with an ether-like odor. The odor threshold is listed at 3.8 (3M), 20−50 ppm[41] and 31 ppm. Molecular weight = 72.12; Specific gravity (H_2O:1) = 0.89 at 25°C; Boiling point = 66.1°C; Freezing/Melting point: −108.5°C; Vapor pressure = 132 mmHg; Flash point = −15°C (cc); Autoignition temperature = 321°C. Explosive limits: LEL = 2%; UEL = 11.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. The primary use of tetrahydrofuran is as a solvent to dissolve synthetic resins, particularly polyvinyl chloride and vinylidene chloride copolymers. It is also used to cast polyvinyl chloride films, to coat substrates with vinyl and vinylidene chloride; and to solubilize adhesives based on or containing polyvinyl chloride resins. A second large market for THF is as an electrolytic solvent in the Grignard reaction-based production of tetramethyl lead. THF is used as an intermediate in the production of polytetramethylene glycol.

Incompatibilities: Forms thermally explosive peroxides in air on standing (in absence of inhibitors). Peroxides can be detonated by heating, friction, or impact. Reacts violently with strong oxidizers, strong bases, and some metal halides. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.95 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/590 mg/m^3 TWA.

NIOSH REL: 200 ppm/590 mg/m^3 TWA; 250 ppm/735 mg/m^3 STEL.

ACGIH TLV®[1]: 50 ppm/147 mg/m^3 TWA; 100 ppm/295 mg/m^3 STEL [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 2000 ppm [LEL].

Protective Action Criteria (PAC)*
TEEL-0: 50 ppm
PAC-1: **100** ppm
PAC-2: **500** ppm
PAC-3: **5000** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 50 ppm/150 mg/m^3 TWA; Peak Limitation Category I(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 8 mg/L in urine/end-of-shift.

Australia: TWA 200 ppm (590 mg/m^3), STEL 250 ppm, 1993; Austria: MAK 200 ppm (590 mg/m^3), 1999; Belgium: TWA 200 ppm (590 mg/m^3), STEL 250 ppm (738 mg/m^3), 1993; Denmark: TWA 100 ppm (295 mg/m^3), 1999; Finland: TWA 100 ppm (290 mg/m^3), STEL 150 ppm (440 mg/m^3), 1999; France: VME 200 ppm (590 mg/m^3), 1999; Hungary: TWA 200 mg/m^3, STEL 400 mg/m^3, 1999; Japan: 200 ppm (590 mg/m^3), 1999; the Netherlands: MAC-TGG 300 mg/m^3 [skin], 2003; Norway: TWA 50 ppm (150 mg/m^3), 1999; the Philippines: TWA 200 ppm (590 mg/m^3), 1993; Poland: MAC (TWA) 600 mg/m^3, MAC (STEL) 750 mg/m^3, 1999; Russia: TWA 200 ppm, STEL 100 mg/m^3, 1993; Sweden: NGV 50 ppm (150 mg/m^3), KTV 80 ppm (250 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (590 mg/m^3), STEL 1000 ppm, 1999; Turkey: TWA 200 ppm (590 mg/m^3), 1993; United Kingdom: TWA 100 ppm (300 mg/m^3), STEL 200 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 250 ppm; Russia[43] set a MAC values for ambient air in residential areas of 0.2 mg/m^3 both on a momentary and a daily average basis. Several states have set guidelines or standards for tetrahydrofuran in ambient air[61] ranging from zero (North Carolina) to 0.8 mg/m^3 (Massachusetts) to 5.9−7.35 mg/m^3 (North Dakota) to 9.8 mg/m^3 (Virginia) to 11.8 mg/m^3 (Connecticut, Florida, New York) to 14.048 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1609[18]; 3800; OSHA Analytical Method #7.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible ambient goal of 8100 μg/L (based on health effects). Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L (500 μg/L). States which have set guidelines for tetrahydrofuran in drinking water include Wisconsin at 50.0 μg/L and New Hampshire at 154 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Tetrahydrofuran can affect you when breathed in and may enter the body through the skin. Eye contact causes severe irritation and possible damage. Skin contact causes severe irritation. If covered by clothing or prolonged, blistering can occur. The vapors irritate the eyes, nose, throat, and lungs. Very high exposures can affect the central nervous system causing narcosis, unconsciousness, and rapid death. High exposure can damage the liver and kidneys.

Long Term Exposure: May cause dermatitis; drying and cracking. Repeated exposure may cause liver and kidney damage. May cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, respiratory system; central nervous system; liver and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetrahydrofuran must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where tetrahydrofuran is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of tetrahydrofuran should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of tetrahydrofuran.

Shipping: Tetrahydrofuran requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to

fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Concentrated waste containing peroxides—perforation of a container of the waste from a safe distance followed by open burning.

References

US Environmental Protection Agency. (October 21, 1977). *Chemical Hazard Information Profile: Tetrahydrofuran*. Washington, DC (Revised edition issued 1979)

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities*, Report PB-274,073. Cincinnati, OH, pp. 314−316

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 64−65 (1980) and 5, No. 5, 83−87 (1985)

New Jersey Department of Health and Senior Services. (May 2004). *Hazardous Substances Fact Sheet: Tetrahydrofuran*. Trenton, NJ

Tetramethyl lead T:0360

Molecular Formula: $C_4H_{12}Pb$

Common Formula: $Pb(CH_3)_4$

Synonyms: Lead, tetramethyl-; Plumbane, tetramethyl-; Tetramethylplumbane; TML

CAS Registry Number: 75-74-1

RTECS® Number: TP4725000

UN/NA & ERG Number: UN1649 (motor fuel antiknock mixture)/131

EC Number: 200-897-0; Listed in Title I, Part 3 with no Index Number. HS2931.00

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: (organolead) Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Toxic Substance (World Bank).[15]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

EPCRA Section 313 (as organic lead compound) Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

European/International Regulations: Listed in Annex 1, Part 3 without Index Number.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Tetramethyl lead is a colorless liquid with a slight musty odor. In commerce it is usually dyed red, orange, or blue. Molecular weight = 267.35; Boiling point ≥100°C (decomposes); Freezing/Melting point = −27°C; Flash point = 37°C. Explosive limits: LEL = 1.8%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 3₩. Insoluble in water.

Potential Exposure: Compound Description: Organometallic; Reproductive Effector. Those engaged in the manufacture, distribution, and blending into gasoline of this antiknock agent for aviation gasoline.

Incompatibilities: Violent reaction with oxidizers, such as sulfuryl chloride or potassium permanganate; strong acids; especially nitric acid; chemically active metals. Decomposes and may explode in heat above 90°C. Attacks rubber.

Permissible Exposure Limits in Air

OSHA PEL: 0.075 mg[Pb]/m^3 TWA [skin].

NIOSH REL: 0.075 mg[Pb]/m^3 TWA [skin].

ACGIH TLV®[1]: 0.15 mg[Pb]/m^3 [skin].

NIOSH IDLH: 40 mg[Pb]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0968 mg/m^3

PAC-1: 0.581 mg/m^3

PAC-2: 4 mg/m^3

PAC-3: 51.6 mg/m^3

DFG MAK: 0.05 mg[Pb]/m^3; Peak Limitation Category II (2); Peak Limitation Category II(2) [skin]; Pregnancy Risk Group B.

Arab Republic of Egypt: TWA 0.05 mg[Pb]/m^3, 1993; Australia: TWA 0.15 mg[Pb]/m^3, 1993; Australia: TWA 0.15 mg/m^3 [skin], 1993; Austria: MAK 0.01 ppm (0.075 mg/m^3) [skin], 1993; Austria: MAK 0.01 ppm (0.075 mg/m^3), 1999; Belgium: TWA 0.15 mg[Pb]/m^3, 1993; Belgium: TWA 0.15 mg/m^3 [skin], 1993; Denmark: TWA 0.007 ppm (0.05 mg/m^3) [skin], 1999; the Netherlands: MAC-TGG 0.05 mg/m^3 [skin], 2003; Finland: TWA 0.1 mg[Pb]/m^3, 1993; France: VME 0.15 mg[Pb]/m^3 [skin], 1999; VME 0.15 mg/m^3 [skin], 1993; Hungary: STEL 0.04 mg[Pb]/m^3, carcinogen, 1993; Hungary: TWA 0.005 mg/m^3, STEL 0.01 mg/m^3 [skin], 1993; Norway: TWA 0.01 ppm (0.075 mg/m^3), 1999; the Philippines: TWA 0.07 mg/m^3 [skin], 1993; TWA 0.15 mg[Pb]/m^3, 1993; Russia: STEL 0.005 ppm (0.01 mg[Pb]/m^3), 1993; Sweden: NGV 0.05 mg[Pb]/m^3, KTV 0.2 mg[Pb]/m^3 [skin], 1999; NGV 0.05 mg/m^3, STEL 0.2 mg/m^3 [skin], 1993; Switzerland: MAK-W 0.01 ppm (0.075 mg/m^3), KZG-W 0.02 ppm [skin], 1999; TWA 0.01 ppm (0.075 mg/m^3), STEL 0.02 ppm [skin], 1993; TWA 0.1 mg[Pb]/m^3, 1993; Thailand: TWA 0.07 mg/m^3, 1993; TWA 0.2 mg[Pb]/m^3, 1993; Turkey: TWA 0.2 mg[Pb]/m^3, 1993; United Kingdom: LTEL 0.15 mg[Pb]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.15 mg[Pb]/m^3 [skin]. Several states have set guidelines or standards for TML in ambient air[60] ranging from 1.5 μg/m^3 (Connecticut and North Dakota) to 2.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2534.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 2 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vapors are very toxic. Tetramethyl lead irritates the moist skin, eyes, and mucous membrane. May affect the central nervous system. Fatal lead poisoning may occur by ingestion, vapor inhalation, or skin absorption. Several cases of acute toxicity, usually in the form of degenerative brain disease, have been described following occupational exposure. Signs and symptoms of acute exposure to tetramethyl lead may be severe and include nausea, delirium, mania, anxiety, irritability, headache, insomnia, disorientation, violent/frightening dreams; hyperexcitability, delusions, and hallucinations. Muscular weakness, tremor, a lack of coordination; convulsions, cerebral edema; and coma may occur. A metallic taste may be noted. Sneezing, bronchitis, and pneumonia may be noted. Bradycardia (slow heart rate), hypotension (low blood pressure), hypothermia, and pallor may also occur. Gastrointestinal symptoms include vomiting and diarrhea.

Long Term Exposure: High levels can cause muscle and joint pains, weakness, muscle cramps; and fatigue. Lead can accumulate in the body with repeated exposure. May affect the kidneys.

Points of Attack: Central nervous system; cardiovascular system, kidneys.

Medical Surveillance: NIOSH lists the following tests: Biologic monitoring of urine every 3 months; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urinalysis (routine). If symptoms develop or overexposure is suspected, the following may be useful: urine test for lead levels of 0.1 mg/L of urine indicate increased exposure. Such levels increase risk from further exposure. Blood lead tests are not usually accurate with exposure to tetramethyl lead. Complete blood count (CBC). Kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.75 mg/m^3:* Sa (APF = 10) (any supplied-air respirator). *1.875 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *3.75 mg/m^3:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *40 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA

(APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetramethyl lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where Tetramethyl lead is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of tetramethyl lead should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of tetramethyl lead. Wherever tetramethyl lead is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Motor fuel antiknock mixtures requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tetramethyl lead is a flammable and reactive liquid. Use dry chemical, carbon dioxide, water spray; or foam extinguishers. Poisonous gases, including lead, lead oxides and carbon monoxide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with scrubbing for collection of lead oxides which may be recycled or landfilled. It is also possible to recover alkyl lead compounds from wastewaters (A-58) as an alternative to disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tetramethyl Lead*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: Tetramethyl Lead*. Trenton, NJ

Tetramethyl succinonitrile T:0370

Molecular Formula: $C_8H_{12}N_2$

Common Formula: $(CH_3)_2C(CN)C(CN)(CH_3)_2$

Synonyms: Tetramethylbutane dinitrile; Tetramethylsuccinic acid dinitrile; TMSN

CAS Registry Number: 3333-52-6

RTECS® Number: WN4025000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Tetramethyl succinonitrile is a colorless, odorless solid. Molecular weight = 136.22; Specific gravity (H_2O:1) = 1.07 at 25°C; Boiling point = sublimes; Freezing/Melting point = 170°C (sublimes). Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector. Tetramethyl succinonitrile is reported to be a breakdown product of azobisisobutyronitrile, which is used as a blowing agent or propellant for the production of vinyl foams. Forms cyanide in the body.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.57 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 3 mg/m^3/0.5 ppm TWA [skin].

NIOSH REL: 3 mg/m^3/0.5 ppm TWA [skin].

ACGIH TLV®[1]: 0.5 ppm TWA [skin].

No Teel available.

DFG MAK: [skin] No numerical value established. Data may be available.

NIOSH IDLH: 5 ppm.

Australia: TWA 0.5 ppm (3 mg/m^3) [skin], 1993; Austria: MAK 0.5 ppm (3 mg/m^3) [skin], 1999; Belgium: TWA 0.5 ppm (28 mg/m^3) [skin], 1993; Denmark: TWA 0.5 ppm (3 mg/m^3) [skin], 1999; Finland: TWA 0.5 ppm (3 mg/m^3), STEL 1.5 ppm (8.4 mg/m^3) [skin], 1999; France: VME 0.5 ppm (3 mg/m^3) [skin], 1999; the Netherlands: MAC-TGG 3 mg/m^3 [skin], 2003; the Philippines: TWA 0.5 ppm (3 mg/m^3) [skin], 1993; Switzerland: MAK-W 0.3 ppm (5 mg/m^3), KZG-W 2 ppm [skin], 1999; United Kingdom: TWA 0.5 ppm (2.8 mg/m^3), STEL 2 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.5 ppm [skin]. Several states have set guidelines or standards for TMSN in ambient air[60] ranging from 30 μg/m^3 (North Dakota) to 50 μg/m^3 (Virginia) to 60 μg/m^3 (Connecticut) to 71 μg/m^3 (Nevada).

Determination in Air: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; NIOSH II (3), Method #S155.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 41 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: May affect the nervous system. Symptoms of exposure are headaches, nausea, convulsions, coma. May affect the liver, kidneys, gastrointestinal tract. Exposure to high concentrations may result in death. The fatal dose for humans is about 25 mg/kg of body weight.

Long Term Exposure: May affect the kidneys, liver.

Points of Attack: Central nervous system; liver, kidneys, gastrointestinal tract.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Blood cyanide level. Kidney and liver functions. G.I. series. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Up to 28 mg/m^3: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Toxic solids, organic, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration—incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

Tetranitromethane T:0380

Molecular Formula: CN_4O_8
Common Formula: $C(NO_2)_4$
Synonyms: Methane, tetranitro-; NCI-C55947; Tetan; Tetranitrometano (Spanish); TNM
CAS Registry Number: 509-14-8
RTECS® Number: PB4025000
UN/NA & ERG Number: UN1510/143
EC Number: 208-094-7
Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1996; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

US EPA Hazardous Waste Number (RCRA No.): P112.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 10 lb (4.54 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

California Proposition 65 Chemical: Cancer 7/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetranitromethane, a nitroparaffin, is a colorless to pale yellow liquid or solid with a pungent odor. It causes tears. Molecular weight = 196.05; Specific gravity (H_2O:1) = 1.62 at 25°C; Boiling point = 126.1°C; Freezing/Melting point 14°C; Vapor pressure = 8 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 3 (Oxidizer). Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Tetranitromethane is used as a solvent for polymers and as a stabilizer; as an oxidizer in rocket propellant combinations. It is also used as an explosive in admixture with toluene.

Incompatibilities: Tetranitromethane is a powerful oxidizer. It is more easily detonated than TNT. Contact with hydrocarbons, alkalis, or metals form explosive mixtures. Contact with toluene or cotton may cause fire and explosion. Combustible material wet with tetranitromethane may be highly explosive. The potential for explosion is severe, especially when exposed to heat, powerful oxidizers, or reducing agents; or, when subject to mild shock. Impurities can also cause explosives. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 8.02 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1 ppm/8 mg/m^3 TWA.

NIOSH REL: 1 ppm/8 mg/m^3 TWA.

ACGIH TLV®[1]: 0.005 ppm/0.04 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 4 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 0.52 ppm

PAC-1: 0.52 ppm

PAC-2: **0.52** ppm

PAC-3: **1.7** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 1 ppm (8 mg/m^3), 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (8 mg/m^3), 1993; Denmark: TWA 1 ppm (8 mg/m^3), 1999; Finland: TWA 1 ppm (8 mg/m^3), STEL 3 ppm (24 mg/m^3), 1999; France: VME 1 ppm (8 mg/m^3), 1999; the Netherlands: MAC-TGG 0.04 mg/m^3, 2003; the Philippines: TWA 1 ppm (8 mg/m^3), 1993; Poland: MAC (TWA) 0.04 mg/m^3, 1999; Russia: STEL 0.3 mg/m^3, 1993; Sweden: NGV 0.05 ppm (0.4 mg/m^3), KTV 0.2 ppm (0.8 mg/m^3), 1999; Switzerland: MAK-W 1 ppm (8 mg/m^3), carcinogen, 1999; Turkey: TWA 1 ppm (8 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for TNM in ambient air[60] ranging from 80 μg/m^3 (North Dakota) to 130 μg/m^3 (Virginia) to 160 μg/m^3 (Connecticut) to 190 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3513.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact causes burns. After more prolonged inhalation, headache, dizziness, chest pain; dyspnea, and respiratory distress may occur. After prolonged exposure, central nervous system; heart, liver, and kidney damage can occur as well as pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Can cause methemoglobinemia and cyanosis.

Long Term Exposure: Chronic signs and symptoms include weariness and pneumonia. May cause CNS, kidney, and liver damage.

Points of Attack: Respiratory system, eyes, skin, blood, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Kidney and liver function tests. Complete blood count (CBC). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 4 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); ccrFS (APF = 50) [any chemical cartridge respirator with a full face-piece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note:* Substance causes eye irritation or damage; requires eye protection. Only nonoxidizable sorbents allowed (not charcoal).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in an explosion-proof freezer. Keep away from metals and other organic and easily oxidized compounds. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Tetranitromethane requires a shipping label of "OXIDIZER, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 5.1 and Packing Group I. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid shock and friction if liquid spills on combustible material, such as wood or paper. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Flush area with flooding amounts of water and dike spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.2/0.3
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60.
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 0.6/1.4

Fire Extinguishing: Combustible liquid, but difficult to ignite. Poisonous gases, including nitrogen oxides, are produced in fire. Material is a strong oxidizer. The potential for explosion is severe, especially when exposed to heat or to powerful oxidizing or reducing agents; or when shocked or heated. It is more easily detonated than TNT. Impurities can also cause explosives. Extinguish small fires with water only, no dry chemicals or carbon dioxide. For large fires, flood the fire area with water. Do not move cargo or vehicle if cargo has been exposed to heat. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant

(≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Open burning at remote burning sites is not entirely satisfactory since it makes no provision for the control of the toxic effluents, nitrogen oxides and HCN. Suggested procedures are to employ modified closed pit burning, using blowers for air supply and passing the effluent combustion gases through wet scrubbers.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 5, 87−91

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tetranitromethane*. Washington, DC: Chemical Emergency Preparedness Program

Tetrasodium EDTA T:0390

Molecular Formula: $C_{10}H_{12}N_2Na_4O_8$

Common Formula: $[(NaOOCCH_2)_2NCH_2]_2$

Synonyms: *N*,*N*′-1,2-Ethanediylbis[*N*-(carboxymethyl)] glycine tetrasodium salt; Ethylene dinitrilotetra-acetic acid tetrasodium salt; Sodium EDTA; Sodium ethylene-diaminetetraacetate; Sodium ethylenediaminetetraacetic acid; Sodium salt of ethylene-diaminetetraacetic acid; Tetrasodium ethylenediaminetetraacetate; Tetrasodium ethylene-diaminetetracetate; Tetrasodium (ethylenedinitrilo)-tetraacetate; Tetrasodium salt of EDTA; Tetrasodium salt of ethylenediaminetetracetic acid

CAS Registry Number: 64-02-8

RTECS® Number: AH5075000

UN/NA & ERG Number: UN3077/171

EC Number: 200-573-9 [*Annex I Index No.:* 607-428-00-2]

Regulatory Authority and Advisory Bodies

This chemical is not specifically listed by the EPA, but ETDA is regulated.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 5000 lb (2270 kg).

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R41; Safety phrases: S2; S26; S39; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Tetrasodium EDTA is a white crystalline solid. Molecular weight = 380.20; Freezing/Melting point = 240°C (decomposition). Highly soluble in water.

Potential Exposure: Used therapeutically in treating arteriosclerosis. Used as a metal cleaner; in detergents, liquid soaps; shampoos; metal chelating agent; in textiles industry to improve dyeing, scouring, and detergent operations; antioxidant.

Incompatibilities: Incompatible with strong acids, nitrates, oxidizers. Can solubilize metals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Permissible Concentration in Water: Russia[43] set a MAC for the disodium salt in water bodies used for fishery purposes of 0.05 mg/L. Maryland[61] has set a guideline for drinking water of 180 μg/L (0.18 mg/L).[61]

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Dust may cause irritation of the nose and throat. *Skin:* May cause irritation. Prolonged skin contact to high concentrations may cause irritation, even a mild burn. *Eyes:* May cause irritation. Alkaline solution can burn the eyes. *Ingestion:* Doses of 200 mg/kg have caused muscle spasms. Kidney damage has been reported at doses of 600 mg/kg for 4 days.

Long Term Exposure: ETDA may cause kidney injury, which may be due to chelating action, not inherent nephrotoxicity. Symptoms of exposure include vomiting, depression, and bloody diarrhea. It is not known if this chemical has the same effects.

Points of Attack: Kidneys.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: May cause a negative calcium imbalance.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a

full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a well-ventilated area away from sources of heat. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Use extinguisher appropriate to other burning material. Poisonous gases are produced in fire, including sodium and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 76−80 (for EDTA)

New York State Department of Health. (July 1986). *Chemical Fact Sheet: Tetrasodium-EDTA*. Albany, NY: Bureau of Toxic Substance Assessment

Tetrasodium pyrophosphate T:0400

Molecular Formula: $Na_4O_7P_2$
Common Formula: $Na_4P_2O_7$
Synonyms: Natriumpyrophosphat; Phosphotex; Pyrophosphate; Sodium pyrophosphate; Tetranatriumpyrophosphat (German); Tetrasodium diphosphate; Tetrasodium pyrophosphate, anhydrous; TSPP; Victor TSPP
CAS Registry Number: 7722-88-5
RTECS® Number: UX7350000
UN/NA & ERG Number: Not regulated.
EC Number: 231-767-1

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: TSPP is a colorless or white crystalline powder or granules. Molecular weight = 265.90; Specific gravity (H_2O:1) = 2.45 at 25°C; Boiling point = (decomposes); Freezing/Melting point = 987.8°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water; solubility = 7% at 25°C.

Potential Exposure: Compound Description: Drug TSPP is used as a water softener, as a builder in synthetic detergents; as a metal cleaner; in boiler water treatment; in viscosity control of drilling muds and in textile scouring and dyeing.

Incompatibilities: Strong acids; magnesium. The aqueous solution is a weak base.

Permissible Exposure Limits in Air

OSHA PEL: None.
NIOSH REL: 5 mg/m^3 TWA.
ACGIH TLV®[1]: withdrawn.
Protective Action Criteria (PAC)
TEEL-0: 5 mg/m^3
PAC-1: 15 mg/m^3
PAC-2: 25 mg/m^3
PAC-3: 500 mg/m^3

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3, 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; United Kingdom: TWA 5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3.

Several states have set guidelines or standards for TSPP in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: TSPP is basically of low toxicity but it is an alkaline material. The dust is irritating to the eyes, skin, and respiratory tract. Contact irritates the skin.

Long Term Exposure: May cause dermatitis. May affect the lungs.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids and magnesium.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type or surrounding fire. Tetrasodium pyrophosphate itself does not burn. Poisonous gases are produced in fire, including oxides of phosphorus and sodium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report), Washington, DC

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: Tetrasodium Pyrophosphate*. Trenton, NJ

Tetryl T:0410

Molecular Formula: $C_7H_5N_5O_8$

Common Formula: $(NO_2)_3C_6H_2N(NO_2)CH_3$

Synonyms: *N*-Methyl-*N*-2,4,6-tetranitroaniline; Nitramine; Picrylnitromethylamine; Pyrenite; Tetralite; *N*-2,4,5-Tetranitro-*N*-methylaniline; 2,4,6-Tetryl; 2,4,6-Trinitrophenyl-*N*-methylnitramine; 2,4,6-Trinitro-phenylmethylnitramine; Trinitrophenylmethylnitramine

CAS Registry Number: 479-45-8
RTECS® Number: BY6300000
UN/NA & ERG Number: UN0208/112
EC Number: 207-531-9 [*Annex I Index No.:* 612-017-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: The carcinogenicity of tetryl in humans and animals has not been studied.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, T; Risk phrases: R3; R23/24/25; R33; Safety phrases: S1/2; S35; S36/37; S45; R63 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tetryl is a colorless to yellow, odorless crystalline solid. High explosive material. Molecular weight = 287.17; Specific gravity (H_2O:1) = 1.57 at 25°C; Boiling point = 180−190°C (explodes); Freezing/Melting point = 129−131°C; Flash point = 187°C (explodes); Vapor pressure = <1 mmHg at 25°C. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Tetryl is used in explosives; as an intermediary detonating agent; and as a booster charge for military devices; it is also used as a chemical indicator. No longer manufactured or used in the US.

Incompatibilities: Violent reaction with hydrazine; oxidizable materials. May explosively decompose from heat, shock, friction, or concussion. Explosive decomposition/detonation from heat takes: approximately 1000 s at 160°C; 0.1 s at 500°C.

Permissible Exposure Limits in Air

OSHA PEL: 1.5 mg/m^3 TWA [skin].
NIOSH REL: 1.5 mg/m^3 TWA [skin].
ACGIH TLV®[1]: 1.5 mg/m^3 TWA [skin].
NIOSH IDLH: 750 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 1.5 mg/m^3
PAC-1: 7.5 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 500 mg/m^3

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 3B.

Australia: TWA 1.5 mg/m^3, 1993; Austria: MAK 1.5 mg/m^3 [skin], 1999; Belgium: TWA 1.5 mg/m^3, 1993; Denmark: TWA 1.5 mg/m^3 [skin], 1999; Finland: TWA 1.5 mg/m^3, STEL 3 mg/m^3 [skin], 1993; France: VME 1.5 mg/m^3 [skin], 1999; the Netherlands: MAC-TGG 1.5 mg/m^3 [skin], 2003; the Philippines: TWA 1.5 mg/m^3 [skin], 1993; Switzerland: MAK-W 1.5 mg/m^3 [skin], 1999; Turkey: TWA 1.5 mg/m^3, 1993; United Kingdom: TWA 1.5 mg/m^3, STEL 3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1.5 mg/m^3. Several states have set guidelines or standards for tetryl in ambient air[60] ranging from 15 μg/m^3 (North Dakota) to 25 μg/m^3 (Virginia) to 30 μg/m^3 (Connecticut) to 36 μg/m^3 (Nevada).

Determination in Air: Use NIOSH II(3), Method #S225.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the nervous system. Contact may stain skin and hair yellow or orange. Tetryl is acutely irritating to the mucous membranes of the respiratory tract and the eyes, causing coughing, sneezing, epistaxis, conjunctivitis, and palpebral and periorbital edema.

Long Term Exposure: Tetryl is a potent sensitizer, and allergic dermatitis is common. Dermatitis first appears on exposed skin areas, but can spread to other parts of the body in fair-skinned individuals or those with poor personal hygiene. Repeated or prolonged inhalation exposure may cause asthma. The severest forms show massive generalized edema with partial obstruction of the trachea due to swelling of the tongue, and these cases require hospitalization. Tetryl exposure may cause irritability, easy fatigability; malaise, headaches, lassitude, insomnia, nausea, and vomiting. Anemia of the marrow depression or deficiency type has been observed among tetryl workers. Tetryl exposure has produced liver and kidney damage in animals. The substance may have effects on the liver, kidneys, and blood.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: complete blood count; anemia; liver function tests. Preplacement physical examination should give special attention to those individuals with a history of allergy, blood dyscrasias, or skin, liver, or kidney disease. Periodic examinations should be directed primarily to the control of dermatitis and allergic reactions, plus any effects on the respiratory tract, eyes, central nervous system; blood, liver, and kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 7.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 15 mg/m^3:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 37.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 75 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 750 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, hydrazine and sources of heat. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Tetryl requires a shipping label of "EXPLOSIVE." It falls in Hazard Class 1.1D and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive solid. If material is on fire and conditions permit, do not extinguish. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Solution in acetone and incineration in furnace equipped with afterburner and caustic soda solution scrubber.

References

New Jersey Department of Health and Senior Services. (September 2000). *Hazardous Substances Fact Sheet: Tetryl*. Trenton, NJ

Thallium & compounds T:0420

Molecular Formula: Tl

Synonyms: *Elemental:* Ramor; Talio (TL) (Spanish); Thallium elemental

Acetate: Acetato de talio (Spanish); Thallium(1+) acetate; Thallium(I) acetate; Thallium monoacetate; Thallous acetate

Carbonate: Carbonato de talio (Spanish); Carbonic acid, dithallium(1+) salt; Carbonic acid, dithallium(I) salt;

Dithallium carbonate; Thallium(1+) carbonate; Thallium(I) carbonate; Thallous carbonate; Thiochoman-4-one, oxime

Chloride: Cloruro de talio (Spanish); Thallium(1+) chloride; Thallium(I) chloride; Thallium monochloride; Thallous chloride

Malonite: Formomalenic thallium; Malonic acid, thallium salt (1:2); Propanedioic acid, dithallium salt; Thallium malonite; Thallous malonate (EPA)

Nitrate: Nitrato de talio (Spanish); Nitric acid, thallium(1+) salt; Nitric acid, thallium(I) salt; Thallium mononitrate; Thallium(1+) nitrate (1:1); Thallium(I) nitrate; Thallous nitrate

Oxide: Dithallium trioxide; Oxido talico (Spanish); Thallic oxide (EPA); Thallium oxide; Thallium(3+) oxide; Thallium(III) oxide; Thallium peroxide; Thallium sesquioxide

Selinide: Thallium monoselenide

Sulfate: C.F.S; CFS-giftweizen; Dithallium sulfate; Dithallium(1+) sulfate; Dithallium(I) sulfate; Eccothal; M7-giftkoerner; Ratox; Rattengiftkonserv; Sulfato de talio (Spanish); Sulfuric acid, dithallium(+1) salt; Sulfuric acid, dithallium(I) salt(8CI,9CI); Sulfuric acid, Thallium salt; Sulfuric acid, thallium(1+) salt(1:2); Sulfuric acid, thallium (I) salt(1:2); Thallium sulfate; Thallium(1+) sulfate (2:1); Thallium(I) sulfate (2:1); Thallium sulfate; Thallous sulfate; Zelio sulfate(I)

CAS Registry Number: 7440-28-0 (elemental); 563-68-8 (acetate); 6533-73-9 (carbonate); 7799-12-0 (chloride); 2757-18-8 (malonite); 10102-45-1 (nitrate); 1314-32-5 (oxide); 12039-52-0 (selinide); 10031-59-1 (sulfate); 7446-18-6 [sulfate(I)]

RTECS® Number: XG3425000 (elemental); AJ5425000 (acetate); XG4000000 (carbonate); XG4200000 (chloride); OO1770000 (malonite); XG5950000 (nitrate); XG2975000 (oxide); XG6300000 (selinide); XG6600000 (sulfate); XG7800000 [sulfate(I)]

UN/NA & ERG Number: UN1707 (thallium compounds, n.o.s.)/151

EC Number: 081-001-00-3 (elemental); 081-002-00-9 [sulfate(I)]

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (many countries) (UN)[13].

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Thallium, elemental:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.4; Nonwastewater (mg/L), 0.78 TCLP.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL µg/L); total dust 6010 (400); 7840 (1000); 7841 (10).

Safe Drinking Water Act: MCL, 0.002 mg/L; MCLG, 0.005 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (Thallium compounds).

Thallium acetate:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U214.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Thallium carbonate; thallous carbonate:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U215.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Thallium chloride:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U216.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Thallium compounds:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as thallium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

PCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as thallium compounds, n.o.s.; thallium compounds (pesticides).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*thallium*; 7440-28-0): Hazard Symbol: T+, N; Risk phrases: R26/28; R33; R53; Safety phrases: S1/2; S13; S28; S45; S61; (*thallium compounds*): Hazard Symbol: T+, N; Risk phrases: R28; R38; R48/25; R51/53; Safety phrases: S1/2; S13; S36/37; S45; S61; (*thallic sulfate*; 7446-18-6) Hazard Symbol: T+, N; Risk phrases: R28; R38; R48/25; R51/53; Safety phrases: S1/2; S13; S36/37; S45; S61.

Thallium nitrate:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U217.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Thallium(I) sulfate (7446-18-6):
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants.
US EPA Hazardous Waste Number (RCRA No.): P115.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Thallium sulfate (10031-59-1):
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Thallium malonite:
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
WGK (German Aquatic Hazard Class): 2—Water polluting (*thallium chlorate, nitrate(I), nitrate(II), and sulfate*).

Description: Thallium is a soft, bluish-white, heavy, very soft metal insoluble in water and organic solvents. It turns gray on exposure to air. Molecular weight = 204.38; Boiling point = 1457°C; Freezing/Melting point = 304°C; Vapor pressure = 1.41×10^{-23} mmHg at 25°C. The nitrate is a colorless, crystalline powder. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in hot water. Thallium(I)carbonate(2:1) has molecular weight = 468.75. Thallium(I)sulfate(2:1) (7446-18-6) is a white or colorless, odorless crystalline solid. Molecular weight = 504.80; Freezing/Melting point = 632°C. Soluble in water. Thallium is usually obtained as a by-product from the flue dust generated during the roasting of pyrite ores in the smelting and refining of lead and zinc.

Potential Exposure: Compound Description: [elemental] Mutagen, Human Data; [thallium(I) carbonate] Mutagen; Reproductive Effector; [sulfate(I)] Agricultural Chemical; Reproductive Effector; Human Data. Thallium has not been produced in the United States since 1984, but is imported for use in the manufacture of electronics, optical lenses, and imitation precious jewels. It also has use in some chemical reactions and medical procedures. Thallium and its compounds are used as a rodenticide* and fungicide; in the manufacture of plates and prisms, high-density liquids; as insecticides, catalysts; in certain organic reactions, in phosphor activators; in bromoiodide crystals for lenses, plates, and prisms in infrared optical instruments; in photoelectric cells; in mineralogical analysis; alloyed with mercury in low-temperature thermometers, switches, and closures; in high-density liquids; in dyes and pigments; in fireworks; and imitation precious jewelry. It forms a stainless alloy with silver and a corrosion-resistant alloy with lead. Its medicinal use for epilation has been almost discontinued. Highly persistent in the environment.

*Thallium was used in the past as a rodenticide, it has been banned in the US due to its toxicity from accidental exposure. In some countries, thallium(I)sulfate(2:1) is still used as a rat poison and ant bait.

Incompatibilities: Varies. Thallium metal reacts violently with strong acids (such as hydrochloric, sulfuric, and nitric) and strong oxidizers (such as chlorine, bromine, and fluorine). Cold thallium ignites on contact with fluorine. Reacts with other halogens at room temperature.

Permissible Exposure Limits in Air
OSHA PEL: 0.1 mg[Tl]/m^3 TWA [skin].
NIOSH REL: 0.1 mg[Tl]/m^3 TWA [skin].
ACGIH TLV®[1]: 0.1 mg[Tl]/m^3 TWA [skin].
NIOSH IDLH: 15 mg[Tl]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.02 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 3 mg/m^3
Protective Action Criteria (PAC) *thallium sulfate (10031-59-1)*
TEEL-0: 0.0213 mg/m^3
PAC-1: 0.064 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 16 mg/m^3
Protective Action Criteria (PAC)
7446-18-6 [thallium(I) sulfate]
TEEL-0: 0.123 mg/m^3
PAC-1: 0.37 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 18.5 mg/m^3
Protective Action Criteria (PAC)
6533-73-9 [thallium(I) carbonate (2:1)]
TEEL-0: 0.115 mg/m^3
PAC-1: 0.344 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 17.2 mg/m^3
Protective Action Criteria (PAC)
7791-12-0 [thallium(I) chloride]
TEEL-0: 0.0235 mg/m^3

PAC-1: 0.0704 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 17.6 mg/m^3
Protective Action Criteria (PAC)
12026-06-1 (thallium hydroxide)
TEEL-0: 0.0217 mg/m^3
PAC-1: 0.065 mg/m^3
PAC-2: 0.108 mg/m^3
PAC-3: 16.2 mg/m^3
Protective Action Criteria (PAC)
2757-18-8 (thallous malonate)
TEEL-0: 0.025 mg/m^3
PAC-1: 0.075 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 18.7 mg/m^3
10102-45-1 (thallium nitrate)
TEEL-0: 0.0261 mg/m^3
PAC-1: 0.0782 mg/m^3
PAC-2: 19.6 mg/m^3
PAC-3: 19.6 mg/m^3
13826-63-6 (thallium nitrite)
TEEL-0: 0.0245 mg/m^3
PAC-1: 0.0735 mg/m^3
PAC-2: 0.125 mg/m^3
PAC-3: 18.4 mg/m^3
1314-12-1 (thallium oxide)
TEEL-0: 0.0208 mg/m^3
PAC-1: 0.0623 mg/m^3
PAC-2: 0.104 mg/m^3
PAC-3: 15.6 mg/m^3

DFG MAK: *soluble compounds:* No numerical value established. Data may be available.

Australia: TWA 0.1 mg/m^3 [skin], 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3 [skin], 1993; Finland: TWA 0.1 mg/m^3 [skin], 1999; France: VME 0.1 mg/m^3, 1999; Norway: TWA 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3 [skin], 2003; Poland: MAC (TWA) 0.1 mg[Tl]/m^3; MAC (STEL) 0.3 mg[Tl]/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3 [skin], 1999; Thailand: TWA 0.1 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3 [skin], 1993; United Kingdom: LTEL 0.1 mg/m^3 [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg[Tl]/m^3 [skin]. Several states have set guidelines or standards for thallium soluble compounds in ambient air[60] ranging from 0.238 μg/m^3 (Kansas) to 0.33 μg/m^3 (New York) to 1.0 μg/m^3 (Florida, North Dakota) to 1.6 μg/m^3 (Virginia) to 2.0 μg/m^3 (Connecticut and Nevada) to 2.47 μg/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method (IV) #7300; #7301; #7303; #9102; #8005 (Elements in blood or tissue); OSHA Analytical Method ID-121.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 1400 μg/L on an acute toxicity basis and 40 μg/L on a chronic basis. *To protect saltwater aquatic life:* 2130 μg/L on an acute toxicity basis. For the protection of human health from the toxic properties of thallium ingested through water and contaminated aquatic organisms, the ambient water criterion is 13.0 μg/L.[6] Kansas[61] has set a guideline for thallium in drinking water of 13.0 μg/L. Russia set a MAC in water bodies used for domestic purposes of 0.1 μg/L.

Determination in Water: Digestion followed by atomic absorption measurement gives total thallium. Dissolved thallium may be determined by the same procedure preceded by 0.45 μm filtration. Octanol−water coefficient: Log K_{ow} = (estimated) 0.23.

Routes of Entry: Ingestion and percutaneous absorption of dust, eye/skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Thallium salts may be eye and skin irritants and skin sensitizes. Exposure can cause fatigue, weakness, poor appetite; insomnia and mood changes. Acute poisoning rarely occurs in industry, and is usually due to ingestion of thallium. When it occurs, gastrointestinal symptoms, abdominal colic; loss of kidney function; peripheral neuritis; strabismus, disorientation, convulsions, joint pain; and alopecia develop rapidly. The symptoms of acute thallium poisoning (except for gastrointestinal symptoms) do not become manifest until 12 h to 4 days after exposure. Death is due to damage to the central nervous system. Thallium may affect the peripheral and the central nervous system; liver and kidneys; the gastrointestinal tract; skin (hair) and the cardiovascular system; resulting in polyneuritis; optic nerve atrophy; encephalopathy, cardiac disturbances; liver and kidney damage; alopecia. Exposure may result in death. The nitrate can irritate and burn the skin and eyes. The nitrate can damage the nervous system causing headache, weakness, irritability, pain, "pins and needles" in arms and leg; convulsions, coma, and death. The sulfate(I) irritates the eyes and the skin. May affect the nervous system; cardiovascular system; kidneys and gastrointestinal tract. Exposure may result in death. Exposure may result in hair loss.

Long Term Exposure: Thallium is an extremely toxic and cumulative poison. In nonfatal occupational cases of moderate or long-term exposure, early symptoms usually include fatigue, limb pain; metallic taste in the mouth and loss of hair; although loss of hair is not always present as an early symptom. Later, peripheral neuritis, proteinuria, and joint pains occur. Occasionally, neurological signs are the presenting factor, especially in more severe poisonings. Long-term exposure may produce optic atrophy, paresthesia, and changes in papillary and superficial tendon reflexes (slowed responses). Some thallium compounds are teratogens in animals.

Points of Attack: Eyes, central nervous system; lungs, liver, kidneys, gastrointestinal tract; body hair.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; nerve conduction studies; urine (chemical/metabolite); urinalysis (routine). Preplacement and periodic examinations should give special consideration to the eyes, central nervous system; gastrointestinal symptoms; and liver and kidney function. Hair loss may be a significant sign.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit. The symptoms of acute thallium poisoning (except for gastrointestinal symptoms) do not become manifest until 12 h to 4 days after exposure.

For severe poisoning BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of thallium it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA [as thallium (soluble compounds)]: *0.5 mg/m*^{3}*:* Qm (APF = 25), if not present as a fume (any quarter-mask respirator). *1 mg/m*^{3}*:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *2.5 mg/m*^{3}*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter). *5 mg/m*^{3}*:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *15 mg/m*^{3}*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Thallium must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur.

Shipping: Thallium compounds n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thallium *metal* may burn, but does not readily ignite. Extinguish fire using an agent suitable for type of surrounding fire. For the *nitrate* use water only; *do not* use chemicals, foam, or carbon dioxide. Poisonous gases produced in fire will vary, including (*sulfide:* thallium and sulfur oxides; *nitrates:* nitrogen oxides and thallium). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dilute thallium solutions may be disposed of in chemical waste landfills. When possible, thallium should be recovered and returned to the suppliers.

References

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US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thallous Carbonate*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thallous Chloride*. Washington, DC: Chemical Emergency Preparedness Program

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New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Thallium*. Trenton, NJ

Thioacetamide T:0430

Molecular Formula: C_2H_5NS
Common Formula: CH_3CSNH_2
Synonyms: Acetamide, thio-; Acetimidic acid, thio-; Acetothioamide; Ethanethioamide; TAA; Thiacetamide; Tioacetamida (Spanish)
CAS Registry Number: 62-55-5
RTECS® Number: AC8925000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n. o.s.)/154
EC Number: 200-541-4 [*Annex I Index No.:* 616-026-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: 11th Report on Carcinogens, 2002: Reasonably anticipated to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—mouse embryo; Positive: Cell transform.—RLV F344 rat embryo; Host-mediated assay; Positive: *D. melanogaster* sex-linked lethal; Weakly Positive: *S. cerevisiae*—homozygosis; Negative: *E. coli* polA with S9; Histidine reversion—Ames test; Negative: Sperm morphology—mouse; Inconclusive: *E. coli* polA without S9.

Banned or Severely Restricted (Sweden) (UN)[13].

US EPA Hazardous Waste Number (RCRA No.): U218.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R36/38; R52/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Thioacetamide is combustible, crystalline compound with a slight mercaptan odor. Molecular weight = 75.14; Freezing/Melting point = 115°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector. Thioacetamide is used as a replacement for hydrogen sulfide in qualitative analyses. Thioacetamide has been used as an organic solvent in the leather, textile, and paper industries; as an accelerator in the vulcanization of buna rubber; and as a stabilizer of motor fuel.

Incompatibilities: Strong oxidizers; strong acids; strong bases.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.5 mg/m^3

PAC-1: 5 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 125 mg/m^3

United Kingdom: carcinogen, 2000. North Dakota[60] has set a guideline for thioacetamide in ambient air at zero concentration.

Determination in Water: Octanol−water coefficient: Log K_{ow} = low, about −0.40.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Skin and eye irritation; conjunctivitis. Irritates the respiratory tract causing coughing. Symptoms of exposure include fatigue, nausea, vomiting, anorexia, liver damage; respiratory depression; central nervous system depression; acidosis, hypotension, tremors, convulsions, and unconsciousness.

Long Term Exposure: May cause liver damage severe enough to cause death. May cause lung damage. May cause dermatitis; eczema. A potential occupational carcinogen.

Points of Attack: Liver, lungs.

Medical Surveillance: Liver function tests. Lung function tests.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water or milk to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Thioacetamide is a potential occupational carcinogen. Toxic solids, organic, n.o.s., requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Use absorbent dampened with 60−70% acetone to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thioacetamide is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including hydrogen sulfide and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Treatment in an incinerator, boiler, or cement kiln.

References

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4,4′-Thiobis(6-*tert*-butyl-*m*-cresol) T:0440

Molecular Formula: $C_{12}H_{18}OS$

Common Formula: $[(CH_3)_3CC_6H_2(OH)(CH_3)_2]S$

Synonyms: Bis-3-*tert*-butyl-4-hydroxy-6-methylphenyl) sulfide; Bis(4-hydroxy-5-*tert*-butyl-2-methylphenyl) sulfide; *m*-Cresol, 4,4′-thiobis(6-*tert*-butyl-); Disperse MB-61; Santonox; Santowhite crystals; Santox; Thioalkofen BM4; 4,4′-Thiobis(3-methyl-6-*tert*-butylphenol); 1,1′-Thiobis(2-methyl-4-hydroxy-5-*tert*-butylbenzene)

CAS Registry Number: 96-69-5

RTECS® Number: GP3150000

EC Number: 202-525-2

Regulatory Authority and Advisory Bodies

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse, rat.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 4,4′-Thiobis(6-*tert*-butyl-*m*-cresol) is a light gray to tan powder with an aromatic odor. Molecular weight = 358.58; Specific gravity (H_2O:1) = 1.10 at 25°C; Freezing/Melting point = 150°C; Vapor pressure = 6×10^{-7} mmHg at 25°C; Flash point = 207°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility 0.08%.

Potential Exposure: Compound Description: Tumorigen. This material is used as an antioxidant in the plastics and rubber industries; in Neoprene™ and other synthetic rubbers; in polyethylene and polypropylene.

Incompatibilities: None reported. However, it is combustible and may react with strong oxidizers. Many sulfides evolve explosive hydrogen sulfide upon contact with moisture or acids.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3, total dust TWA; 5 mg/m^3, respirable fraction TWA.

NIOSH REL: 10 mg/m^3, total dust TWA; 5 mg/m^3, respirable fraction TWA.

ACGIH TLV®[1]: 10 mg/m^3, total dust TWA, not classifiable as a human carcinogen; *Notice of intended change*: 1 mg/m^3 inhalable fraction TWA.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 300 mg/m^3

PAC-3: 500 mg/m^3

Denmark: TWA 10 mg/m^3, 1999; France: VME 10 mg/m^3, 1999; Switzerland: MAK-W 10 mg/m^3, 1999; United Kingdom: TWA 10 mg/m^3, STEL 20 mg/m^3, 2000; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for this material in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air: Use NIOSH(IV), Particulates NOR: Method #0500, total dust; Method #0600 (respirable).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Although reported to be poisonous, this compound is insignificantly toxic on the basis of acute oral toxicity to rats. However, gastroenteritis, retarded weight gain, and enlarged livers resulted in rat feeding studies.

Long Term Exposure: Repeated or high exposures may cause liver damage.

Points of Attack: Eyes, skin, respiratory system; liver.

Medical Surveillance: Liver function tests.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures over *10 mg/m*^{3}, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. The spilled material may be dampened with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire, including oxides of sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 4,4′-Thiobis(6-t-Butyl-m-Cresol).* Trenton, NJ

Thiofanox T:0450

Molecular Formula: $C_9H_{18}N_2O_2S$

Common Formula: $(CH_3)_3CC(CH_2SCH_3){=}NOCONHCH_3$

Synonyms: Dacamox; Diamond Shamrock DS-15647; 3,3-Dimethyl-1-(methylthio)-2-butanone-*O*-[(methylamino) carbonyl] oxime; DS-15647; ENT 27,851; Thiofanocarb (South Africa)

CAS Registry Number: 39196-18-4

RTECS® Number: EL8200000

UN/NA & ERG Number: UN2757/151

EC Number: 254-346-4 [*Annex I Index No.:* 006-064-00-6]

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P045.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R27/28; R50/53; Safety phrases: S1/2; S27; S36/37; S45; S60, 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Thiofanox is a colorless solid with a pungent odor. Molecular weight = 218.35; Freezing/Melting point = 57°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: Those involved in the manufacture, formulation, and application of this systemic insecticide and acaricide.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 35 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 100 mg/m^3

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This material is moderately to highly toxic. It is a cholinesterase inhibitor. Symptoms of exposure include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; sweating, weakness, runny nose; tightness of chest (inhalation exposure); blurred vision; tearing, muscle spasm; loss of eye coordination; ocular pain, extreme dilation of the pupil; loss of muscle coordination; slurring of speech; difficulty in breathing; excessive respiratory tract mucus; skin discoloration; and hypertension. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Blood, eyes, lungs.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate or organophosphate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Eye examination. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Carbamate pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Stay upwind; keep out of low areas. Ventilate closed spaces before entering. Use water spray, fog or foam. Move container from fire area (only without risk). Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. Poisonous gases are produced in fire, including oxides of sulfur and nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thiofanox*. Washington, DC: Chemical Emergency Preparedness Program

Thioglycolic acid T:0460

Molecular Formula: $C_2H_4O_2S$

Common Formula: $HSCH_2COOH$

Synonyms: Acetic acid, mercapto-; Acetyl mercaptan; Acide thioglycolique (French); Glycolic acid, 2-thio-; Glycolic acid, thio-; Mercaptoacetate; 2-Mercaptoacetic acid; α-Mercaptoacetic acid; Mercaptoacetic acid; 2-Thioglycolic acid; Thioglycolic acid; Thioglycollic acid; Thiovanic acid

CAS Registry Number: 68-11-1

RTECS® Number: AI5950000

UN/NA & ERG Number: UN1940/153

EC Number: 200-677-4 [*Annex I Index No.:* 607-090-00-6]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; R34; Safety phrases: S1/2; S25; S27; S28; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Thioglycolic acid is a colorless liquid with a strong unpleasant odor like rotten eggs. Molecular weight = 92.12; Specific gravity (H_2O:1) = 1.32 at 25°C; Boiling point = 123°C at 29 mmHg; also reported at 120°C at 20 mmHg; 104−106°C at 11 mmHg; Freezing/Melting point = −16.5°C; Vapor pressure = 10 mmHg at 18°C; Flash point = >110°C; Autoignition temperature = 350°C. Explosive limits: LEL = 5.9%; UEL—unknown. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Primary Irritant. Thioglycolic acid is used to make thioglycolates; in sensitivity tests for iron; in formulations of permanent wave solutions and depilatories; in pharmaceutical manufacture; as a stabilizer in vinyl plastics.

Incompatibilities: Air, strong oxidizers; bases, active metals (e.g., sodium potassium, magnesium, calcium). Readily oxidized by air. Decomposition can lead to release of H_2S.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.77 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/4 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 1 ppm/3.8 mg/m^3 TWA [skin].

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 1 ppm

PAC-2: 1.25 ppm

PAC-3: 6 ppm

Australia: TWA 1 ppm (4 mg/m^3), 1993; Belgium: TWA 1 ppm (3.8 mg/m^3), 1993; Denmark: TWA 1 ppm (5 mg/m^3), 1999; Finland: TWA 1 ppm (5 mg/m^3), STEL 3 ppm (15 mg/m^3), 1993; France: VME 1 ppm (5 mg/m^3) [skin], 1999; Hungary: TWA 0.5 mg/m^3, STEL 1 mg/m^3, 1993; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Netherlands: MAC-TGG 4 mg/m^3 [skin], 2003; Russia: STEL 0.1 mg/m^3 [skin], 1993; United Kingdom: TWA 1 ppm, 3.8 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 ppm [skin]. Several states have set guidelines or standards for thioglycolic acid in ambient air[60] ranging from 40 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Octanol−water coefficient: Log K_{ow} = low, <0.1.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause eye and skin burns and blisters. It can also cause conjuctival edema and corneal damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ingesting the liquid may cause chemical pneumonitis. Exposure can cause death. Irritation, blistering, and severe burns of the skin, eyes, and mucous membranes; corrosion of tissues.[52] If ingested, severe burning pain in the mouth, pharynx, and abdomen; vomiting, bloody diarrhea; sharp drop in blood pressure: and asphyxia. If inhaled; coughing, choking, headache, dizziness, weakness, tightness in the chest; air hunger; and cyanosis. In animals: weakness, asping respirations; convulsions.

Long Term Exposure: Repeated contact may cause a skin rash.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. If conscious, do not induce vomiting. For dilute acid, give water, milk, milk of magnesia; A $(OH)_3$, or $Ca(OH)_2$. Avoid carbonates or bicarbonates. For concentrated acid, it may be dangerous to administer water or antacids. Some authorities suggest ice water or a snow slurry. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema or pneumonitis, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thioglycolic acid may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray; or foam extinguishers. Poisonous gases, including sulfur oxides and hydrogen sulfide, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in flammable solvent and burn in furnace equipped with afterburner and alkaline scrubber.

References

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Thioglycolic Acid*. Trenton, NJ

Thionazin T:0470

Molecular Formula: $C_8H_{13}N_2O_3PS$

Synonyms: AC 18133; American Cyanamid 18133; CL 18133; Cynem; *O*,*O*-Diaethyl-*O*-(pyrazin-2yl)-monothiophosphat (German); *O*,*O*-Diaethyl-*O*-(2-pyrazinyl)-thionophosphat (German); *O*,*O*-Diethyl *O*-2-pyrazinyl phosphorothioate; Diethyl *O*-2-pyrazinyl phosphorothionate; *O*,*O*-Diethyl *O*-2-pyrazinyl phosphothionate; *O*,*O*-Diethyl *O*-pyrazinyl thiophosphate; EN 18133; ENT 25 580; Experimental nematocide 18,133; Nemafos; Nemaphos; Nematocide; Phosphorothioic acid, *O*,*O*-diethyl *O*-2-pyrazinyl ester; Pyrazinol *O*-ester with *O*,*O*-diethyl phosphorothioate pyrazinol *O*-ester; Thionazin; Zinophos®

CAS Registry Number: 297-97-2

RTECS® Number: TF5775000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 206-049-6 [*Annex I Index No.*: 015-112-00-5]

Regulatory Authority and Advisory Bodies

Very Toxic Substance (World Bank).[15]

US EPA Hazardous Waste Number (RCRA No.): P040.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

European/International Regulations: Hazard Symbol: T+; Risk phrases: R27/28; Safety phrases: S1/2; S36/37/39; S38; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Thionazin is an amber to colorless liquid. Molecular weight = 248.46; Boiling point = 80°C at 0.001 mmHg; Freezing/Melting point = −1.7°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Those involved in the manufacture, formulation, and application of this insecticide, fungicide, and nematocide.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 3.5 mg/m^3

PAC-3: 3.5 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus pesticides.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact may cause burns to skin and eyes. Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Acute effects include loss of appetite; nausea, vomiting, diarrhea, excessive salivation; papillary constriction; bronchoconstriction, muscle twitching; convulsions, and coma. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause dermatitis.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Shampoo hair. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if possible; use water spray to reduce vapors. *Small spill*: take up with sand or other noncombustible absorbent material and place into container for later disposal. *Large spills*: dike far ahead of spill for later disposal. Avoid breathing vapors. Avoid bodily contact with materials. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Extinguish fire using agent suitable for type of surrounding fire. Use water in flooding quantities as fog. Use foam, carbon dioxide; or dry chemicals. Poisonous gases, including oxides of nitrogen, phosphorus, and sulfur, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thionazin*. Washington, DC: Chemical Emergency Preparedness Program

Thionyl chloride T:0480

Molecular Formula: Cl_2OS

Common Formula: $SOCl_2$

Synonyms: Sulfinyl chloride; Sulfur chloride oxide; Sulfur oxychloride; Sulfurous dichloride; Sulfurous oxychloride; Thionyl dichloride

CAS Registry Number: 7719-09-7

RTECS® Number: XM5150000

UN/NA & ERG Number: UN1836/137

EC Number: 231-748-8 [*Annex I Index No.:* 016-015-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R20/22; R29; R35; Safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Thionyl chloride is a pale yellow to reddish liquid with a suffocating odor like sulfur dioxide. Fumes form when exposed to moist air. Molecular weight = 118.96; Specific gravity (H_2O:1) = 1.64 at 25°C; Boiling point = 79°C (decomposes to SO_2 and S_2Sl_2 at 140°C); Freezing/Melting point = −104°C; Vapor pressure = 100 mmHg at 21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2₩. Reacts with water.

Potential Exposure: Thionyl chloride is used as specialty chlorinating agent, particularly in preparation of organic acid chlorides; in organic synthesis; as a catalyst.

Incompatibilities: Reacts violently with water to form sulfur dioxide and hydrogen chloride. Keep away from water, acids, alkalis, ammonia, chloryl perchlorate.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.87 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/5 mg/m^3 Ceiling Concentration.

Protective Action Criteria (PAC)*

ACGIH TLV®[1]: 0.2 ppm TWA Ceiling Concentration

TEEL-0: 0.06 ppm

PAC-1: **0.2** ppm

PAC-2: **2.4** ppm

PAC-3: **14** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 1 ppm (5 mg/m^3), 1993; Belgium: STEL 1 ppm (4.9 mg/m^3), 1993; Denmark: TWA 1 ppm (5 mg/m^3, 1999; Switzerland: MAK-W 1 ppm (5 mg/m^3), 1999; United Kingdom: STEL 1 ppm (4.9 mg/m^3), 2000; the Netherlands: MAC 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 1 ppm.

North Dakota[60] has set a guideline for thionyl chloride in ambient air of 50 μg/m^3 (5 mg/m^3).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: A corrosive irritant to the eyes, skin, and mucous membrane. Contact causes eye and skin burns. Can cause dermatitis, rhinitis (inflammation of the nose), and pneumonia. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. This chemical is more toxic than sulfur dioxide.

Long Term Exposure: Highly irritating substances can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs. Consider chest X-ray following acute overexposure.

Medical Surveillance: Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to medical personnel: Administer oxygen, using intermittent positive-pressure breathing apparatus: 5% solution of sodium bicarbonate may be used, as well as bronchodilators and decongestants.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with thionyl chloride you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, acids, alkalis, ammonia, chloryl perchloride. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Cover with sodium bicarbonate or an equal mixture of soda ash and slaked lime. After mixing, spray water from an atomizer with great caution. Transfer slowly into a large container of water. Neutralize and drain into the sewer with sufficient water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

When spilled on land

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.2/0.3
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100.
Then: Protect persons downwind (miles/kilometers).
Day 0.6/0.9
Night 1.2/1.9

When spilled in water

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.2/0.3
Night 0.9/1.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300.
Then: Protect persons downwind (miles/kilometers).
Day 2.1/3.3
Night 4.7/7.5

Fire Extinguishing: This chemical is a noncombustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Keep water out of open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray on a thick layer of a (1:1) mixture of dry soda ash and slaked lime behind a shield. After mixing, spray water from an atomizer with great precaution. Transfer slowly into a large amount of water. Neutralize and drain into the sewer with sufficient water.

Thiosemicarbazide T:0490

Molecular Formula: CH_5N_3S
Common Formula: $H_2NNHCSNH_2$
Synonyms: AI3-16319; *N*-Aminothiourea; 1-Amino-2-thiourea; 1-Aminothiourea; Aminothiourea; Hydrazinecarbothioamide; Isothiosemicarbazide; Semicarbazide, 3-thio-; Semicarbazide, thio-; Thiocarbamoylhydrazine; Thiocarbamylhydrazine; 2-Thiosemicarbazide; 3-Thiosemicarbazide; Tiosemicarbazida (Spanish); TSC; TSZ
CAS Registry Number: 79-19-6
RTECS® Number: VT4200000
UN/NA & ERG Number: UN2771/151
EC Number: 201-184-7

Regulatory Authority and Advisory Bodies

US EPA Hazardous Waste Number (RCRA No.): P116.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Thiosemicarbazide is an odorless, white crystalline powder. Molecular weight = 91.15; Freezing/Melting point = 180−184°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This compound is used as an intermediate for pharmaceuticals and herbicides; as a reagent for ketones and certain metals; in certain photography and dye operations; as a rodenticide. It is also effective for control of bacterial leaf blight of rice.

Incompatibilities: None listed, but may react with nitrates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 9.2 mg/m^3
PAC-3: 9.2 mg/m^3

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.67$. See Feigel, *Spot Tests in Organic Analysis*, Elsevier Publishing Company, New York.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This material is highly toxic by ingestion. May cause delayed toxic effects in blood and skin. May be mutagenic in human cells. Thiosemicarbazide may induce goiter and has also been reported to cause bone marrow depression with accompanying decreases in white blood cells and platelets. It may also cause skin irritation.

Long Term Exposure: May cause delayed toxic effects in blood and skin. May be mutagenic in human cells. May be a cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides (or organophosphates) is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Thiosemicarbazide, pesticides, solid, toxic, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Avoid skin contact, ingestion, or inhalation. Do not touch spilled material; stop leak if you can do it without risk. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Remove all ignition sources. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing
Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Thiosemicarbazide*. Washington, DC: Chemical Emergency Preparedness Program

Thiotepa T:0500

Molecular Formula: $C_6H_{12}N_3PS$
Synonyms: 1,1′,1″-Phosphinothioylidynetrisaziridine; Phosphorothioic acid triethylenetriamide; SK 6882; Tespamine; Thiofozil; Thiophosphamide; Thio-TEP; Tiofosfamid; Tiofozil; Triaziridinylphosphine sulfide; *N*,*N*′, *N*″-Tri-1,2-ethanediylphosphorothioic triamide; *N*,*N*′,*N*″-Tri-1,2-ethanediylthiophosphoramide; Tri(ethyleneimino) thiophosphoramide; *N*,*N*′,*N*″-Triethylenephosphorothioic triamide; *N*,*N*′,*N*″-Triethylenethiophosphamide; *N*,*N*′,*N*″-Triethylen-ethiophosphoramide; Triethylenethiophosphorotriamide; Tris(1-aziridinyl)phosphine sulfide; Tris(ethylenimino)thiophosphate
CAS Registry Number: 52-24-4
RTECS® Number: SZ2975000
UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151
EC Number: 200-135-7
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Human Sufficient Evidence, 1978; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat.
Banned or Severely Restricted (In Household Products) (Japan).[13]
California Proposition 65 Chemical: Cancer 1/1/88.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Thiotepa is a crystalline substance. Molecular weight = 189.24; Freezing/Melting point = 51.5°C. Insoluble in water.
Potential Exposure: Thiotepa has been prescribed for a wide variety of neoplastic diseases (adenocarcinomas of the breast and the ovary; superficial carcinoma of the urinary bladder; controlling intracavitary or localized neoplastic disease; lymphomas, such as lymphosarcomas and Hodgkin's disease; as well as bronchogenic carcinoma). It is now largely superseded by other treatments.
Permissible Exposure Limits in Air
No standards or TEEL available.
Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.
Harmful Effects and Symptoms
Long Term Exposure: Tris(1-aziridinyl)phosphine sulfide (Thiotepa) is carcinogenic in mice and rats after administration by various routes, producing a variety of malignant tumors. There are several reports and epidemiological studies suggesting the development of acute nonlymphocytic leukemia in patients treated with thiotepa for ovarian and other malignant tumors.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: Medicine, solid, toxic, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." This material falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including oxides of nitrogen, sulfur, and phosphorus. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). (1980). Dangerous Properties of Industrial Materials Report, 1, No. 2, 69−70

Thiourea T:0510

Molecular Formula: CH_4N_2S

Common Formula: H_2NCSNH_2

Synonyms: Carbamide, thio-; Isothiourea; Pseudothiourea; Pseudourea, 2-thio-; Sulfourea; Sulourea; Thiocarbamate; Thiocarbamide; β-Thiopseudourea; 2-Thiourea; THU; Tiourea (Spanish); TSIZP 34; Urea, 2-thio-

CAS Registry Number: 62-56-6

RTECS® Number: YU2800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-543-5 [*Annex I Index No.:* 612-082-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 2000; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/F344 rat EPA; Positive: SHE—clonal assay; Cell transform.—RLV F344 rat embryo EPA; Positive: Host-mediated assay EPA; Negative: Cell transform.—SA7/SHE; *E. coli* polA with S9 EPA; Negative: Histidine reversion—Ames test; Sperm morphology—mouse EPA; Negative: *S. cerevisiae*—homozygosis EPA; Inconclusive: *E. coli* polA without S9.

Banned or Severely Restricted (Sweden) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U219.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R40; R51/53; Safety phrases: S2; S36/37; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Thiourea consists of colorless, lustrous crystals or powder with a bitter taste. Molecular weight = 76.13; Boiling point = decomposes below BP; Freezing/Melting point = 180−182°C; Flash point = 55°C. Partially soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Thiourea is used as rubber antiozonant, toning agent; corrosion inhibitor; and in pharmaceutical manufacture; in the manufacture of photosensitive papers; flame-retardant textile sizes; boiler water treatment. It is also used in photography; pesticide manufacture; in textile chemicals.

Incompatibilities: Reacts violently with acrolein, strong acids (nitric acid), and strong oxidants.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 1.25 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 125 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; danger of photo-contact sensitization; Carcinogen Category 3B.

Austria Suspected: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Russia: STEL 0.3 mg/m^3, 1993; Sweden: carcinogen, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3 [skin], 2003. Several states have set guidelines or standards for thiourea in ambient air[60] ranging from zero (North Dakota) to 0.03 μg/m^3 (New York).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -2.38/-0.95$.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes. Thiourea may affect you when breathed in. A related chemical (naphthylthiourea) in higher exposures can cause fluid in the lungs, a medical emergency. It is not known if thiourea has this effect.

Long Term Exposure: Repeated exposure can cause goiter (enlarged thyroid gland). Exposure may damage the bone marrow, causing reduced red blood cells; white blood cells and platelets (reduced blood clotting ability). Thiourea has been identified as a sensitizer in people suffering from photosensitivity. A possible human carcinogen.

Points of Attack: Thyroid gland, blood, skin. Cancer site in animals: thyroid, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Complete blood count. Consider thyroid test for thyroxin. If symptoms develop or overexposure is suspected, the following may be useful. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with has head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any exposure level, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Thiourea must be stored to avoid contact with acrolein, hydrogen peroxide; and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Toxic solids, organic, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire, including nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant

(≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Thiourea*. Washington, DC

New Jersey Department of Health and Senior Services. (July 2002). *Hazardous Substances Fact Sheet: Thiourea*. Trenton, NJ

Thiram T:0520

Molecular Formula: $C_6H_{12}N_2S_4$

Synonyms: Aapirol; Aatack; Aatiram; Accelerator T; Accelerator thiuram; Accel TMT; Aceto TETD; AI3-00987; Anles; Arasan; Arasan 42S; Arasan 42-S; Arasan 70; Arasan 70-S Red; Arasan 75; Arasan-M; Arasan-SF; Arasan-SF-X; Atiram; Attack; Aules; Bis(diethylthiocarbamoyl) sulfide; Bis [(dimethylamino)carbonothioyl] disulfide; Bis[(dimethylamino)carbonothioyl] disulphide; Bis(dimethylthiocarbamoyl) disulfide; Bis(dimethylthiocarbamoyl) disulphide; Chipco Thiram 75; Cunitex; Cyuram DS; Delsan; Disulfide, bis (dimethylthiocarbamoyl); α,α′-Dithiobis(dimethyl-thio)formamide; *N*,*N*-(Dithio-dicarbonothioyl)bis(*N*-methylmethanamine); Ekagom TB; ENT 987; Falitiram; Fermide; Fermide 850; Fernacol; Fernasan; Fernasan A; Fernide; Flo Pro T seed protectant; FMC 2070; Formalsol; Formamide, 1,1′-dithiobis (*N*,*N*-dimethylthio-); Hermal; Hermat TMT; Heryl; Hexathir; HY-VIC; Kregasan; Mercuram; Methyl thiram; Methylthiuram disulfide; Methyl tuads; Metiurac; NA2771; Nobecutan; Nomersan; Normersan; NSC 1771; Panoram 75; Polyram ultra; Pomarsol; Pomarsol forte; Pomasol; Puralin; Rezifilm; Royal TMTD; Sadoplon; Spotrete; Spotrete-F; SQ 1489; Sranan-SF-X; STCC 4941187; Teramethylthiuram disulfide; Tersan; Tersan 75; Tersantetramethyl diurane sulfide; Tetramethyldiurane sulphite; Tetramethylenethiuram disulfide; Tetramethylenethiuram disulphide; Tetramethylthiocarbamoyldisulphide; Tetramethyl-thioperoxydicarbonic diamide; Tetramethylthiuram; Tetramethylthiuram bisulfide; Tetramethylthiuram bisulphide; *N*,*N*,*N*′,*N*′-Tetramethylthiuram disulfide; *N*,*N*-Tetramethylthiuram disulfide; Tetramethylthiuram disulfide; Tetramethylthiuram disulphide; Tetramethylthiuran disulphide; Tetramethylthiurane disulfide; Tetramethyl thiurane disulphide; Tetramethylthiurum disulfide; Tetramethylthiurum disulphide; Tetrapom; Tetrasipton; Tetrathiuram disulfide; Tetrathiuram disulphide; Thianosan; Thillate; Thimar; Thimer; Thioknock; Thioperoxydicarbo NIC diamide, tetramethyl-; Thioperoxydicarbonic diamide, tetramethyl-; Thiosan; Thioscabin; Thiotex; Thiotox; Thiram 75; Thiram 80; Thiramad; Thiram B; Thirame (French); Thirampa; Thirasan; Thiulin; Thiulix; Thiurad; Thiuram; Thiuram D; Thiuramin; Thiuramyl; Thylate; Tiram (Spanish); Tirampa; Tiuramyl; TMTD; TMTDS; Trametan; Tridipam; Tripomol; TTD; Tuads; Tuex; Tulisan; Vancida TM-95; Vancide TM; Vuagt-1-4; Vulcafor TMTD; Vulkacit MTIC; Vulkacit Thiuram; Vulkacit Thiuram/C

CAS Registry Number: 137-26-8; *(alt.)* 12680-07-8; *(alt.)* 12680-62-5; *(alt.)* 39456-80-9; *(alt.)* 66173-72-6; *(alt.)* 93196-73-7

RTECS® Number: JO14000000

UN/NA & ERG Number: UN2771/151

EC Number: 205-286-2 [*Annex I Index No.:* 006-005-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1991.

US EPA Gene-Tox Program, Positive: Mammalian micronucleus; *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

US EPA Hazardous Waste Number (RCRA No.): U244.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as dustable powder formulations containing a combination of: Benomyl at or >7%; carbofuran at or >10%; thiram at or >15%).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R20/22; R36/38; R43; R48/22; R50/53; Safety phrases: S2; S26; S36/37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Thiram is a colorless to yellow, crystalline solid (which is sometimes dyed blue) with a characteristic odor. Commercial pesticide products may be dyed blue. Molecular weight = 240.44; Boiling point = 129°C; Freezing/Melting point = 156°C; Flash point = 148°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Human Data; Hormone, Primary Irritant. Some thiurams have been used as rubber components: thiram is used as a rubber accelerator and vulcanizer; a seed, nut, fruit, and mushroom disinfectant; a bacteriostat for edible oils and fats; and as an ingredient in suntan and antiseptic sprays and soaps. It is also used as a fungicide, rodent repellent; wood preservative; and may be used in the blending of lubricant oils.

Incompatibilities: Strong oxidizers; strong acids; oxidizable materials.

Permissible Exposure Limits in Air

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 5 mg/m^3 TWA.
ACGIH TLV®[1]: 0.05 mg/m^3, measured as inhalable fraction and vapor TWA; not classifiable as a human carcinogen.
NIOSH IDLH: 100 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.05 mg/m^3
PAC-1: 10 mg/m^3
PAC-2: 75 mg/m^3
PAC-3: 100 mg/m^3
DFG MAK: MAK: 1 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2); danger of skin sensitization; Pregnancy Risk Group C.
Australia: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 5 mg/m^3, STEL 10 mg/m^3 [skin], 1999; France: VME 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; the Philippines: TWA 5 mg/m^3, 1993; Poland: MAC (TWA) 0.5 mg/m^3; MAC (STEL) 2 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3 [skin], 1993; Sweden: TWA 1 mg/m^3, STEL 2 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, STEL 25 mg/m^3, 1999; Thailand: TWA 5 mg/m^3, 1993; Turkey: TWA 5 mg/m^3, 1993; United Kingdom: TWA 5 mg/m^3, STEL 10 mg/m^3 2000 Occupational Exposure Limit; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[35, 43] has set MAC values for ambient air in residential areas of 0.01 mg/m^3 on a momentary basis and 0.006 mg/m^3 on a daily average basis. Several states have set guidelines or standards for Thiram in ambient air[60] ranging from 50 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5005, Thiram.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 μg/L. Further, it set a MAC in water bodies used for fishery purposes of zero. The state of Maine[61] has set a guideline for thiram in drinking water of 10 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin irritation can lead to rash, and allergy. High exposures can cause kidney and liver damage. Brain and nerve damage can also occur. Inhalation can cause irritation of the respiratory tract with stuffy nose; nosebleeds, hoarseness, cough, and/or phlegm. *Inhalation:* Animal studies indicate that irritation of the nose and throat may occur at levels above 5 mg/m^3. *Skin:* Exposure to spray containing 45% Thiram resulted in irritation and skin sensitization. *Eyes:* May cause irritation, tearing, and sensitivity to light. *Ingestion:* No information available on human exposure. In animal studies, 38 ppm in food caused nausea, vomiting, diarrhea, hyperexcitability, weakness, and loss of muscle control. Death may occur from ingestion of approximately one teaspoonful.

Note: Can cause extreme illness when exposure is combined with alcohol ingestion.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization. Prolonged contact has caused eye irritation; tearing, increased sensitivity to light; reduced night vision and blurred vision. Occupational exposures to 0.03 mg/m^3 over a 5-year period has caused mild irritation of the nose and throat. Whether it has this effect in humans is not known. May affect the thyroid and liver. Thiram has caused birth defects in laboratory animals and has been shown to be a teratogen in animals.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Preplacement and periodic medical examinations should give special attention to history of skin allergy, eye irritation; and significant respiratory, liver, or kidney disease. Workers should be aware of the potentiating action of alcoholic beverages when working with tetramethylthiuram disulfide.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *100 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or

GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprOvHie (APF = 25) (any powered, air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool place away from strong oxidizers; strong acids; oxidizable materials.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with weak solution of calcium hypochlorite (up to 15%). Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including sulfur dioxide, carbon disulfide, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Thiram can be dissolved in alcohol or other flammable solvent and burned in an incinerator with an afterburner and scrubber.

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 41−42

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Thiram.* Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Thiram.* Trenton, NJ

Thorium & compounds T:0525

Common Formula: Th; $Th(NO_3)_4$; ThO_2

Synonyms: *Metal:* Thorium-232; Thorium metal, pyrophoric

Chloride: (Spanish) Tetrochlorothorium; Thorium tetrachloride

Dioxide: Dioxido de torio (Spanish); Thoria; Thorium oxide (tho2); thorium(IV) oxide; Thorotrast; Thortrast; Umbrathor

Nitrate: Nitric acid, thorium(4+) salt; Thorium(4+) nitrate; Thorium(IV) nitrate; Thorium tetranitrate

CAS Registry Number: 7440-29-1 (elemental); 10026-08-1 (chloride); 13823-29-5 (nitrate); 1314-20-1 (dioxide); 13825-36-0 (hydroxide); 2040-52-0 (oxalate); 16045-17-3 (perchlorate)

RTECS® Number: XO6400000 (elemental); XO6825000 (nitrate); XO6950000 (dioxide); 237-514-1(nitrate)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric. UN2975 (metal, pyrophoric)/162; UN2976 (nitrate); UN3077/171 (dioxide)

EC Number: 231-139-7 (elemental); 233-056-1 (chloride); 215-225-1(dioxide)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence [diagnostic injection of thorium-232 as stabilized thorium-232 dioxide in colloidal form (Thorotrast)]; Humans Inadequate Evidence (inhalation thorium-232), generally in Group, 2001; RTECS: (thorium dioxide).[9]

Thorium dioxide:
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
California Proposition 65 Chemical: Cancer 2/27/87.
European/International Regulations: Not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned (all CAS numbers shown above).

Description: Thorium is a silvery-white, soft, ductile metal which is a natural radioactive element. Atomic weight = 232.00; Freezing/Melting point = 1750±30°C. Insoluble in water. It occurs in the minerals monazite, thorite, and thorinite; usually mixed with its disintegration products. Thorium chloride is a crystalline solid. Molecular weight = 373.80; Boiling point = 927.5°C; Freezing/Melting point = 770°C. Soluble in water; Thorium nitrate, $Th(NO_3)_4$ is a crystalline solid which decomposes at 500°C. Thorium oxide, ThO_2 is a white crystalline powder or solid. Molecular weight = 264.00; Boiling point = 4400°C; Freezing/Melting point = 3320°C. Insoluble in water.

Potential Exposure: *Metallic thorium* is used in nuclear reactors to produce nuclear fuel; in the manufacture of incandescent mantles; as an alloying material, especially with some of the lighter metals, e.g., magnesium as a reducing agent in metallurgy; for filament coatings in incandescent lamps and vacuum tubes; as a catalyst in organic synthesis; in ceramics; and in welding electrodes. Exposure may occur during production and use of thorium-containing materials, in the casting and machining of alloy parts; and from the fume produced during welding with thorium electrodes.

Thorium nitrate is an oxidizer. Contact with combustibles and reducing agents will cause violent combustion or ignition.

Incompatibilities: *Metal:* The powder may ignite spontaneously in air. Heating may cause violent combustion or explosion. May explosively decompose from shock, friction, or concussion. Potentially hazardous reactions with strong oxidizers, chlorine, fluorine, bromine, oxygen; phosphorus, nitryl fluoride; peroxyformic acid; silver, sulfur.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.35 mg/m^3
PAC-1: 1 mg/m^3
PAC-2: 6 mg/m^3
PAC-3: 35 mg/m^3
Nitrate
TEEL-0: 0.75 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 25 mg/m^3
Perchlorate
TEEL-0: 31.4 mg/m^3
PAC-1: 94.3 mg/m^3
PAC-2: 157 mg/m^3
PAC-3: 500 mg/m^3
Oxide
TEEL-0: 25 mg/m^3
PAC-1: 75 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
Oxalate
TEEL-0: 42.1 mg/m^3
PAC-1: 126 mg/m^3
PAC-2: 210 mg/m^3
PAC-3: 500 mg/m^3
Hydroxide
TEEL-0: 0.75 mg/m^3
PAC-1: 0.75 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 75 mg/m^3
North Dakota[60] has set a guideline for ambient air of zero for thorium dioxide.

Routes of Entry
Ingestion of liquid, inhalation of dust or gas, and percutaneous absorption.

Harmful Effects and Symptoms
Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation may cause damage to the bone marrow and lungs. May affect the blood-forming system, reducing the ability to produce white blood cells, resulting in pernicious anemia.

Long Term Exposure: Gas and aerosols can penetrate the body by way of the respiratory system, the digestive system, and the skin. Only 0.001% of an ingested dose is retained in the body. Thorium, once deposited in the body, remains in the bones, lymph system; lungs and other body organs; and parenchymatous tissues for long periods of time. Low repeated exposures may scar the lungs, and damage the liver and kidneys. Characteristic effects of the activity of thorium and its disintegration products are changes in blood-forming, nervous and reticuloendothelial systems; and functional and morphological damage to lung and bone tissue. Only much later do illness and symptoms characteristic of chronic radiation disease appear. After a considerable time, neoplasms may occur and the immunological activity of the body may be reduced. Repeated or prolonged contact with skin may cause dermatitis. A potential occupational carcinogen. May cause heritable genetic damage. May cause birth defects.

Points of Attack: Bone marrow, lungs. Liver, kidneys, lungs. Cancer site in humans (thorium dioxide): liver.

Medical Surveillance: Monitoring of personnel for early symptoms and changes, such as abnormal leukocytes in the blood smear, may be of value. In cases of chronic or acute exposure, the determination of thorium in the urine or the use of whole body radiation counts and breath radon are useful methods of monitoring the exposure dose and excretion rates. White blood cell count. Lung function test. Consider periodic chest X-ray for persons with potentially high or repeated lower exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to thorium nitrate, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered, air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Radioactive. Color Code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Thorium nitrate must be stored to avoid contact with combustible, organic, or other readily oxidizable materials, since violent reactions occur.

Shipping: Thorium metal, pyrophoric, requires a shipping label of "RADIOACTIVE, SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 7. Thorium nitrate, solid, requires a shipping label of "RADIOACTIVE, OXIDIZER." It falls in Hazard Class 7.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thorium dioxide may burn, but does not readily ignite. Thorium nitrate can cause violent combustion or ignition when in contact with readily combustible substances. On thorium nitrate, use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides in thorium nitrate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is in the preferred route.

References

Sax, N. I. (Ed.). (1988). *Dangerous Properties of Industrial Materials Report: Thorium Chloride*, 8, No. 4, 72−74

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Thorium Nitrate*. Trenton, NJ

New Jersey Department of Health and Senior Services. (June 2006). *Hazardous Substances Fact Sheet: Thorium Dioxide*. Trenton, NJ

Tin & inorganic compounds T:0530

Molecular Formula: Sn

Synonyms: Alloy 510; Alloy 511; Alloy 521; Alloy 725; Estano (Spanish); Metallic tin; Prepared bath 2137; Tin, elemental; Tin flake; Tin metal; Tin powder; Zinn (German)

Other tin inorganic compounds for reference: Tin fluoroborate (B_2F_8Sn) (13814-97-6); Tin hydroxide (H_2O_2Sn) (12026-24-3); Tin nitrate (41480-79-9); Tin nitrite (100737-27-7); Tin(II) chloride dihydrate ($C_{12}H_4O_2Sn$) (10025-69-1); Tin(II) oxide (1332-29-2); Tin(IV) oxide (O_2Sn) (18282-10-5); Stannic tetrachloride ($C_{14}Sn$); (7646-78-8); Stannous chloride (Cl_2Sn) (7772-99-8)

CAS Registry Number: 7440-31-5 (metal); 18282-10-5 [Tin(IV) oxide]; 21651-19-4 (oxide)

RTECS® Number: XP7320000 (elemental)

UN/NA & ERG Number: No citation.

EC Number: 231-141-8

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, tin, elemental and tin compounds, n.o.s.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent (metal, oxide).

Description: Tin is a gray to almost silver-white, ductile, malleable, lustrous metal. Specific gravity (H_2O:1) = 7.28 at 25°C; Molecular weight = 118.69; Boiling point = 2625°C; Melting point = 232°C. Ignition temperature of dust cloud = 630°C; Minimum Explosive concentration = 0.19 oz/ft^3.[USBM] Relative explosion hazard of dust: Moderate (due to oxide coating). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water. The primary commercial source of tin is cassiterite (SnO_2, tinstone).

Potential Exposure: Compound Description: Tumorigen; Human Data. The most important use of tin is as a protective coating for other metals, such as in the food and beverage canning industry; in roofing tiles; silverware, coated wire; household utensils; electronic components; and pistons. Common tin alloys are phosphor bronze; light brass; gun metal; high tensile brass; manganese bronze; die-casting alloys; bearing metals; type metal; and pewter. These are used as soft solders, fillers in automobile bodies; and as coatings for hydraulic brake parts; aircraft landing gear and engine parts. Metallic tin is used in the manufacture of collapsible tubes and foil for packaging. Exposures to tin may occur in mining, smelting, and refining; and in the production and use of tin alloys and solders. Inorganic tin compounds are important industrially in the production of ceramics; porcelain, enamel, glass; and inks; in the production of fungicides; anthelmintics, insecticides; as a stabilizer it is used in polyvinyl plastics and chlorinated rubber paints; and it is used in plating baths.

Incompatibilities: Tin is a reducing agent; keep away from strong oxidizers; turpentine, acids, bases, alkalis. Powder quickly corrodes in air, especially if moist.

Permissible Exposure Limits in Air

Metal

OSHA PEL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn), including tin oxides].

NIOSH REL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn) *except* tin oxides].

ACGIH TLV®[1]: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn), including tin oxides].

NIOSH IDLH: 100 mg[Sn]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 20 mg/m^3

PAC-2: 100 mg/m^3

PAC-3: 100 mg/m^3

EUR OEL: 2 mg[Sn]/m^3 as TWA.

DFG MAK: *inorganic compounds:* Not established (Section Iib); *organic compounds:* 0.1 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D.

Australia: TWA 0.1 mg[Sn]/m^3 [skin], 1993; Australia: TWA 2 mg/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg/m^3, 1993; Denmark: TWA 2 g/m^3, 1999; Finland: TWA 2 mg/m^3, 1999; Hungary: TWA 1 mg/m^3, STEL 2 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 2 mg/m^3, 2003; Norway: TWA 1 mg/m^3, 1999; the Philippines: TWA 2 mg/m^3, 1993; Poland: TWA 2 mg/m^3, 1999; Switzerland: MAK-W 2 mg/m^3, KZG-W 4 mg/m^3, 1999; Thailand: TWA 2 mg/m^3, 1993; United Kingdom: TWA 2 mg[Sn]/m^3, STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg/m^3.

Several states have set guidelines or standards for tin in ambient air[60] ranging from 1.6 μg/m^3 (Virginia) to 20.0 μg/m^3 (North Dakota) to 40.0 μg/m^3 (Connecticut) to 48.0 μg/m^3 (Nevada).

1332-29-2 [tin(II) oxide] and 18282-10-5 [Tin(IV) oxide; (stannic oxide)]

Protective Action Criteria (PAC)

TEEL-0: 2.54 mg/m^3

PAC-1: 7.62 mg/m^3

PAC-2: 1.27 mg/m^3

PAC-3: 1270 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Element; #7301; #7303; OSHA Analytical Method ID-121; ID-206.

Routes of Entry: Inhalation of dust, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Dust irritates the eyes, skin, and respiratory tract. Tin may be contaminated with toxic lead or arsenic, causing exposure to these chemicals from dust or fumes. Inorganic tin salts are irritants to the skin and mucous membranes; they may be strongly acidic or basic depending on the cation or anion present. In animals: vomiting, diarrhea, paralysis with muscle twitching.

Long Term Exposure: Exposure to dust or fumes of inorganic tin is known to cause a benign pneumoconiosis (stannosis). Tin or dust fumes can cause "spots" to appear on chest X-ray and may represent reduced lung function. This form of pneumoconiosis produces distinctive progressive X-ray changes of the lungs as long as exposure persists, but there is no distinctive fibrosis; no evidence of disability; and no special complicating factors. Because tin is so radio-opaque, early diagnosis is possible. Fumes can also cause chronic cough and may cause reduced lung function. Tin may interfere with the body's ability to absorb iron from food or vitamin pills, contributing to iron-deficiency anemia.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Chest X-ray; urine (chemical/metabolite). Also, see NIOSH Analytical Method #8310, Metals in urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA: *Up to 10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 100 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Powdered tin is a moderate explosion risk. Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Color Code—Green (*tin metal*): General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Tin must be stored to avoid contact with chlorine, bromine, bromine trifluoride; chlorine monofluoride; copper nitrate; turpentine, and potassium dioxide, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where tin is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tin dust may be a fire hazard. Toxic metal fumes may be produced in a fire. Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Tin, Report EPA-600/1-77-022*. Research Triangle Park, NC, pp. 405−426

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 82−83. New York, NY: Van Nostrand Reinhold Co.

New Jersey Department of Health and Senior Services. (April 2001). *Hazardous Substances Fact Sheet: Tin*. Trenton, NJ

Tin organic compounds T:0540

Molecular Formula: $Sn(R)_{4-x}$ (radical); $C_{18}H_{16}OSn$ *(used as an example)*

Synonyms: *varies, this is used as an example:* Dowco 186; Du-Ter; ENT 28,009; Fenolovo; Fentin hydroxide; Fintine hydroxyde (French); Fintin hydroxid (German); Haitin; Hydroxyde de triphenyl-etain (French); Hydroxytriphenyltin; NCI-C00260; Suzu H; TPTH; Triphenyltin hydroxide; Triphenyltin oxide; Triphenyl-zinn-hydroxid (German); Tubotin; Vancide KS

See also entries for "Tetraethyltin" (597-64-8); "Cyhexatin" (13121-70-5)

CAS Registry Number: (varies) Fentin acetate ($C_{20}H_{18}O_2Sn$) (900-95-8); Fentin hydroxide ($C_{18}H_{16}OSn$) (76-87-9); Tin(IV) isopropoxide ($C_{12}H_{28}O_4Sn$) (1184-61-8); Triphenyltin chloride ($C_{18}H_{15}ClSn$) 639-58-7; Fentin chloride (C_3H_9ClSn) (1066-45-1)

RTECS® Number: WH8750000 (varies; used as an example)

UN/NA & ERG Number: UN2777 (organotin compound, liquid, n.o.s.); UN2786 (organotin pesticide, solid, toxic)/153; 3146 (organotin compound, solid, n.o.s.)/153; UN2787 (organotin pesticide, liquid, flammable, toxic)/131; UN2788 (organotin compounds, liquid, n.o.s.)/153; UN3019 (organotin pesticide, liquid, toxic, flammable)/131; UN3020 (organotin pesticides, liquid, toxic)/153; UN3145 (organotin compound, solid, n.o.s.)/153

EC Number: 200-990-6 [*Annex I Index No.:* 050-004-00-1] (fentin hydroxide)

Regulatory Authority and Advisory Bodies

Banned or Severely Restricted (Japan) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*900-95-8; fentin acetate* and *76-87-9; fentin hydroxide*): European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R37/38; R40; R41; R48/23; R63; R50/53; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*fentin acetate; fentin hydroxide; Triphenyltin chloride; Trimethyltin chloride*).

Description: $Sn(R)_{4-x}$ $(\text{radical})_x$. A typical compound is triphenyltin hydroxide, $C_{18}H_{16}OSn$, which is a white powder; Freezing/Melting point = 122°C. Slightly soluble in water.

Potential Exposure: Organotin compounds are used as additives in a variety of products and processes. Diorganotins find application as heat stabilizers in plastics, as catalysts in the production of urethane foams; in the cold curing of rubber; and as scavengers for halogen acids. Tri- and tetraorganotins are used as preservatives for wood, leather, paper, paints, and textiles; and as biocides.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Sn]/m^3 TWA (*Note*: The PEL applies to all organic tin compounds).

NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin] (*Note:* The REL applies to all organic tin compounds, except Cyhexatin).

ACGIH TLV®[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin].

NIOSH IDLH: 25 mg[Sn]/m^3.

DFG MAK: 0.1 mg[Sn]/m^3; inhalable fraction TWA; Peak Limitation Category II(2); [skin]; Pregnancy Risk Group D.

Cyhexatin

Australia: TWA 0.1 mg[Sn]/m^3 [skin], 1993; Austria: MAK 0.1 mg[Sn]/m^3 [skin], 1999; Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 0.1 mg[Sn]/m^3 [skin], 1999; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 0.1 mg[Sn]/m^3; STEL 0.3 mg[Sn]/m^3, 1999; France: VME 5 mg/m^3, 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Hungary: STEL 0.1 mg[Sn]/m^3 [skin], 1993; Norway: TWA 0.1 mg[Sn]/m^3, 1999; the Philippines: TWA 0.1 mg[Sn]/m^3, 1993; Russia: STEL 0.02 mg/m^3 [skin], 1993; Switzerland: MAK-W 0.1 mg [Sn]/m^3, KZG-W 0.2 mg[Sn]/m^3 [skin], 1999; Thailand: TWA 0.1 mg[Sn]/m^3, 1993; United Kingdom: TWA 5 mg/m^3; STEL 10 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Phenyltin compounds

DFG MAK: 0.002 mg[Sn]/m^3; inhalable fraction TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Determination in Air: Use NIOSH Analytical Method (IV) #5504, Organotin.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Organic tin compounds, especially tributyl and dibutyl compounds, may cause acute burns to the skin. The burns produce little pain but may itch. They heal without scarring. Clothing contaminated by vapors or liquids may cause subacute lesions and diffuse erythermatoid dermatitis on the lower abdomen, thighs, and groin of workmen who handle these compounds. The lesions heal rapidly on removal from contact. The eyes are rarely involved, but accidental splashing with tributyltin has caused lacrimation and conjunctival edema which lasted several days; there was no permanent injury. Triphenyltin hydroxide has been subjected to a carcinogenesis bioassay by NCL and found to be not carcinogenic. Certain organic tin compounds, especially alkyltin compounds, are highly toxic when ingested. The trialkyl and tetraalkyl compounds cause damage to the central nervous system with symptoms of headaches, dizziness, photophobia, vomiting, and urinary retention; some weakness and flaccid paralysis of the limbs in the most severe cases. Percutaneous absorption of these compounds has been postulated, but to date, deaths and serious injury have resulted only from ill-advised attempts at therapeutic use by mouth. The mechanism of action of the organotins is not clearly understood, although triethyltin is an extremely potent inhibitor of oxidative phosphorylation. Occasionally, mild organotin intoxication is seen in chemical laboratories with headache, nausea, and EEG changes. Symptoms also include sore throat and cough, abdominal pain; skin burns and itching.

Points of Attack: Central nervous system; eyes, liver, urinary tract, skin, blood.

Medical Surveillance: NIOSH lists the following tests: complete blood count [RBC hemolysis; electrocardiogram, especially on workers over 40 years; glaucoma, liver function tests; urine (chemical/metabolite)]. For organotins, preplacement and periodic examinations should include the skin, eyes, blood, central nervous system; liver and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: It is important that employees be trained in the correct use of personal protective equipment. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Depending on physical properties, wear splash or dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Skin contact should be prevented by protective clothing, and, especially in the case of organic tin compounds, clean work clothes should be supplied daily and the worker required to shower following the shift and prior to change to street clothes.

Respirator Selection: *(organotin) Up to 1 mg/m^3:* CcrOvDM [any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust and mist filter]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 25 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage.

Shipping: Organotin compounds, liquid, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." Hazard Class 6.1 and Packing Group II.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up

spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Dry material:* This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Poisonous gases are produced in fire, including tin. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Organotin Compounds*, NIOSH Document No. 77-115

Tin tetrachloride T:0550

Molecular Formula: Cl_4Sn

Common Formula: $SnCl_4$

Synonyms: Libavius fuming spirit; Stannic chloride, anhydrous; Tetrachlorostannane; Tin perchloride; Tin chloride, fuming; Tin perchloride; Tin tetrachloride, anhydrous; Zinntetrachlorid (German)

CAS Registry Number: 7646-78-8

RTECS® Number: XP8750000

UN/NA & ERG Number: UN1827/137

EC Number: 231-588-9 [*Annex I Index No.:* 050-001-00-5]

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Negative: *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R34; R52/53; Safety phrases: S1/2; S7/8; S26; S45; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Tin tetrachloride is a colorless fuming liquid. Molecular weight = 260.49; Boiling point = 114°C; Freezing/Melting point = −33°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Reacts with water; soluble.

Potential Exposure: Compound Description: Mutagen, Hormone. Tin tetrachloride is used in the production of blueprints and electroconductive readings, as a bleaching agent for sugar and resin stabilizer.

Incompatibilities: Water, turpentine, potassium, sodium, ethylene oxide; nitrates, alcohols, amines, chlorine, strong acids; strong bases.

Permissible Exposure Limits in Air

OSHA PEL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn) except tin oxides].

NIOSH REL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn) except tin oxides].

ACGIH TLV®[1]: 2 mg[Sn]/m^3 TWA.

EUR OEL: 2 mg[Sn]/m^3 as TWA.

Protective Action Criteria (PAC)

TEEL-0: 4.39 mg/m^3

PAC-1: 4.39 mg/m^3

PAC-2: 5 mg/m^3

PAC-3: 219 mg/m^3

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

NIOSH IDLH: 100 mg[Sn]/m^3.

Australia: TWA 2 mg[Sn]/m^3, 1993; Austria: MAK 2 mg/m^3, 1999; Belgium: TWA 2 mg[Sn]/m^3, 1993; Denmark: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg[Sn]/m^3, 1999; Hungary: TWA 1 mg[Sn]/m^3; STEL 2 mg[Sn]/m^3 [skin], 1993; Norway: TWA 2 mg[Sn]/m^3, 1999; the Philippines: TWA 2 mg[Sn]/m^3, 1993; Poland: TWA 2 mg [Sn]/m^3, 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 mg[Sn]/m^3.

Determination in Air: Filter; Acid; Inductively coupled plasma; NIOSH Analytical Method (IV) #7300, Element.

Routes of Entry: Inhalation, eyes, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Tin tetrachloride can affect you when breathed in. Tin tetrachloride is a corrosive chemical and eye or skin contact can cause severe burns. Breathing tin tetrachloride can irritate the throat and bronchial tubes, causing cough, and/or difficulty breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: May affect the nervous system. May cause lung irritation; bronchitis may develop. Changes may occur on chest X-ray with repeated exposures.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys, urinary tract; blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite). Chest X-ray; urine (chemical/metabolite). Also, see NIOSH Analytical Method #8310, Metals in urine. Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Hemoglobin or hematocrit.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA: *Up to 10 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 20 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 100 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Tin tetrachloride must be stored to avoid contact with water, alcohols, amines, chlorine, turpentine, ethylene oxide; alkyl nitrates; potassium and sodium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep tin tetrachloride dry and out of direct sunlight. If moisture enters containers, pressure may cause the containers to burst. Tin tetrachloride can attack some plastics, rubbers, and coatings.

Shipping: This compound requires a shipping label of “CORROSIVE.” It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tin tetrachloride does not burn, but it does react violently with water. *Do not use water*. Use dry chemical or carbon dioxide extinguishers to extinguish surrounding fire. Poisonous gases, including hydrogen chloride, chlorine, and tin oxides, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers, but do not get water inside containers or on spilled tin tetrachloride as poisonous gases will be formed. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: $SnCl_4$: Pour onto sodium bicarbonate; spray with ammonium hydroxide while adding crushed ice; when reaction subsides, flush down drain.

References

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Tin Tetrachloride*. Trenton, NJ

Titanium & compounds T:0560

Molecular Formula: Ti

Synonyms: C.P. Titanium; IMI 115; NCI-C04251; Ontimet 30; Oremet; T 40; Titanate; Titanium 50A; Titanium alloy; Titanium, elemental; VT 1

Other titanium compounds: titanium carbide (CTi) 12070-08-5; titanium disulfide (S_2Ti) (12039-13-3); titanium hydride (H_2Ti) (7704-98-5); titanium monoxide (Oti) 12137-20-1; titanium sulfate (O_5STi) (13825-74-6); titanium trichloride (Cl_2Ti) (7705-07-9)

CAS Registry Number: 7440-32-6 (metal)

RTECS® Number: XR1700000 (elemental)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric. UN2546 (Titanium powder, dry)/135; UN2878 (Titanium sponge powders)/170; UN1352 (Titanium powder, wetted with not less than 25% water)170

EC Number: 231-142-3

Regulatory Authority and Advisory Bodies

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Titanium is a silvery metal or dry, dark-gray amorphous, lustrous powder. Molecular weight = 47.90; Boiling point = 3260°C; Freezing/Melting point = 1675°C; Autoignition temperature = 1200°C (solid); 480°C (powder in air). Hazard Identification (based on NFPA-704 M Rating System) (powder): Health 1, Flammability 3, Reactivity 1; (solid metal) Health 1, Flammability 0, Reactivity 0. It is brittle when cold and malleable when hot. The dry powder is easily ignited, and burns with an intense flame. Ignition temperature of dust cloud = 460°C; Minimum Explosive concentration = 0.45 oz/ft^3.[USBM] Relative explosion hazard of dust: Severe. Insoluble in water. The most important minerals containing titanium are ilmenite, rutile, perovskite, and titanite or sphene. Insoluble in water.

Potential Exposure: Titanium metal, because of its low weight, high strength, and heat resistance, is used in the aerospace and aircraft industry as tubing, fittings, fire walls; cowlings, skin sections; jet compressors; and it is also used in surgical appliances. It is also used as control-wire casings in nuclear reactors, as a protective coating for mixers in the pulp-paper industry, and in other situations in which protection against chlorides or acids is required; in vacuum lamp bulbs and X-ray tubes; as an addition to carbon and tungsten in electrodes and lamp filaments; and to the powder in the pyrotechnics industry. It forms alloys with iron, aluminum, tin, and vanadium, of which ferrotitanium is especially important in the steel industry. Other titanium compounds are utilized in smoke screens, as mordants in dyeing; in the manufacture of cemented metal carbides; as thermal insulators; and in heat-resistant surface coatings in paints and plastics.

Incompatibilities: Dust may ignite spontaneously in air. Violent reactions occur on contact with water, steam, halocarbons, halogens, and aluminum. The dry powder is a strong reducing agent; violent reaction with strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

Metal

TEEL-0: 0.6 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 60 mg/m^3

Titanium compounds including titanium carbide

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 250 mg/m^3

Determination in Air: Filter; Acid; Hydride generation atomic absorption spectrometry; NIOSH Analytical Method (IV) #7900. See also #7300, Elements.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal for titanium compounds (as Ti) of 83 μg/L, based on health effects.

Routes of Entry: Inhalation of dust or fume, eyes.

Harmful Effects and Symptoms

Short Term Exposure: Titanium can affect you when breathed in. Contact may irritate the eyes. Breathing titanium may irritate the throat and air passages with cough and phlegm.

Long Term Exposure: Repeated exposure may cause chronic bronchitis and possibly emphysema. There is limited evidence that titanium may damage the developing fetus.

Points of Attack: Lungs.

Medical Surveillance: Preemployment and periodic physical examinations should give special attention to lung disease, especially if irritant compounds are involved. Chest X-ray should be included in both examinations and pulmonary function evaluated periodically. Smoking history should be taken. Careful attention should be given to the eyes and the skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to titanium, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (Dust/fume/mist) filters. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered, air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Titanium powder is a severe explosion risk. (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Titanium must be stored to avoid contact with water, steam, halocarbons, halogens, and aluminum, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where titanium is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only non-sparking tools and equipment, especially when opening and closing containers of titanium. Wherever titanium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Titanium powders require a shipping label of "SPONTANEOUSLY COMBUSTIBLE." They fall in Hazard Class 4.2 and Packing Group III. Titanium powder, wetted [with not $<25\%$ water (a visible excess of water must be present) (a) mechanically produced, particle size $<53\,\mu m$; (b) chemically produced, particle size <840 microns require a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Titanium is a flammable solid; dust and powders are an explosion hazard. *Do not use water* on burning titanium; this can cause explosion. Ordinary extinguishers are often ineffective. Use special extinguishers designed for metal fires. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Titanium, Report EPA-600/1-77-022*. Research Triangle Park, NC, pp. 427−441

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 83 (1981) and 4, No. 3, 27−29 (1984)

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Titanium.* Trenton, NJ

Titanium dioxide T:0570

Molecular Formula: O_2Ti
Common Formula: TiO_2

Synonyms: A-FIL cream; Anatase; Atlas white titanium; Austiox; Bayeritian; Bayertitan; Brookite; Calcotone white T; C.I. 77891; C.I. Pigment white 6; Cosmetic white C47-5175; C-Weiss 7 (German); Flamenco; Hombitan; Horse head A-410; KH 360; Kronos titanium dioxide; Levanox white RKB; NCI-C04240; Rayox; Runa RH20; Rutile; Tiofine; Tioxide; Titanium oxide; Tronox Unitane 0-110; Zopaque 1700 white

CAS Registry Number: 13463-67-7; *(alt.)* 1309-63-3

RTECS® Number: XR2275000

EC Number: 236-675-5

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE.

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Titanium dioxide is an odorless white powder. Molecular weight = 79.90; Specific gravity (H_2O:1) = 4.26 at 25°C; Boiling point = 2500−3000°C; Freezing/Melting point = 1830−1850°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Titanium dioxide is a white pigment used as a pigment in paint; in the rubber, plastics, ceramics, paint, and varnish industries, in dermatological preparations; and is used as a starting material for other titanium compounds; as a gem; in curing concrete; and in coatings for welding rods. It is also used in paper and cardboard manufacture.

Incompatibilities: Strong acids.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3, total dust TWA.

NIOSH REL: Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 mg/m^3 TWA, not classifiable as a human carcinogen.

NIOSH IDLH: 5000 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 15 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 500 mg/m^3

DFG MAK: 1.5 mg/m^3, respirable fraction (previously "fine dust"); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 15 mg/m^3, 1993; Australia: TWA 10 mg/m^3, 1993; Austria: MAK 6 mg/m^3, 1999; Belgium: TWA 10 mg/m^3, 1993; Denmark: TWA 6mg[Ti]/m^3, 1999; France: VME 10 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; Poland: MAC (TWA) 10mg[Ti]/m^3; MAC (STEL) 30mg[Ti]/m^3, 1999; Sweden: NGV 5 mg/m^3, 1999; Turkey: TWA 15 mg/m^3, 1993; United Kingdom: TWA 10 mg/m^3 (total inhalable dust); TWA 4 mg/m^3 (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia have set limits for ambient air in residential areas at 0.5 mg/m^3 on a momentary basis. Several states have set guidelines or standards for titanium dioxide in ambient air[60] ranging from 0.13−0.79 μg/m^3 (Montana) to 17.86 μg/m^3 (Kansas) to 80.0 μg/m^3 (Virginia) to 300.0 μg/m^3 (Connecticut).

Determination in Air: Use NIOSH II(3), Method #S385; #7300, Elements by ICP.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal for titanium compounds (as Ti) of 83 μg/L, based on health effects.

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause irritation of the eyes and respiratory tract, causing cough and phlegm. Irritates the skin.

Long Term Exposure: High exposures may cause lung irritation; bronchitis may develop. Continued exposure may result in emphysema, lung scarring; lung fibrosis; and tumors. A potential occupational carcinogen.

Points of Attack: Respiratory system. Cancer site in animals: lung tumors.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from strong acids and other metals. Where possible, automatically transfer material from other storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fires. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 84 (1981) and 3, No. 1, 85−89 (1983)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Titanium Dioxide*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: Titanium Dioxide*. Trenton, NJ

Titanium tetrachloride T:0580

Molecular Formula: Cl_4Ti

Common Formula: $TiCl_4$

Synonyms: FM (military designation); Tetrochlorure de titane (French); Tetrachlorotitanium; Titane (tetrachlorure de) (French); Tetracloruro de titanio (Spanish); Titanium chloride (TICL4) (T-4)-; Titantetrachlorid (German); Titanium(IV) chloride

CAS Registry Number: 7550-45-0

RTECS® Number: XR1925000

UN/NA & ERG Number: UN1838/137

EC Number: 231-441-9 [*Annex I Index No.:* 022-001-00-5]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (1.00% concentration); *Theft hazard* 45 (≥13.33% concentration); Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 2500 lb (1135 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C; Risk phrases: R14; R34; Safety phrases: S1/2; S7/8; S26; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Titanium tetrachloride is a noncombustible, colorless to light yellow liquid with a penetrating acrid odor. Molecular weight = 189.70; Boiling point = 136°C; Freezing/Melting point = −24°C. Reacts with water. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1₩. Decomposes in water.

Potential Exposure: Used in the manufacture of titanium salts; mordant dye; titanium pigments; and used as a chemical intermediate for titanium metal; titanium dioxide; as an agent in smoke screens; polymerization catalyst; and iridescent agent in glass and pearl manufacturing.

Incompatibilities: Violent reaction with water or steam, releasing heat and hydrogen chloride fumes. Contact with moist air releases hydrogen chloride. Attacks many metals in presence of moisture.

Permissible Exposure Limits in Air

AIHA WEEL: 0.5 mg/m^3 TWA.

Protective Action Criteria (PAC)*

TEEL-0: 0.645 ppm

PAC-1: 0.645 ppm

PAC-2: **1.0** ppm

PAC-3: **5.7** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: This compound is a highly corrosive, acute irritant to the skin, eyes, mucous membranes and the respiratory tract. It is capable of causing death or permanent injury due to exposures encountered in normal use. Even short contact may lead to eye inflammation which may result in corneal opacities. Inhalation symptoms include congestion and irritation of upper respiratory tract, coughing, burning of the throat; headache and weakness. Prolonged exposure to low concentrations may cause cough and pneumonia. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Ingestion causes mouth, throat, and GI tract irritation, nausea, vomiting, cramps, and diarrhea.

Long Term Exposure: May cause respiratory problems; lung damage; bronchitis may develop.

Points of Attack: Respiratory system, eyes.

Medical Surveillance: Lung function tests. Eye examination. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store away from possible contact with all forms of moisture. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: This compound requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group II. A plus sign (+) symbol indicates that the designated proper shipping name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of

potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

FM, when used as a weapon—not listed in DOT tables

When spilled on land

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

When spilled in water

First: Isolate in all directions (feet/meters) 200/60.
Then: Protect persons downwind (miles/kilometers).
Day 0.4/0.6
Night 1.2/1.9

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.
Then: Protect persons downwind (miles/kilometers).
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60.
Then: Protect persons downwind (miles/kilometers).
Day 0.4/0.6
Night 1.2/1.9

Fire Extinguishing: Not flammable. For small fires, use dry chemical or carbon dioxide. For large fires, flood fire area with water from a distance. Do not get solid streams of water on spilled material. Move container from fire area if this can be done without risk. Cool containers exposed to flames with water until well after fire is out. Poisonous gases are produced in fire, including hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Titanium Tetrachloride*. Washington, DC: Chemical Emergency Preparedness Program

o-Tolidine T:0590

Molecular Formula: $C_{14}H_{16}N_2$

Common Formula: $H_2NC_6H_3(CH_3)\text{-}C_6H_3(CH_3)NH_2$

Synonyms: Benzidine, 3,3′-dimethyl-; Bianisidine; (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dimethyl-; 4,4′-Bi-*o*-toluidine; C.I. 37230; C.I. azoic diazo component 113; (4,4′-Diamine)-3,3′-dimethyl(1,1′-biphenyl); 4,4′-Diamino-3,3′-dimethylbiphenyl; Diaminoditolyl; 3,3′-Dimethylbenzidin (German); 3,3′-Dimethylbenzidine; 3,3′-Dimethyl-(1,1′-biphenyl)-4,4′-diamine; 3,3′-Dimethyl-4,4′-biphenyldiamine; 3,3′-Dimethyl-4,4′-diaminobiphenyl; 3,3′-Dimethyl-4,4′-diphenyldiamine; 3,3′-Dimethyldiphenyl-4,4′-diamine; 4,4′-Di-*o*-toluidine; Fast dark blue base R; 3,3′-Methylphenyl-4,4′-diamine; *o*-Tolidin (German); 3-Tolidin (German); *o*-Tolidina (Spanish); 2-Tolidina (Spanish); *o*,*o*′-Tolidine; 2-Tolidine; 3,3′-Tolidine; Tolidine

CAS Registry Number: 119-93-7

Dyes based on *o*-tolidine for reference: 612-82-8 (3,3′-dimethylbenzidine dihydrochloride); 41766-75-0 (3,3′-Dimethylbenzidine dihydrofluoride); 992-59-6 [Disodium *o*-tolidinediazobis(1-naphthylamine-4-sulfonate)]

RTECS® Number: DD1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 210-322-5 [*Annex I Index No.:* 612-081-00-5] (*4,4′-bi-o-toluidine dihydrochloride*)
[*Annex I Index No.:* 612-041-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: Mammalian micronucleus; Histidine reversion—Ames test; Inconclusive: *In vitro* UDS—human fibroblast.

US EPA Hazardous Waste Number (RCRA No.): U095.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 1/1/88; 4/1/92 (dihydrochloride).

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R22; R51/53; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: *o*-Tolidine is a white to reddish crystal or powder. Darkens on exposure to air. Often used in paste or wet cake form. Used as a basis for many dyes. Molecular weight = 212.32; Boiling point = 300°C (also listed at 200°C); Freezing/Melting point = 129°C; Flash point = 244°C; Autoignition temperature = 526°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.1% at 25°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Over 75% of *o*-tolidine is used as a dye and as an intermediate in the production of dyestuffs and pigments. Approximately 20% of *o*-tolidine is used in the production of polyurethane-based high-strength elastomers, coatings, and rigid plastics. *o*-Tolidine has also been used in small quantities in chlorine test kits by water companies and swimming pool owners. Used as a laboratory agent to detect blood.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: Carcinogen: 0.02 mg/m^3 [60 min.] Ceiling Concentration; [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendices A and C.

Note: OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine [119-90-4] (and dyes based on these chemicals) may present a cancer risk to workers and should be handled with caution and exposure minimized.

ACGIH TLV®[1]: [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.1 mg/m^3

PAC-1: 0.3 mg/m^3

PAC-2: 2 mg/m^3

PAC-3: 100 mg/m^3

No TEEL available for dihydrochloride.

DFG MAK: Carcinogen Category 2

Australia [skin], carcinogen, 1993; Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Guidelines or standards which have been set for *o*-tolidine in ambient air[60] range from zero (North Dakota) to 20.0 μg/m^3 (Virginia).

Determination in Air: OSHA Analytical Method #ID-71; NIOSH Analytical Method (IV) #5013, Dyes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.34$.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *o*-Tolidine can affect you when breathed in and can rapidly enter the body through the skin. High exposure can irritate the nose and throat.

Long Term Exposure: *o*-Tolidine may affect the kidneys and bladder. A potential occupational carcinogen.

Points of Attack: Eyes, respiratory system; liver, kidneys. Cancer site in animals: liver, bladder, and mammary gland tumors.

Medical Surveillance: Before employment and every 6 months thereafter, the following are recommended to detect bladder cancer at an early stage: Kidney function tests. Urine cytology test (a test for abnormal cells in urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter].

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from direct light. Sources of ignition, such as smoking and open flames, are prohibited where 3,3′-dimethylbenzidine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s., must be labeled "POISONOUS/TOXIC MATERIALS." *o*-Tolidine falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in flammable solvent and spray into firebox of an incinerator equipped with afterburner and scrubber.[22] Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 75−77

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: 3,3′-Dimethylbenzidine*. Trenton, NJ

Toluene T:0600

Molecular Formula: C_7H_8

Common Formula: $C_6H_5CH_3$

Synonyms: Antisal 1A; Benzene, methyl-; Black out black; CP 25; Methacide; Methane, phenyl-; Methylbenzene; Methylbenzol; NCI-C07272; Phenylmethane; Tolueno (Spanish); Toluol; Tolu-sol

CAS Registry Number: 108-88-3

RTECS® Number: XS5250000

UN/NA & ERG Number: UN1294/130

EC Number: 203-625-9 [*Annex I Index No.:* 601-021-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal No Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Inadequate Information to assess carcinogenic potential; NCI: Carcinogenesis Studies, inhalation; no evidence: mouse, rat; US EPA Gene-Tox Program, Negative: Cell transform.—SA7/SHE; *In vitro* SCE—human; Negative: Sperm morphology—mouse; Inconclusive: *E. coli* polA without S9.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U220.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.080; Nonwastewater (mg/kg), 10.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5).

Safe Drinking Water Act: MCL, 1.0 mg/L; MCLG, 1.0 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin 1/1/91; (female) 8/7/09.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F, Xn; Risk phrases: R11; R38; R48/20; R63; R65; R67; Safety phrases: S2; S36/37; S46; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Toluene is a clear, colorless, noncorrosive liquid with a sweet, pungent, benzene-like odor. The odor threshold in air is variously given as 0.17 ppm,[41] 2.9 ppm (NJ) and 8 ppm (EPA). The odor threshold in water is 0.04−1.0 mg/L. Molecular weight = 92.15; Specific gravity (H_2O:1) = 0.87; Boiling point = 111.1°C; Freezing/Melting point = −95°C; Vapor pressure = 21 mmHg; Flash point = 4°C (cc); Autoignition temperature = 480°C. Explosive limits: LEL = 1.1%; UEL = 7.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Toluene is used as an industrial chemical, chemical intermediate; solvent, and emulsifier; may be encountered in the manufacture of benzene. It is also used as a chemical feed for toluene diisocyanate, phenol, benzyl and benzoyl derivatives; benzoic acid; toluene sulfonates; nitrotoluenes, vinyltoluene, and saccharin; as a solvent for paints and coatings; or as a component of automobile and aviation fuels.

Incompatibilities: Strong oxidizers may cause fire and explosions. Violent reaction with mixtures of nitric and sulfuric acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.77 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 200 ppm/754 mg/m^3 Ceiling Concentration; 300 ppm/500 ppm [10-min maximum peak per 8-h shift].

NIOSH REL: 100 ppm/375 mg/m^3 TWA; 150 ppm/560 mg/m^3 STEL.

ACGIH TLV®[1]: 20 ppm/75 mg/m^3 TWA [skin]. BEI; 0.5 mg[*o*-cresol]/L in urine/end-of-shift; 1.6 g[hippuric acid]g/g creatinine in urine/end-of-shift; 0.05 mg[toluene]/L in blood, prior to last shift of workweek, not classifiable as a human carcinogen.

NIOSH IDLH: 500 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 20 ppm

PAC-1: **200** ppm

PAC-2: **1200** ppm

PAC-3: **4500** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 50 ppm/190 mg/m^3 TWA; Peak Limitation Category II(4) [skin], Pregnancy Risk Group: C; BAT:0.1 mg[toluene]/L in blood/end-of-shift; 0.3 mg[*o*-cresol]/L in urine/end-of-shift, for long-term exposure, after several shifts.

Australia: TWA 100 ppm (375 mg/m^3), STEL 150 ppm, 1993; Austria: MAK 100 ppm (380 mg/m^3), 1999; Belgium: TWA 100 ppm (377 mg/m^3), STEL 150 ppm (565 mg/m^3), 1993; Denmark: TWA 35 ppm (130 mg/m^3) [skin], 1999; Finland: TWA 100 ppm (375 mg/m^3), STEL 150 ppm [skin], 1999; France: VME 100 ppm (375 mg/m^3), VLE 150 ppm (550 mg/m^3), 1999; Hungary: TWA 100 mg/m^3, STEL 300 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 150 mg/m^3, 2003; Norway: TWA 25 ppm (94 mg/m^3), 1999; the Philippines: TWA 100 ppm (375 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3; MAC (STEL) 350 mg/m^3, 1999; Russia: TWA 100 ppm, STEL 50 mg/m^3, 1993; Sweden: NGV 50 ppm (200 mg/m^3), TKV 100 ppm (400 mg/m^3) [skin], 1999; Switzerland: MAK-W 50 ppm (190 mg/m^3), KZG-W 250 ppm (950 mg/m^3), 1999; Thailand: TWA 200 ppm, STEL 300 ppm, 1993; Turkey: TWA 200 ppm (750 mg/m^3), 1993; United Kingdom: TWA 50 ppm (191 mg/m^3), STEL 150 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Russia[35, 43] has also set a MAC for ambient air in residential areas of 0.6 mg/m^3, both on a momentary and a daily average basis. Several states have set guidelines or standards for toluene in ambient air[60] ranging from 0.05 mg/m^3 (Massachusetts) to 1.0 mg/m^3 (Arizona) to 0.4−2.0 mg/m^3 (Rhode Island) to 1.875 mg/m^3 (Indiana) to 3.75−5.60 mg/m^3 (North Dakota) to 6.0 mg/m^3 (Virginia) to 7.5 mg/m^3 (Connecticut, New York, and South Dakota) to 8.929 mg/m^3 (Nevada) to 4.7−56.0 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #8002, Toluene in blood; #1500 Hydrocarbons (BP 36−126°C), #1501, Hydrocarbons, aromatic, #4000, Toluene (passive); OSHA Analytical Method #111.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 17,500 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 6300 μg/L on an acute toxicity basis and 5000 μg/L on a chronic basis. To protect human health—14.3 mg/L.[6] EPA more recently[48] set a lifetime health advisory of 2.42 mg/L and even more recently[62] proposed a drinking water standard of 2.0 mg/L (2000 μg/L). Several states have set guidelines for toluene in drinking water[61] ranging from 100 μg/L (California and Maine) to 340 μg/L (Massachusetts) to 343 μg/L (Wisconsin) to 750 μg/L (New Mexico) to 1000 μg/L (Connecticut) to 2000 μg/L (Arizona, Kansas, Minnesota, and Vermont). Russia[35,43] set a MAC in water bodies used both for household purposes and fishery purposes of 0.5 mg/L (500 μg/L). Octanol−water coefficient: Log K_{ow} = 2.69.

Determination in Water: Inert gas purge followed by gas chromatography and photoionization detection (EPA Method #602) or gas chromatography plus mass spectrometry (EPA Method #624).

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. Causes central nervous system depression. High levels of exposure may cause fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils; lacrimation (discharge of tears); nervousness, muscle fatigue, insomnia, paresthesia; cardiac dysrhythmia; unconsciousness and death may occur. *Inhalation:* 100 ppm exposure can cause dizziness, drowsiness, and hallucinations. 100−200 ppm can cause depression; 200−500 ppm can cause headache; nausea, loss of appetite; loss of energy; loss of coordination and coma. In addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time. *Skin:* Can cause dryness and irritation. Absorption may cause or increase the severity of symptoms listed above. *Eyes:* Can cause irritation at 300 ppm. *Ingestion:* Can cause a burning sensation in the mouth and stomach, upper abdominal pain; cough, hoarseness, headache, nausea, loss of appetite; loss of energy; loss of coordination; and coma.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis; drying, cracking, itching, and skin rash. May cause liver, kidney, and brain damage; decreased learning ability; psychological disorders. Levels below 200 ppm may produce headache, tiredness, and nausea. From 200 to 750 ppm symptoms may include insomnia, irritability, dizziness, some loss of memory; cause heart palpitations and loss of coordination. Blood effects and anemia have been reported but are probably due to contamination by benzene.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: Whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-workweek; whole blood (chemical/metabolite), prior to last shift of workweek, Expired Air, During Exposure; urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following is recommended before beginning work and at regular times after that: Urinary hippuric acid excretion (at the end-of-shift) as an index of overexposure. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Liver and kidney function tests, and evaluation for renal tubular acidosis. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Exposure to toluene at levels greater than 200 ppm may result in hippuric acid levels above 5 g/L urine. After elevated exposure, toluene may also be detected in blood.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton™/Neoprene™, Teflon™, Viton™/chlorobutyl, and Silvershield™ are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Toluene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where toluene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of toluene should be grounded and bonded. Drums must be equipped with self-closing, valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of toluene.

Shipping: Toluene requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases may be produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Toluene*. Washington, DC

US Environmental Protection Agency. (1980). *Toluene: Ambient Water Quality Criteria*. Washington, DC

National Institute for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Toluene*. NIOSH Document No. 73-11023

US Environmental Protection Agency. (April 30, 1980). *Toluene, Health and Environmental Effects Profile No. 160*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 83−87 (1982); 5, No. 5, 94−99 (1985); and 7, No. 5, 2−14 (1987)

US Public Health Service. (December 1988). *Toxicological Profile for Toluene*. Atlanta, GA: Agency for Toxic Substance and Disease Registry

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Toluene*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (August 1998). *Hazardous Substances Fact Sheet: Toluene*. Trenton, NJ

Toluene-2,4-diamine other toluenediamine isomers T:0610

Molecular Formula: $C_7H_{10}N_2$

Common Formula: $H_3CC_6H_3(NH_2)_2$

Synonyms: 3-Amino-*p*-toluidine; 5-Amino-*o*-toluidine; Azogen developer H; 1,3-Benzenediamine, 4-methyl; Benzofur MT; C.I. 76035; C.I. Oxidation base; C.I. Oxidation base 20; C.I. Oxidation base 200; C.I. Oxidation base 35; Developer B; Developer DB; Developer DBJ; Developer H; Developer MC; Developer MT; Developer MT-CF; Developer MTD; Developer T; 1,3-Diamino-4-methylbenzene; 2,4-Diamino-1-toluene; Diaminotoluene; 2,4-Diaminotolueno (Spanish); 2,4-Diaminotoluol; Eucanine GB; Fouramine; Fouramine J; Fourrine 94; Fourrine M; 4-Methyl-1,3-benzenediamine; 4-Methyl-*m*-phenylenediamine; MTD; Nako TMT; NCI-C02302; Pelagol grey J; Pelagol J; Pontamine developer TN; Renal MD; TDA; Tetral G; 2,4-Tolamine; *m*-Toluenediamine; Toluene-2,4-diamine; *m*-Toluylenediamine; *m*-Tolylenediamine; 2,4-Tolylenediamine; 4-*m*-Tolylenediamine; Zoba GKE; Zogen developer H

Mixed isomers: Benzenediamine, *ar*-methyl-; Diaminotoluene; Diaminotolueno (Spanish); Methylphenylenediamine; Toluen diamina (Spanish); Toluene-*ar,ar′*-diamine; Toluene-*ar,ar*-diamine; Toluenediamine; Tolylenediamine

CAS Registry Number: 95-80-7 (toluene-2,4-diamine); 25376-45-8 (toluenediamine); *(alt.)* 26764-44-3; *(alt.)* 30143-

13-6; 108-71-4 (toluene-3,5-diamine); 95-70-5 (toluene-2,5-diamine); 823-40-5 (toluene-2,6-diamine)

RTECS® Number: XS9625000; XS944500 (toluenediamine)

UN/NA & ERG Number: UN1709 (2,4-toluylenediamine, solid or 2,4- toluenediamine. solid)/151; UN3814 (2,4-toluylenediamine solution or 2,4-toluenediamine solution)/151

EC Number: 202-453-1 [*Annex I Index No.:* 612-099-00-3] (toluene-2,4-diamine); 246-910-3 (toluenediamine); 203-609-1 (toluene-3,5-diamine)

Regulatory Authority and Advisory Bodies

Carcinogenicity: (*toluene-2,4-diamine*) IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NTP: Carcinogenesis studies; test completed (peer review), October 2000.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Negative: *N. crassa—aneuploidy*; Sperm morphology—mouse; Inconclusive: SHE—clonal assay.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Reportable Quantity (RQ): 10 lb (4.54 kg).

US EPA Hazardous Waste Number (RCRA No.): U221.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations (*95-80-7*, *toluene-2,4-diamine*): Hazard Symbol: T, N; Risk phrases: R45; R21; R25; R36; R43; R48/22; R62; R68; Safety phrases: S51/53; S53; S45; S61; *(95-70-5; toluene-2,6-diamine*): Hazard Symbol: T,N; Risk phrases: R20/21; R25; R43; R51/53; Safety phrases: S1/2; S24; S37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*95-80-7*): 3—Highly water polluting.

Mixed isomers:

US EPA Hazardous Waste Number (RCRA No.): U221.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer (95-80-7) 1/1/88; [25376-45-8 (mixed isomers)]1/1/90.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% *as Toluene-2,4-diamine, Toluene-ar,ar′-diamine, Toluene-3,4-diamine, Toluene-3,5-diamine*.

Description: Toluene-2,4-diamine takes the form of colorless needles. Molecular weight = 122.19; Specific gravity (H_2O:1) = 1.05 (liquid at 100°C); Freezing/Melting point = 98.9°C; Vapor pressure = 1 mmHg at 107°C; Flash point = 148°C. Soluble in water.

Potential Exposure: Compound Description (*toluene-2,4-diamine*): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Compound Description (*toluene-2,6-diamine*): Mutagen. Toluene-2,4-diamine is a chemical intermediate for toluene diisocyanate (used in the production of flexible and rigid polyurethane foams, polyurethane coatings; cast elastomers including fabric coatings and polyurethane and other adhesives), for dyes used on textiles; leather, furs; and in hair-dye formulations.

Incompatibilities: Strong acids; chloroformates, oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: (*all isomers*) Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

Mixed isomers

AIHA WEEL: 0.005 ppm TWA [skin].

Toluene-2,4-diamine

Protective Action Criteria (PAC)

TEEL-0: 0.005 ppm

PAC-1: 1.5 ppm

PAC-2: 12.5 ppm

PAC-3: 50 ppm

DFG MAK (*toluene-2,4-diamine*): [skin] danger of skin sensitization; Carcinogen Category 2; DFG TRK: *Air*: toluene-2,4-diamine 0.100 mg/m^3; *Urine*: Sampling time: end-of-exposure or end-of-shift, Total toluene-2,4-diamine 100 μg[creatinine]/g in urine.

Austria: carcinogen, 1999; Finland: carcinogen, 1999; Poland: MAC (TWA) 0.04 mg/m^3; MAC (STEL) 0.1 mg/m^3, 1999; Russia: STEL 2 mg/m^3 [skin], 1993; Sweden: carcinogen, 1993; Switzerland: MAK-W 0.1 mg/m^3, carcinogen, 1999.

Toluene-2,5-diamine

DFG MAK (*toluene-2,4-diamine*): [skin] danger of skin sensitization.

Determination in Air: Use NIOSH Analytical Method (IV) #5516, OSHA Analytical Method #ID-65.

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and skin. Eye contact may cause permanent damage. Skin contact may cause burns and blistering. Methemoglobinemia, central nervous system depression, and degeneration of the liver typically result from exposure to toluene-2,4-diamine. Exposure can cause cyanosis, headache, fatigue, dizziness, nausea, vomiting.

Long Term Exposure: May cause liver damage. Jaundice and anemia are reported. Repeated exposure causes CNS depression causing headache, weakness, dizziness, fatigue, nausea, vomiting, and possible death. There is limited evidence that toluenediamines may reduce fertility in males and may affect the developing fetus. 2,4-Diaminotoluene is carcinogenic in rats and after its oral administration, producing hepatocellular carcinomas; and its subcutaneous injection, inducing local sarcomas. Diaminotoluenes are mutagens.

Points of Attack: Central nervous system; liver, blood. Cancer site in animals: liver, mammary glands.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examination. Examination of the nervous system. Methemoglobin level. Complete blood count (CBC). Liver function tests.

First Aid: *Skin Contact:* [52] Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use self-contained breathing apparatus.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place or a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: 2,4-Toluylenediamine requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Toluene-2,4-Diamine*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *2,4-Toluenediamine, Health and Environmental Effects Profile No. 161*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 5, 99−103

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: 2,4-Diaminotoluene*. Trenton. NJ

New Jersey Department of Health and Senior Services. (December 2005). *Hazardous Substances Fact Sheet: Diaminetoluenes (mixed isomers)*. Trenton, NJ

Toluene 2,4-diisocyanate T:0620

Molecular Formula: $C_9H_6N_2O_2$

Common Formula: 2,4-$CH_3C_6H_3(NCO)_2$

Synonyms: Benzene, 2,4-diisocyanato-1-methyl-; Benzene, 2,4-diisocyanato-1-methyl-; Benzene,2,4-diisocyanatomethyl-; Cresorcinol diisocyanate; Desmodur T80; Di-*iso*-cyanatoluene; Di-isocyanate de toluylene (French); 2,4-Diisocyanato-1-methylbenzene; 2,4-Diisocyanatotoluene; Diisocyanat-toluol (German); Hylene T; Hylene TCPA; Hylene TLC; Hylene TM; Hylene TM-65; Hylene TRF; Isocyanic acid, 4-methyl-*m*-phenylene ester; Isocyanic acid, methylphenylene ester; 4-Methyl-phenylene diisocyanate; 4-Methyl-phenylene isocyanate; Mondur TDS; Nacconate 1OO; NCI-C50533; Niax TDI; Niax TDI-P; Scuranate; 2,4-TDI; TDI; TDI-80; Toluen-2,4-diisociato (Spanish); 2,4-Toluene diisocyanate; Toluene diisocyanate; Toluene di-isocyanate; Toluylene 2,4-diisocyanate; Tolyene 2,4-diisocyanate; 2,4-Tolylene diisocyanate; 2,4-Tolylenediisocyanat E; Tolylene 2,4-diisocyanate; Tuluylen diisocyanat (German); Tuluylene 2,4-diisocyanate; Voranate T-80; Voranate T-80, type I; Voranate T-80, type II

CAS Registry Number: 584-84-9

RTECS® Number: CZ6300000

UN/NA & ERG Number: UN2078/156

EC Number: 209-544-5 [*Annex I Index No.:* 615-006-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (127.5 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R26; R36/37/38; R42/43; R52/53; Safety phrases: S1/2; S23; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Toluene diisocyanate is a colorless, yellow, or dark liquid or solid with a sweet, fruity, pungent odor. Toluene diisocyanate (technical) is an 80:20 mixture of 2,4- and 2,6-isomers. A solid above 71°F/22°C. The odor threshold is 0.4−2.14 ppm. Molecular weight = 174.17; Specific gravity (H_2O:1) = 1.22; Boiling point = 251.1°C; Freezing/Melting point = 21.7°C; Vapor pressure = 0.01 mmHg at 25°C; Relative vapor density (air = 1) = 6.1; Flash point = 127°C; Autoignition temperature = 620°C. Explosive limits: LEL = 0.9%; UEL = 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 3. Insoluble; reacts exothermically with water.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Toluene diisocyanate is used in the production of polyurethane flexible foams, coatings, and elastomers. It is more widely used than MDI (diphenylmethane diisocyanate). Polyurethanes are formed by the reaction of isocyanates with polyhydroxy compounds. Since the reaction proceeds rapidly at room temperature, the reactants must be mixed in pots or spray guns just before use. These resins can be produced with various physical properties, e.g., hard, flexible, semirigid foams; and have found many uses, e.g., upholstery padding; thermal insulation; molds, surface coatings; shoe inner soles; and in rubbers, adhesives, paints, and textile finishes. Because of TDI's high volatility, exposure can occur in all phases of its manufacture and use. MDI has a much lower volatility, and problems generally arise only in spray applications.

Incompatibilities: Strong oxidizers, water, acids, bases, and amines (may cause foam and spatter); alcohols. Reacts slowly with water to form carbon dioxide and polyureas (NIOSH). Contact with bases, tertiary amines, and acyl-chlorides may cause explosive polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.13 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 0.02 ppm/0.14 mg/m^3 Ceiling Concentration.

NIOSH REL: Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.005 ppm/0.036 mg/m^3 TWA; 0.02 ppm/0.14 mg/m^3, STEL, danger of sensitization of respiratory tract; not classifiable as a human carcinogen.

Notice of intended change: 0.001 ppm/0.007 mg/m^3, measured as inhalable fraction and vapor TWA; 0.003 ppm/0.021 mg/m^3, measured as inhalable fraction and vapor STEL, danger of sensitization of respiratory tract; not classifiable as a human carcinogen.

NIOSH IDLH: Potential occupational carcinogen, 2.5 ppm

Protective Action Criteria (PAC)*

TEEL-0: 0.005 ppm

PAC-1: **0.020** ppm

PAC-2: **0.083** ppm

PAC-3: **0.51** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Danger of sensitization of the airways; Carcinogen Carcinogen Category 3A.

Arab Republic of Egypt: TWA 0.02 ppm (0.14 mg/m^3), 1993; Austria: MAK 0.01 ppm (0.07 mg/m^3), 1999; Belgium: TWA 0.005 ppm (0.036 mg/m^3), STEL 0.02 ppm, 1993; Denmark: TWA 0.005 ppm (0.035 mg/m^3), 1999; France: VME 0.01 ppm (0.08 mg/m^3), STEL 0.02 ppm (0.16 mg/m^3), 1993; Hungary: STEL 0.04 mg/m^3, 1993;

Japan; 0.02 ppm (0.14 mg/m^3), 1993; the Netherlands: MAC-TGG 0.04 mg/m^3, 2003; Norway: TWA 0.005 ppm (0.035 mg/m^3), 1999; the Philippines: TWA 0.02 ppm (0.14 mg/m^3), 1993; Poland: MAC (TWA) 0.035 mg/m^3; MAC (STEL) 0.070 mg/m^3, 1999; Russia: STEL 0.05 mg/m^3, 1993; Sweden: NGV 0.005 ppm (0.04 mg/m^3), KTV 0.01 ppm (0.07 mg/m^3), 1999; Switzerland: MAK-W 0.005 ppm (0.04 mg/m^3), KZG-W 0.01 ppm (0.08 mg/m^3), 1999; Thailand: TWA 0.02 ppm (0.14 mg/m^3), 1993; Turkey: TWA 0.02 ppm (0.14 mg/m^3), 1993; United Kingdom: TWA 0.02 [NCO]mg/m^3, STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 0.02 ppm.

Russia has also set MAC values for ambient air in residential areas of 0.05 mg/m^3 on a momentary basis and 0.02 mg/m^3 on a daily average basis. Several states have set guidelines or standards for TDI in ambient air[60] ranging from 0.03−0.20 μg/m^3 (Rhode Island) to 0.13 μg/m^3 (New York) to 0.4 μg/m^3 (South Carolina) to 0.48 μg/m^3 (Massachusetts) to 0.70 μg/m^3 (Virginia) to 0.72 μg/m^3 (Connecticut and South Dakota) to 0.4−1.5 μg/m^3 (North Dakota) to 0.9 μg/m^3 (Nevada) to 4.8−16.0 μg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #5521, Isocyanates, monomeric, #5522 Isocyanates, #2535, Toluene-2,4-diisocyanate, and OSHA Analytical Method #18, superseded by #42 and #33.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.22$.

Routes of Entry: Inhalation of vapor, ingestion and skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritate the eyes, skin, and respiratory tract. Inhalation of the vapor may cause asthmatic reactions; chemical bronchitis, pneumonitis, and pulmonary edema. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death.

Note: TDI is a strong sensitizer. Allergic individuals may experience symptoms at very low concentrations.

Inhalation: Causes irritation of nose, throat, and lungs; insomnia, euphoria, difficulty in walking; loss of consciousness; poor memory; personality changes; irritability, and depression. Allergic response is also possible. Sensitive individuals may react to 0.007 ppm or less. Exposure to high levels leads to chemical pneumonia. Levels of 0.01−0.03 ppm reportedly caused no symptoms. At 0.03−0.07 ppm, respiratory illness with continuous coughing, sore throat; difficulty in breathing; fatigue and nocturnal sweating were reported. In another study, 10 min at 0.5 ppm caused nose and throat irritation. Lung damage may be permanent. *Skin:* If not removed promptly, may cause redness, pain, swelling, and blistering. TDI is corrosive and may be absorbed through the skin. Repeated contact has caused skin sensitization in humans and allergic eczema. *Eyes:* May cause redness, pain; blurred vision; severe irritation, tears and damage to the cornea. Prolonged contact may cause permanent damage. *Ingestion:* May cause sore throat, abdominal pain; diarrhea, and irritation of mouth and stomach.

Long Term Exposure: May produce asthma-like allergy and chronic lungs disease; chronic obstructive bronchitis; emphysema, chemical bronchitis; asthmatic syndrome. May cause memory loss and concentration problems; psychological effects; central nervous system effects. May cause chest tightness (sometimes very severe), sneezing, cyanosis (blue coloration), blood changes; and collapse. Sensitization may occur after exposure to spills or other unusually high concentrations. Decreased lung function has been reported from estimated exposure to 0.02 ppm for 2 years. It has also been reported that excessive loss of pulmonary function occurs at 0.0035 ppm possibly to 0.002 ppm. Sensitization has been reported on the first exposure at concentration below 0.05 ppm and as late as 14 years (0.06 ppm) after first exposure. This substance is a probable carcinogen in humans. There is limited evidence that TDI may cause temporary impotence in males.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: pancreas, liver, mammary gland; circulatory system; and skin tumors.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; blood plasma; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); pulmonary function tests; pre- and postshift; sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Preplacement and periodic medical examinations should include chest roentgenography, pulmonary function tests; and an evaluation of any respiratory disease or history of allergy. Periodic pulmonary function tests may be useful in detecting the onset of pulmonary sensitization. See also "References."[4]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide

recommendations on the most protective glove/clothing material for your operation. Teflon™, Silvershield™, Viton™, polyethylene, nitrile, chlorinated polyethylene; and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from amines, strong bases (such as sodium hydroxide), and alcohols. Toluene 2,4-diisocyanate should not be stored in contact with water, because they react and release carbon dioxide gas. Toluene 2,4-diisocyanate will polymerize and rupture containers at temperatures over 177°C/350°F. At normal temperatures (21°C/70°F) Toluene 2,4-diisocyanate levels quickly exceed the PEL and therefore proper ventilation must be in practice or personal protective equipment must be worn. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. *Solid:* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. *Liquid:* Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Solid:* Water gently applied to surface or foam may cause frothing which will extinguish the fire (NFPA). If material is on fire or involved in fire, do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, carbon dioxide, or dry chemical. Use water spray to absorb vapor. Poisonous gases are produced in fire, including cyanide and oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: This chemical is a combustible liquid. Poisonous gases, including cyanide and oxides of nitrogen, are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices). In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

National Institute for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Toluene Diisocyanate*. NIOSH Document No. 73-11022

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Organoisocyanates*, Report PB-276,678. Rockville, MD, pp. 265−275

US Environmental Protection Agency. (April 30, 1980). *Toluene Diisocyanate, Health and Environmental Effects Profile No. 162*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Toluene 2,4-Diisocyanate*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (July 25, 1984). *Chemical Hazard Information Profile: Toluene Diisocyanate*. Washington, DC: Office of Toxic Substances

New York State Department of Health. (May 1986). *Chemical Fact Sheet: Toluene Diisocyanate*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Toluene 2,4-Diisocyanate*. Trenton, NJ

Toluene sulfonic acid T:0630

Molecular Formula: $C_7H_8O_3S$

Common Formula: $C_6H_4(CH_3)SO_3H$

Synonyms: Benzenesulfonic acid, methyl-; Benzenesulfonic acid, methyl ester; Manro PTSA 65 E; Manro PTSA 65 H; Manro PTSA 65 LS; Methylbenzene sulfonic acid; *p*-Methylbenzenesulfonic acid; 4-Methylbenzenesulfonic acid; *p*-Methylphenylsulfonic acid; Toluenesulfonic acid; 4-Toluenesulfonic acid; *p*-Toluenesulphonic acid; *p*-Tolylsulfonic acid; Tosic acid; TSA-HP; TSA-MH

CAS Registry Number: 104-15-4; 25231-46-3 (NJ and WHMIS); *(alt.)* 402-47-1; *(alt.)* 100901-72-2; *(alt.)* 114213-96-6; *(alt.)* 126033-27-0; *(alt.)* 128739-80-0; *(alt.)* 144647-92-7; *(alt.)* 156627-46-2; 80-48-8 (Toluenesulfonic acid, methyl ester, *p*-)

RTECS® Number: XT1630000

UN/NA & ERG Number: UN2583 (solid, with >5% free H_2SO_4)/153; UN2584 (liquid, with >5% free H_2SO_4)/153; UN2585 (solid, with >5% free H_2SO_4)/153; UN2586 (liquid, with >5% free H_2SO_4)/153

EC Number: 203-180-0 [*Annex I Index No.*: 016-030-00-2] (*toluene-4-sulfonic acid*)

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as toluenesulfonic acid (25231-46-3).

European/International Regulations: Hazard Symbol (*104-15-4*): Xi; Risk phrases: R36/37/38; Safety phrases: S2; S26; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*104-15-4*): 1—Slightly water polluting.

Description: Toluene sulfonic acid is a colorless liquid or colorless crystalline solid. Odorless when pure; the technical grade has a slightly aromatic odor; Freezing/Melting point = 105°C. Molecular weight = 172.21; Boiling point = 140°C at20 mm; Flash point = 184°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Toluene sulfonic acid is used as catalyst, stabilizer for monomers and polymers; cleaning agents; a plating additive; in synthesis of dyes; drugs, and other chemicals.

Incompatibilities: The solution is a strong acid. Incompatible with sulfuric acid, caustics, ammonia, amines, amides, organic anhydrides; isocyanates, vinyl acetate; alkylene oxides; epichlorohydrin, and combustible materials. Attacks metals in the presence of moisture forming hydrogen gas.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

80-48-8 (Toluenesulfonic acid, methyl ester, p-)

TEEL-0: 0.75 mg/m^3

PAC-1: 2.5 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 150 mg/m^3

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Toluene sulfonic acid can affect you when breathed in. Corrosive to the eyes and skin; can cause severe irritation and burns. Irritates the respiratory tract causing burning sensation; dryness, and coughing. Overexposure can cause poisoning, which can lead to death. High levels can burn the lungs, causing a buildup of fluid, which can also cause death.

Long Term Exposure: Can irritate the lungs; bronchitis may develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. Exam of the eyes, nose and throat. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene™, chlorinated polyethylene, and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to solid toluene sulfonic acid, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered, air-purifying respirator. Where there is potential for high exposures to toluene sulfonic acid in liquid form, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from bases, combustibles, and other incompatible materials listed above. Where possible, automatically pump liquid or transfer dry material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Alkyl sulfonic acids, liquid, or aryl sulfonic acids, liquid (with >5% free sulfuric acid), require a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Alkyl sulfonic acids, liquid, or aryl sulfonic acids, liquid (with not >5% free sulfuric acid) requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Alkyl sulfonic acids, solid, or aryl sulfonic acids, solid (with not >5% free sulfuric acid) falls in DOT Hazard Class 8 and Packing Group III.

Alkyl sulfonic acids, solid, or aryl sulfonic acids, solid (with >5% free sulfuric acid) requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. For *small spills*, flush with water, rinse with dilute sodium bicarbonate or lime solution. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Toluene sulfonic acid may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray; or foam extinguishers. However, water may cause frothing. Poisonous gases are produced in fire, including sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: p-Toluene Sulfonic Acid*. Trenton, NJ

o-Toluidine T:0640

Molecular Formula: C_7H_9N

Common Formula: $CH_3C_6H_4NH_2$

Synonyms: 1-Amino-2-methylbenzene; 2-Amino-1-methylbenzene; *o*-Aminotoluene; 2-Aminotoluene; Aniline, 2-methyl-; Benzenamine, 2-methyl-; C.I. 37077; 1-Methyl-1,2-amino-benzene; 1-Methyl-2-aminobenzene; 2-Methyl-1-aminobenzene; *o*-Methylaniline; 2-Methylaniline; *o*-Methylbenzenamine; 2-Methylbenzenamine; *o*-Toluidina (Spanish); 2-Toluidine; Toluidine, *o*-; *o*-Tolylamine

CAS Registry Number: 95-53-4; 636-21-5 (hydrochloride)

RTECS® Number: XU2975000

UN/NA & ERG Number: UN1708/153

EC Number: 202-429-0 [*Annex I Index No.:* 612-091-00-X]; 211-252-8 (hydrochloride)

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC *(95-53-4)*: Human Sufficient Evidence, 1978; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP *(95-53-4 & 636-21-5)*: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH *(95-53-4)*: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: Cell transform.—RLV F344 rat embryo; Positive: *E. coli* polA without S9; Negative: Sperm morphology—mouse; *S. cerevisiae*—homozygosis; Inconclusive: Histidine reversion—Ames test.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U328.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 1/1/88; *o*-Toluidine hydrochloride 1/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol *(95-53-4)*: T, N; Risk phrases: R45; R23/25; R36; R50; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*CAS: 95-53-4*).

Description: *o*-Toluidine is a colorless to pale yellow liquid with a weak, pleasant, aromatic odor. The odor threshold = 0.25 ppm. Molecular weight = 107.17; Relative density (H_2O:1): 1.01; Boiling point = 200°C; Freezing/Melting point = −16°C; Vapor pressure = 0.3 mmHg at 21°C; Flash point = 85°C (cc); Autoignition temperature = 482°C. Explosive limits: LEL = 1.5%; UEL—unknown. Slightly soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. *o*-Toluidine is used as an intermediate in the manufacture of dyes; as an intermediate in pharmaceutical manufacture; in textile printing; in rubber accelerators; in production of *o*-aminoazotoluene.

Incompatibilities: Strong oxidizers, especially nitric acid; bases.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.38 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/22 mg/m^3 TWA [skin].

NIOSH REL: [skin] Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 2 ppm/8.8 mg/m^3 TWA [skin], confirmed animal carcinogen with unknown relevance to humans; BEI_M issued as methemoglobin inducers.

NIOSH IDLH: Potential occupational carcinogen, 50 ppm.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 5 ppm

PAC-2: 5 ppm

PAC-3: 50 ppm

DFG MAK: [skin] Carcinogen Category 1; Germ Cell Mutation Category 3A.

Australia: TWA 2 ppm (9 mg/m^3) [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 2 ppm (8.8 mg/m^3) [skin], Carcinogen 1993; Denmark: TWA 2 ppm (9 mg/m^3) [skin], 1999; Finland: TWA 5 ppm (22 mg/m^3), STEL 10 ppm (44 mg/m^3) [skin], carcinogen, 1999; France: VME 2 ppm (9 mg/m^3), carcinogen, 1999; Carcinogen (salts), 1993; Japan; 1 ppm (4.4 mg/m^3) [skin], 2B carcinogen, 1999; Norway: TWA 1 ppm (4.5 mg/m^3), 1999; the Philippines: TWA 5 ppm (22 mg/m^3) [skin], 1993; Poland: MAC (TWA) 3 mg/m^3; MAC (STEL) 9 mg/m^3, 1999; Russia: TWA 0.5 mg/m^3, STEL 1 mg/m^3 [skin], carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.5 mg/m^3) [skin], carcinogen, 1999; Turkey: TWA 5 ppm (22 mg/m^3) [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Also, many states have set guidelines for ambient air.

Determination in Air: Use NIOSH Analytical Method #2002, amines, aromatic, #2017, #8317, OSHA Analytical Method ID-73.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water goal of 304 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.32$.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure may affect the blood causing cyanosis and formation of methemoglobin. Exposure to high concentrations may result in damage to kidneys and bladder.

Inhalation: Combines with blood cells to prevent binding of oxygen. Early symptoms are headache, nausea, vomiting, diarrhea, low blood pressure; increased salivation and loss of appetite. Causes cyanosis; lips, fingernails, and tongue may turn blue. Symptoms may begin to appear at 6 ppm after several hours, or at 100 ppm after 1 h. Continued exposure may lead to difficult breathing; dizziness, stupor, unconsciousness, and death. *Skin:* Causes irritation. May cause excessive drying of skin and irritation. Absorption is significant and may increase severity of symptoms listed under inhalation. *Eyes:* Causes irritation, redness, and chemical burns. *Ingestion:* Animal studies suggest that symptoms as listed under inhalation would occur, and that death may result from ingestion of about 2 oz by a 150 lb person.

Long Term Exposure: Skin and inhalation exposures may cause the formation of methemoglobin and cyanosis, mild blue coloration of the skin due to lack of oxygen in the blood. Loss of appetite and weight, headache, dizziness may occur. Irritation of the kidneys and bladder may occur, with decreased functions and damage. *o*-Toluidine is a potential occupational carcinogen.

Points of Attack: Eyes, skin, blood, kidneys, liver, cardiovascular system. *Cancer site:* bladder cancer.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Methemoglobin; Complete blood count; red blood cells/count; urine (chemical/metabolite); urine (chemical/metabolite) [Whole Blood (chemical/metabolite)]; urinalysis (routine)]. Before beginning employment and at regular times after that, the following is recommended: Urine exam for blood and abnormal cells (urine cytology) and blood. If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level every 3−6 h for 18−24 h. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. *o*-Toluidine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where *o*-toluidine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

US Environmental Protection Agency. (February 23, 1984). *Chemical Hazard Information Profile Draft Report: o-Toluidine; o-Toluidine Hydrochloride*. Washington, DC

New York State Department of Health. (March 1986). *Chemical Fact Sheet: o-Toluidine*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 121−123

New Jersey Department of Health and Senior Services. (January 2001). *Hazardous Substances Fact Sheet: o-Toluidine*. Trenton, NJ

Toxaphene T:0650

Molecular Formula: $C_{10}H_{10}Cl_8$

Synonyms: 8001-35-2; Agricide Maggot killer (F); Alltex; Alltox; Anatox; Attac-2; Attac 6; Attac 6-3; Camphechlor; Camphene, octachloro-; Camphochlor; Camphoclor; Camphofene huileux; Canfeclor; Chem-Phene; Chlorinated camphene; Chlorocamphene; Clor Chem T-590; Compound 3956; Crestoxo; Cristoxo 90; ENT 9,735; Estonox; Fasco-terpene; Geniphene; GY-Phene; Hercules 3956; Hercules Toxaphene; Kamfochlor; M 5055; Melipax; Motox; NCI-C00259; Octachlorocamphene; PCC; PCHK; Penphene; Phenacide; Phenatox; Polychlorcamphene; Polychlorinated camphene; Polychlorocamphene; Strobane T; Strobane T 90; Synthetic 3956; Technical chlorinated camphene, 67−69% chlorine; Toxadust; Toxafeno (Spanish); Toxakil; Toxaphen (German); Toxaspray; Toxon 63; Toxyphen; Vertac 90%; Vertac toxaphene 90

CAS Registry Number: 8001-35-2; *(alt.)* 8022-04-6

RTECS® Number: XW5250000

UN/NA & ERG Number: UN2761/151

EC Number: 232-283-3 [*Annex I Index No.:* 602-044-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; equivocal evidence: rat.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Banned or Severely Restricted (many countries) (UN).[13]

Persistent Organic Pollutants (UN).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Toxic Pollutant (Section 401.15); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P123.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0095; Nonwastewater (mg/kg), 2.6.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (2); 8250 (10).

Safe Drinking Water Act: MCL, 0.003 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Reportable Quantity (RQ): 1 lb (0.454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

California Proposition 65 Chemical: Cancer 1/1/88.

List of Stockholm Convention POPs: Annex A (Elimination).

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R21; R25; R37/38; R40; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61. (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Toxaphene is an amber, waxy solid with a mild, piney, chlorine- and camphor-like odor. Usually dissolved in a flammable solvent. Flammability depends on the solvent used. Molecular weight = 413.80; Specific gravity (H_2O:1) = 1.65 at 25°C; Boiling point = (decomposes); Freezing/Melting point = 65−90°C; Vapor pressure = 4×10^{-6} mmHg at 20°C; Vapor pressure = 0.4 mmHg at 25°C. Flash point = 135°C (solid); 29°C (solution); Autoignition temperature = 530°C. Explosive limits: LEL = 1.1%; UEL = 6.4% (solvents only). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.0003%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Natural Product; Primary Irritant. Toxaphene is a broad spectrum, chlorinated hydrocarbon pesticide that is used as an insecticide for the control of grasshoppers, army-worms. and all major cotton pests.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard. Decomposes, producing fumes of hydrogen chloride and chlorine in heat above 155°C, on contact with strong bases; strong sunlight; and catalysts, such as iron. Slightly corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg/m^3 TWA [skin].

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 0.5 mg/m^3 TWA [skin]; 1 mg/m^3 STEL [skin]; confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 200 mg/m^3 Potential occupational carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 0.5 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 200 mg/m^3

DFG MAK: [skin]; Carcinogen Category 2.

Arab Republic of Egypt: TWA 0.5 mg/m^3 [skin], 1993; Australia: TWA 0.5 mg/m^3, STEL 1 mg/m^3 [skin], 1993; Austria: MAK 0.5 mg/m^3 [skin], 1999; Belgium: TWA 0.5 mg/m^3, STEL 1 mg/m^3 [skin], 1993; Denmark: TWA 0.5 mg/m^3 [skin], 1999; Finland: TWA 0.5 mg/m^3, STEL 1.5 mg/m^3 [skin], 1999; France: VME 0.5 mg/m^3 [skin], carcinogen, 1999; the Netherlands: MAC-TGG 0.5 mg/m^3 [skin], 2003; Norway: TWA 0.5 mg/m^3, 1999; the Philippines: TWA 0.5 mg/m^3 [skin], 1993; Switzerland: MAK-W 0.5 mg/m^3 [skin], 1999; Thailand: TWA 0.5 mg/m^3, 1993; Turkey: TWA 0.5 mg/m^3 [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1 mg/m^3 [skin].

Russia set a MAC for ambient air in residential areas of 7.0 μg/m^3 on a once-daily basis. Several states have set guidelines or standards for toxaphene in ambient air[60] ranging from 1.19 μg/m^3 (Kansas) to 1.2 μg/m^3 (Pennsylvania) to 1.67 μg/m^3 (New York) to 2.5 μg/m^3 (Connecticut and South Carolina) to 5.0 μg/m^3 (Florida) to 5.0−10.0 μg/m^3 (North Dakota) to 8.0 μg/m^3 (Virginia) to 12.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5039, Chlorinated camphene.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 0.013 μg/L as a 24-h average, never to exceed 1.6 μg/L. *To protect saltwater aquatic life:* never to exceed 0.07 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is presented by a concentration of 0.0071 μ/l.[6] More recently, EPA[62] has proposed a drinking water standard of 5.0 μg/L. States which have set drinking water guidelines include Maine at 5.0 μg/L and Minnesota at 0.3 μg/L.[61] Mexico[35] has set MPC values of 30 μg/L for estuaries, 3.0 μg/L for coastal waters, and 5.0 μg/L for receiving waters used for drinking water supply. Fish Tox = 0.03900000 ppb MATC (EXTRA HIGH).

Determination in Water: Gas chromatography (EPA Method #608) or gas chromatography plus mass spectrometry (EPA Method #625). Octanol−water coefficient: Log $K_{ow} = 3.32$.

Routes of Entry: Inhalation, skin absorption; ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: High concentrations can irritate the skin and eyes. A nervous system depressant causing tremors, weakness, dizziness, increased saliva; convulsions, unconsciousness, and possible death. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation of spray at unknown levels has caused bronchitis and inflammation of the lungs. If spilled on clothing and allowed to remain, can cause pain and reddening. May be absorbed through skin contributing to symptoms described under ingestion. Absorbed through the stomach and intestines. 0.6 g (about 1/50 oz) has caused convulsions. Other symptoms include nausea, vomiting, bluish coloration of the skin; and coma. Estimated lethal dose for an adult is between 2 and 7 g (1/15−1/4 oz).

Long Term Exposure: Aplastic anemia (low blood count) is an uncommon but serious reaction to toxaphene. High or repeated exposure may cause liver and kidney damage. Toxaphene is suspected of causing brain damage. Changes in genetic material have been observed in workers exposed to toxaphene. Toxaphene is potential occupational carcinogen.

Human Tox = 3.00000 ppb (HIGH).

Points of Attack: Central nervous system; skin. Cancer site in animals: liver cancer; thyroid tumors.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood count (CBC). Complete examination of the nervous system. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in sealed containers in a well-ventilated area away from oxidizers. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Organochlorine pesticides, solid toxic, require a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear boots, protective gloves, goggles, and positive-pressure breathing apparatus. Wash away any material which may have contacted the body with copious amounts of water or soap and water. In case of land spill, dig a pit, pond, lagoon, or holding area to contain the liquid or solid material. Cover solids with a plastic sheet to prevent dissolving in rain or firefighting water. In case of water spill, if camphechlor is dissolved, apply activated carbon at 10 times the spilled amounts in the region of 10 ppm or greater concentration. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid that is not easy to ignite, but is usually dissolved in a flammable carrier. Flammability depends on the type of solvent being used. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire, including chlorine and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration of flammable solvent mixture in furnace equipped with afterburner and alkali scrubber.

References

US Environmental Protection Agency. (1980). *Toxaphene: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (1979). *Reviews of the Environmental Effects of Pollutants: X. Toxaphene*. Report No. EPA-600/1-79-044

US Environmental Protection Agency. (April 30, 1980). *Toxaphene, Health and Environmental Effects Profile No. 163*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Camphechlor*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 68−70 (1982), 4, No. 1, 27−28 (1984), and 7, No. 5, 100−107 (1987).

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Toxaphene*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Toxaphene*. Trenton, NJ

Tributyl phosphate T:0660

Molecular Formula: $C_{12}H_{27}O_4P$

Common Formula: $(C_4H_9O)_3PO$

Synonyms: Butyl phosphate, tri-; Celluphos 4; Phosphoric acid, tributyl ester; TBP; Tributyle (phosphate de) (French); Tributylphosphat (German); Tri-*n*-butyl Phosphate

CAS Registry Number: 126-73-8

RTECS® Number: IC7700000

UN/NA & ERG Number: No citation.

EC Number: 204-800-2 [*Annex I Index No.:* 015-014-00-2]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R22; R38; R40; Safety phrases: S2; S36/37; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Tributyl phosphate is a colorless to pale yellow odorless liquid. Molecular weight = 266.36; Specific gravity (H_2O:1) = 0.98; Boiling point = 289°C (decomposes); Freezing/Melting point $\leq$−80°C; Vapor pressure = 0.004 mmHg at 25°C; Autoignition temperature = 410°C; Flash point = 146°C (oc); Autoignition temperature = 410°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Poor solubility in water.

Potential Exposure: Tributyl phosphate is used as plasticizer, solvent, and grinding assistant; in inks and as a dielectric material; as an antifoaming agent. It is also used as a solvent in uranium extraction and as a solvent for cellulose esters. It may be used as a heat exchange medium.

Incompatibilities: Alkalis, strong oxidizers; water, moist air. Reacts with warm water producing phosphoric acid and butanol. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.89 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 mg/m^3 TWA.

NIOSH REL: 0.2 ppm/2.5 mg/m^3 TWA

ACGIH TLV®[1]: 0.2 ppm/2.2 mg/m^3 TWA.

NIOSH IDLH: 30 ppm.

Protective Action Criteria (PAC)

TEEL-0: 0.2 ppm

PAC-1: 6 ppm

PAC-2: 30 ppm

PAC-3: 30 ppm

DFG MAK: 1 ppm/11 mg/m^3 TWA; Peak Limitation Category II(4) [skin]; Carcinogen Category 4; Pregnancy Risk Group C.

Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant.

Australia: TWA 0.2 ppm (2.5 mg/m^3), 1993; Belgium: TWA 0.2 ppm (2.2 mg/m^3), 1993; Denmark: TWA 0.2 ppm (2.5 mg/m^3), 1999; Finland: TWA 5 mg/m^3, STEL 10 mg/m^3 [skin], 1999; France: VME 0.2 ppm (2.5 mg/m^3), 1999; Norway: TWA 0.2 ppm (2.5 mg/m^3), 1999; the Philippines: TWA 5 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Switzerland: MAK-W 0.2 ppm (2.5 mg/m^3), 1999; United Kingdom: TWA 5 mg/m^3, STEL 5 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.2 ppm.

Several states have set guidelines or standards for TBP in ambient air[60] ranging from 25 μg/m^3 (North Dakota) to 40 μg/m^3 (Virginia) to 50 μg/m^3 (Connecticut) to 59 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5034.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.02$.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L.

Routes of Entry: Inhalation of mist, eye and/or skin contact, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Tributyl phosphate can affect you when breathed in. Skin or eye contact can cause severe irritation or even burns. Breathing overexposure can irritate the nose, throat, and bronchial tubes and cause headaches, weakness, muscle twitching; nausea, collapse, and even death. Inhalation exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Animal data have shown weak anticholinesterase activity.

Long Term Exposure: Similar to other highly irritating substances, Tributyl phosphate may be able to cause lung damage. Animal data have shown weak anticholinesterase activity.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Consider lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *2 ppm:* Sa (APF = 10) (any supplied-air respirator). *5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *10 ppm:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *50 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv 100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Tributyl phosphate must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and fluorine, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where tributyl phosphate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides; phosphine, and phosphoric acid; are produced in fire. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Tributyl phosphate may be recovered from nuclear fuel processing operations.

References

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Tributyl Phosphate*. Trenton, NJ

Trichlorfon T:0670

Molecular Formula: $C_4H_8Cl_3O_4P$

Common Formula: $(CH_3O)_2POCHOHCCl_3$

Synonyms: Aerol 1 (pesticide); Agroforotox; Anthon; Bay 15922; Bayer 15922; Bayer L 13/59; Bilarcil; Bovinox; Briton; Britten; Cekufon; Chlorak; Chlorofos; Chloroftalm; Chlorophos; Chlorophthalm; Chloroxyphos; Ciclo-som; Combot; Combot equine; Danex; DEP (pesticide); Depthon; DETF; Dimethoxy-2,2,2-trichloro-1-hydroxy-ethylphosphine oxide; *O*,*O*-Dimethyl (1-hydroxy-2,2,2-trichloraethyl)phosphat (German); *O*,*O*-Dimethyl (1-hydroxy-2,2,2-trichloraethyl)phosphonsaeure ester (German); *O*,*O*-Dimethyl (1-hydroxy-2,2,2-trichloroethyl) phosphonate; Dimethyl 1-hydroxy-2,2,2-trichloroethylphosphonate; *O*,*O*-Dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate; Dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate; Dimetox; Dipterex; Dipterex 50; Diptevur; Ditrifon; Dylox; Dylox-Metasystox-R; Dyrex; Dyvon; ENT 19,763; Equino-acid; Equino-aid; Flibol E; Fliegenteller; Forotox; Foschlor; Foschlor R; Foschlor R-50; 1-Hydroxy-2,2,2-trichloroethylphosphonic acid dimethyl ester; Hypodermacid; Leivasom; Loisol; Masoten; Mazoten; Methyl chlorophos; Metifonate; Metrifonate; Metriphonate; NCI-C54831; Neguvon; Neguvon A; Phoschlor; Phoschlor R50; Phosphonic acid (2,2,2-trichloro-1-hydroxyethyl)-, dimethyl ester; Polfoschlor; Proxol; Ricifon; Ritsifon; Satox 20WSC; Soldep; Sotipox; 2,2,2-Trichloro-1-hydroxyethyl-phosphonate, dimethyl ester; (2,2,2-Trichloro-1-hydroxyethyl)phosphonic acid dimethyl ester; Trichlorophene; Trichlorphon; Trichlorphon FN; Trinex; Tugon; Tugon fly bait; Tugon stable spray; Vermicide bayer 2349; Volfartol; Votexit; WEC 50; Wotexit

CAS Registry Number: 52-68-6

RTECS® Number: AO700000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 200-149-3 [*Annex I Index No.:* 015-021-00-0]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987.

US EPA Gene-Tox Program, Positive: Body fluid assay; Host-mediated assay; Positive: Histidine reversion—Ames test; *S. cerevisiae*—homozygosis; Weakly Positive: *In vitro* UDS—human fibroblast; Positive/dose response: TRP reversion; Negative: *D. melanogaster* sex-linked lethal;

Inconclusive: Mammalian micronucleus; *B. subtilis* rec assay; Inconclusive: *E. coli* polA without S9.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Dropped from Extremely Hazardous Substance (EPA-SARA) in 1988.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R43; R50/53; Safety phrases: S2; S24; S37; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Trichlorfon is a white to pale yellow crystalline solid. Molecular weight = 257.44; Specific gravity (H_2O:1) = 1.73 at 25°C; Boiling point = 100°C at 1 mmHg; Freezing/Melting point = 83−84°C; Vapor pressure = 2×10^{-6} mmHg at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = 15.4 g/100 mL at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Trichlorfon is used as an agricultural and forest insecticide.

Incompatibilities: Alkaline materials: lime, lime sulfur, etc. Corrosive to iron and steel.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®[1]: 1 mg/m^3 (intermittent) TWA, sensitizer, not classifiable as a human carcinogen; BEI$_A$ issued for acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 13 mg/m^3

PAC-3: 500 mg/m^3

Poland: MAC (TWA) 0.5 mg/m^3, MAC (STEL) 2 mg/m^3, 1999; Russia: STEL 0.5 mg/m^3 [skin] 1993. Russia[43] set a MAC in residential areas of 0.04 mg/m^3 on a momentary basis and 0.02 mg/m^3 on a daily average basis.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.05 mg/L and in water bodies used for fishery purposes of zero.

Determination in Water: Fish Tox = 24.99773000 (ppb) (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 0.48.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Very toxic: probable oral lethal dose (human) 50−500 mg/kg, between 1 teaspoon and 1 oz for 150 lb (70 kg) person. Toxicity is relatively low among organic phosphate insecticides, although it is a potent cholinesterase inhibitor. Skin sensitivity has been reported. Symptoms of exposure: muscle weakness; twitching, respiratory depression; sweating, vomiting, diarrhea, chest and abdominal distress; sometimes pulmonary edema; excessive salivation; headache, giddiness, vertigo, and weakness; runny nose and sensation of tightness in chest (inhalation), blurring of vision; tearing, ocular pain; loss of muscle coordination; and slurring of speech.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox; 14.00000 ppb (INTERMEDIATE).

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode. A/P2 filter respirator for organic vapor and harmful dust. *Escape:* GmFOv 100 [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline materials. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Parking Group III.

Spill Handling: As for other organophosphorus pesticides, stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean dry containers and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10.

Fire Extinguishing: This material may burn, but does not ignite readily. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Poisonous gases are produced in fire, including chlorine and phosphorus oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add a combustible solvent and burn in a furnace equipped with an afterburner and an alkali scrubber.[24] In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

Sax, N. I. (Ed.). (1987). *Dangerous Properties of Industrial Materials Report*, 7, No. 2, 95−101

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Trichlorophon*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (November 2004). *Hazardous Substances Fact Sheet: Trichlorofon*. Trenton, NJ

Trichloroacetic acid T:0680

Molecular Formula: $C_2HCl_3O_2$
Common Formula: Cl_3CCOOH

Synonyms: Acetic acid, trichloro-; Aceto-caustin; Acide trichloracetique (French); Amchem grass killer; Dow sodium TCA solution; Konesta; Sodium TCA solution; TCA; Trichloressigsaeure (German); Trichloroethanoic acid; Varitox

CAS Registry Number: 76-03-9

RTECS® Number: AJ7875000

UN/NA & ERG Number: UN1839 (solid)/153; UN2564 (solution)/153

EC Number: 200-927-2 [*Annex I Index No.:* 607-004-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen.

US EPA Gene-Tox Program, Inconclusive: Histidine reversion—Ames test.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R35; R50/53; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Trichloroacetic acid is a colorless crystalline solid which is used in liquid solutions. Molecular weight = 163.38; Specific gravity (H_2O:1) = 1.62 at 25°C; Boiling point = 197.8°C; Freezing/Melting point = 57.8°C; Vapor pressure = 1 mmHg at 51°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Trichloroacetic acid is used as medication, in organic syntheses; and as a reagent for albumin detection; as an intermediate in pesticide manufacture and in the production of sodium trichloroacetate which is itself an herbicide.

Incompatibilities: Moisture, iron, zinc, aluminum, strong oxidizers. Corrosive to metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.68 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 1 ppm/7 mg/m^3 TWA.

ACGIH TLV®[1]: 1 ppm/6.7 mg/m^3 TWA, confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 1 ppm

PAC-1: 1 ppm

PAC-2: 2 ppm

PAC-3: 25 ppm

Austria: MAK 1 ppm (5 mg/m^3), 1999; Belgium: TWA 1 ppm (6.7 mg/m^3), 1993; Denmark: TWA 1 mg/m^3, 1999; France: VME 1 ppm (5 mg/m^3), 1999; Norway: TWA 0.75 ppm (5 mg/m^3), 1999; Russia: STEL 5 mg/m^3 [skin], 1993; Switzerland: MAK-W 1 ppm (7 mg/m^3), 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for TCA in ambient air[60] ranging from 70 μg/m^3 (North Dakota) to 80 μg/m^3 (Virginia) to 100 μg/m^3 (Connecticut) to 119 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Fish Tox: 538434.64955000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Causes irritation to respiratory tract with choking, coughing, dizziness, and weakness. Swelling of throat and lungs can occur. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. *Skin:* Corrosive to the skin. Burns and blisters may result if not removed promptly. May cause thickening of skin. *Eyes:* Corrosive to the eyes. Can cause extremely painful burns and sores on eyes, which can result in blindness. *Ingestion:* May cause intense burning of mouth, throat, and stomach; vomiting, diarrhea, and fatigue. Throat may swell to block airway. The estimated lethal dose is about 1 g (1/30 oz).

Long Term Exposure: Fumes may produce irritation of throat and lungs with persistent cough. Disturbances of the digestive tract may also be noticed. These should only be significant at levels above the recommended occupational exposure limit. Human Tox = 60.00000 ppb (LOW).

Points of Attack: Eyes, skin, respiratory system; gastrointestinal tract.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for

pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full-face-piece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 1 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved respirator with a high-efficiency particulate filter. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered, air-purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. If trichloroacetic acid is a liquid, where the potential exists for exposures *over 1 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with an acid gas canister. Increased protection is obtained from full-face-piece powered, air-purifying respirators.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated place away from strong oxidizers, strong bases. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Trichloroacetic acid, solid, requires a shipping label of "CORROSIVE." Trichloroacetic acid, solution. Both fall in DOT Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Wearing protective equipment and clothing, spread soda ash on spill and mop up with water. Shovel slurry into appropriate container. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 3.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Trichloroacetic acid itself does not burn. Poisonous gases are produced in fire, including chlorine, chloroform, phosgene, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Trichloroacetic Acid*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2004). *Hazardous Substances Fact Sheet: Trichloroacetic Acid*. Trenton, NJ

Trichloroacetyl chloride T:0690

Molecular Formula: C_2Cl_4O

Common Formula: Cl_3CCOCl

Synonyms: Acetyl chloride, trichloro-; Cloruro de tricloroacetilo (Spanish); NSC 190466; Superpalite; Trichloroacetic acid chloride; Trichloroacetochloride

CAS Registry Number: 76-02-8

RTECS® Number: AO7140000

UN/NA & ERG Number: UN2442/156

EC Number: 200-926-7

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (127.5 kg).

Reportable Quantity (RQ): 500 lb (127.5 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trichloroacetyl chloride is a clear liquid. Molecular weight = 181.82; Boiling point = 118°C; Freezing/Melting point = −146°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1₩. Decomposes in water.

Incompatibilities: Violent reaction with water, forming hydrochloric acid and trichloroacetic acid. Keep away from strong oxidizers.

Potential Exposure: Used in chemical syntheses.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 0.03 ppm
PAC-1: 0.075 ppm
PAC-2: 0.606 ppm
PAC-3: 6 ppm
Russia[43] set a MAC in work-place air[43] of 0.1 mg/m^3.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Corrosive. Severe irritation to the eyes, skin, and respiratory tract. Skin or eye contact may cause burns. Moderately toxic by ingestion and inhalation. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Highly irritating substances may affect the lungs; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: This compound requires a shipping label of "CORROSIVE, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 8 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Material may burn but does not ignite readily. Material may react violently with water. Extinguish with dry chemical, carbon dioxide; water spray, fog, or foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear positive-pressure breathing apparatus and special protective clothing. Poisonous gases are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure

position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Trichloroacetyl Chloride*. Washington, DC: Chemical Emergency Preparedness Program

1,2,4-Trichlorobenzene T:0700

Molecular Formula: $C_6H_3Cl_3$

Synonyms: Benzene, 1,2,4-trichloro-; Hostetex L-PEC; 1,2,5-Trichlorobenzene; 1,3,4-Trichlorobenzene; *asym*-Trichlorobenzene; 1,2,4-Trichlorobenzol; 1,2,4-Triclorobenceno (Spanish)

CAS Registry Number: 120-82-1

RTECS® Number: DC2100000

UN/NA & ERG Number: UN2321/153

EC Number: 204-428-0 [*Annex I Index No.*: 602-087-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 19.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL µg/L): 8270 (10).

Safe Drinking Water Act: Regulated chemical (47 FR 9352) as trichlorobenzene.

Safe Drinking Water Act: MCL, 0.07 mg/L; MCLG, 0.7 mg/L.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as trichlorobenzenes, liquid.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: Xn, N; Risk phrases: R22; R38; R50/53; Safety phrases: S2; S37/39; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,2,4-Trichlorobenzene is a low-melting solid or liquid with a pleasant, aromatic odor. The odor threshold is 1.4 ppm. Molecular weight = 181.44; Specific gravity (H_2O:1) = 1.45 at 25°C; Boiling point = 213.3°C; Freezing/Melting point = 17.2°C; Vapor pressure = 1 mmHg; Flash point = 105°C; Autoignition temperature = 571°C. Explosive limits: LEL = 2.5%; UEL = 6.6%, both at 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water; solubility = 0.003%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. 1,2,4-Trichlorobenzene is used as a dye carrier, herbicide intermediate; a heat transfer medium; a dielectric fluid in transformers; a degreaser; a lubricant; as an industrial chemical; solvent, emulsifier, and as a potential insecticide against termites. The other trichlorobenzene isomers are not used in any quantity.

Incompatibilities: Reacts violently with oxidants, acids, acid fumes; steam.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.42 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 5 ppm/40 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 5 ppm/37 mg/m^3 Ceiling Concentration.

European OEL: 2 ppm/15.1 mg/m^3 TWA; 5 ppm, 37.8 mg/m^3 STEL [skin].[2003]

Protective Action Criteria (PAC)

TEEL-0: 0.25 ppm

PAC-1: 0.75 ppm

PAC-2: 5 ppm

PAC-3: 40 ppm

DFG MAK: [skin] Carcinogen Category 3B.

Australia: TWA 5 ppm (40 mg/m^3), 1993; Austria: MAK 5 ppm (40 mg/m^3), 1999; Belgium: STEL 5 ppm (37 mg/m^3), 1993; Denmark: TWA 5 ppm (40 mg/m^3), 1999; Finland: TWA 5 ppm (40 mg/m^3), STEL 10 ppm (74 mg/m^3) [skin], 1999; France: VME 5 ppm (40 mg/m^3), 1999; the Netherlands: MAC-TGG 15.1 mg/m^3 [skin], 2003; Switzerland: MAK-W 5 ppm (40 mg/m^3), 1999; United Kingdom: TWA 1 ppm (7.6 mg/m^3) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 ppm.

Several states have set guidelines or standards for 1,2,4-trichlorobenzene in ambient air[60] ranging from 133 µg/m^3 (New York) to 350 µg/m^3 (Virginia) to 400 µg/m^3 (North Dakota and South Carolina) to 800 µg/m^3 (Connecticut) to 952 µg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5517, Polychlorobenzenes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.98.

Permissible Concentration in Water: To protect human health—no criterion developed due to insufficient data.[6] Several states have set guidelines or standards for 1,2,4-trichlorobenzene in drinking water.[61] These include a guideline of 13 µg/L (Kansas) and a standard of 8 µg/L

(New Jersey). Russia[43] set a MAC for water bodies used for domestic purposes of 30 μg/L.

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method #612) or gas chromatography plus mass spectrometry (EPA Method #625).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May cause irritation to the nose and throat, nervousness, restlessness, tremors, increased heart rate and blood pressure; weakness, digestive disturbances; weight loss; and headache.

Skin: May cause severe irritation. Prolonged contact may cause skin burns.

Eyes: Causes irritation. Levels greater than 5 ppm may cause severe irritation.

Ingestion: Animal studies suggest that a dose of 2 oz may cause liver damage and death.

Long Term Exposure: Removes the skin's natural oils, causing drying and cracking. Possible teratogenic effects. May cause liver and kidney damage.

Points of Attack: Eyes, skin, respiratory system; liver, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function test. Urinary 2,5-dichlorophenol excretion test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™, Neoprene™, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2,4-Trichlorobenzene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where 1,2,4-trichlorobenzene is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene, chlorine, and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees

are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1980). *Chlorinated Benzenes: Ambient Water Quality Criteria*. Washington, DC

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 96−99

New York State Department of Health. (March 1986). *Chemical Fact Sheet: 1,2,4-Trichlorobenzene*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: 1,2,4-Trichlorobenzene*. Trenton, NJ

Trichloro(chloromethyl)-silane T:0710

Molecular Formula: CH_2Cl_4Si

Common Formula: $Si(CH_2Cl)Cl_3$

Synonyms: (Chloromethyl)trichlorosilane; Chloromethyl (trichloro)silane; Trichloro(chloromethyl)silane

CAS Registry Number: 1558-25-4

RTECS® Number: VV2200000

UN/NA & ERG Number: UN1295(trichlorosilane)/139

EC Number: 216-316-9

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Reportable Quantity (RQ): 100 lb (45 kg).

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trichloro(chloromethyl)-silane is a colorless liquid with a sharp, biting odor. Molecular weight = 183.92; Boiling point = 117°C; Freezing/Melting point = 111°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1₩. Violent reaction with water.

Potential Exposure: Used in the synthesis of polysiloxane (silicone polymers).

Incompatibilities: Contact with water forms hydrochloric acid. Incompatible with strong oxidizers, acids. Corrodes metals in the presence of moisture. Contact with ammonia can cause a self-igniting compound. Some chlorosilanes self-ignite in air.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.2 ppm

PAC-1: **0.6** ppm

PAC-2: **7.3** ppm

PAC-3: **33** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact with the eyes causes irritation, pain, swelling; corneal erosion and blindness may result. Contact with the skin causes dermatitis (red, inflamed skin), severe burns; pain, and shock generally follow dermal exposure. Acute inhalation exposure may result in sneezing, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation; and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; pulmonary edema; chronic bronchitis; and pneumonia may also occur. If ingested, symptoms include increased salivation; intense thirst; difficulty in swallowing; chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion.

Long Term Exposure: Highly irritating substances may cause lung effects.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to a health care facility. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Trichlorosilanes require a shipping label of "DANGEROUS WHEN WET, FLAMMABLE LIQUID." They fall in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors do not get water inside container. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

When spilled in water *as trichlorosilane*

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30.

Then: Protect persons downwind (miles/kilometers).

Day	0.1/0.2
Night	0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60.

Then: Protect persons downwind (miles/kilometers).

Day	0.5/0.8
Night	1.4/2.3

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including chlorine, are produced in fire. Use dry chemical, carbon dioxide or foam extinguishers. *Do not use water*. Vapor explosion hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Stay away from ends of tanks. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Trichloro (Chloromethyl)Silane*. Washington, DC: Chemical Emergency Preparedness Program

1,1,1-Trichloroethane T:0720

Molecular Formula: $C_2H_3Cl_3$
Common Formula: CH_3CCl_3
Synonyms: Aerothene TT; CF 2; Chlorotene; Chlorothane NU; Chlorothene; Chlorothene NU; Chlorothene SM; Chlorothene VG; Chlorten; Ethana NU; Ethane, 1,1,1-trichloro-; ICI-CF 2; Inhibisol; Methyl chloroform; Methyltrichloromethane; NCI-C04626; Solvent 111; Strobane; α-T; Tafclean; 1,1,1-TCE; 1,1,1-Trichloraethan (German); 1,1,1-Trichlorethane; α-Trichloroethane; Trichloro-1,1,1-ethane (French); Trichloroethane; Trichloromethylmethane; 1,1,1-Tricloroetano (Spanish); Tri-ethane
CAS Registry Number: 71-55-6; (*alt.*) 74552-83-3
RTECS® Number: KJ2975000
UN/NA & ERG Number: UN2831/160
EC Number: 200-756-3 [*Annex I Index No.:* 602-013-00-2]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Inadequate Information to assess carcinogenic potential; NIOSH: Potential occupational carcinogen.
US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Negative: Sperm morphology—mouse; Inconclusive: Carcinogenicity—mouse/rat; Mammalian micronucleus.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 0.1, all isomers except 1,1,2-trichlorethane.
Clean Water Act: Toxic Pollutant (Section 401.15) as chlorinated ethanes.
US EPA Hazardous Waste Number (RCRA No.): U226.
RCRA 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5).
Safe Drinking Water Act: MCL, 0.2 mg/L; MCLG, 0.20 mg/L; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
Hazard Symbol: Xn, N; Risk phrases: R20; R59; Safety phrases: S2; S24/25; S59; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,1,1-Trichloroethane is a colorless, nonflammable liquid with an odor similar to chloroform. The odor threshold is 120 ppm (NJ) or 400 ppm (NY). Molecular weight = 133.40; Specific gravity (H_2O:1) = 1.34 at 25°C; Boiling point = 73.9°C; Freezing/Melting point = −30.6°C; Vapor pressure = 100 mmHg at 25°C; Flash point = none; Autoignition temperature = 537°C. Explosive limits: LEL = 7.5%; UEL = 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.4%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. 1,1,1-Trichloroethane is used as a cleaning solvent, chemical intermediate for vinylidene chloride. In liquid form it is used as a degreaser and for cold cleaning, dip-cleaning; and bucket cleaning of metals. Other industrial applications of 1,1,1-trichloroethane's solvent properties include its use as a dry-cleaning agent; a vapor degreasing agent; and a propellant. In recent years, 1,1,1-trichloroethane has found wide use as a substitute for carbon tetrachloride.

Incompatibilities: Strong caustics; strong oxidizers; chemically active metals, such as aluminum, magnesium powder; sodium, potassium. Reacts slowly with water to form hydrochloric acid. Upon contact with hot metal or exposure to ultraviolet radiation, it will decompose to form the irritant gases hydrochloric acid, phosgene, and dichloroacetylene. Forms shock-sensitive mixtures with potassium or its alloys. Attacks natural rubber.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 5.46 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 350 ppm/1900 mg/m^3 TWA.
NIOSH REL: 350 ppm/1900 mg/m^3 [15 min] Ceiling Concentration. NIOSH considers methyl chloroform to be a potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix C.
ACGIH TLV®[1]: 350 ppm/1910 mg/m^3 TWA, 450 ppm/2460 mg/m^3 STEL, not classifiable as a human carcinogen; BEI: 40 ppm methyl chloroform in end-exhaled air prior to last shift of workweek; 10 mg/L trichloroacetic acid in urine at end-of-workweek; 30 mg/L total trichloroethanol in urine, end-of-shift at end-of-workweek; 1 mg/L total trichloroethanol in blood, end-of-shift at end-of-workweek.
NIOSH IDLH: 700 ppm.
Protective Action Criteria (PAC)*
TEEL-0: 230 ppm
PAC-1: **230** ppm

PAC-2: **600** ppm
PAC-3: **4200** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 200 ppm/1100 mg/m^3 TWA; Peak Limitation Category II(1) [skin], Pregnancy Risk Group: C; BAT: 550 μg/L in blood after several shifts [for long-time exposure]; at the beginning of next shift.

Australia: TWA 125 ppm (680 mg/m^3), 1993; Austria: MAK 200 ppm (1080 mg/m^3), 1999; Belgium: TWA 350 ppm (1910 mg/m^3), STEL 450 ppm (2460 mg/m^3), 1993; Denmark: TWA 50 ppm (275 mg/m^3), 1999; Finland: TWA 100 ppm (540 mg/m^3), STEL 250 ppm (1400 mg/m^3), 1999; France: VME 300 ppm (1650 mg/m^3), VLE 450 ppm (2500 mg/m^3), 1999; Hungary: TWA 100 mg/m^3, STEL 300 mg/m^3 [skin], 1993; the Netherlands: MAC-TGG 555 mg/m^3, 2003; Norway: TWA 50 ppm (270 mg/m^3), 1999; the Philippines: TWA 350 ppm (1900 mg/m^3), 1993; Poland: MAC (TWA) 300 mg/m^3; MAC (STEL) 1400 mg/m^3, 1999; Russia: TWA 200 ppm, STEL 20 mg/m^3, 1993; Sweden: NGV 50 ppm (300 mg/m^3), KTV 90 ppm (500 mg/m^3), 1999; Switzerland: MAK-W 200 ppm (1080 mg/m^3), KZG-W 1000 ppm, 1999; Turkey: TWA 350 ppm (1900 mg/m^3), 1993; United Kingdom: TWA 200 ppm (1110 mg/m^3), STEL 400 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 450 ppm. Several states have set guidelines or standards for 1,1,1-Trichloroethane in ambient air[60] ranging from 1.3 mg/m^3 (Massachusetts) to 12.0−245.0 mg/m^3 (North Carolina) to 19.0 mg/m^3 (Indiana) to 19.0−24.5 mg/m^3 (North Dakota) to 32.0 mg/m^3 (Virginia) to 38.0 mg/m^3 (Connecticut, New York, South Dakota) to 45.238 mg/m^3 (Nevada). Russia set a MAC for ambient air[43] in residential areas of 2.0 mg/m^3 on a once-daily basis and 0.2 mg/m^3 on a daily average basis.

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated[18]; OSHA Analytical Method 14. See also NIOSH Analytical Method #2549, Volatile organic compounds.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.49$.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 18,000 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 31,200 μg/L on an acute toxicity basis. To protect human health, on the basis of fish consumption alone—1,030,000 μg/L.[6] The EPA has recently set a lifetime health advisory for 1,1,1-trichloroethane of 0.2 mg/L (200 μg/L).[48] Several states have set guidelines or standards for drinking water ranging from 26 μg/L (New Jersey) to 60 μg/L (New Mexico) to 140 μg/L (Massachusetts) to 200 μg/L (California, Maine, Minnesota) to 300 μg/L (Connecticut).

Determination in Water: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons.

Routes of Entry: Inhalation of vapor, moderate skin adsorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* Exposure can cause headache, lassitude (weakness, exhaustion), central nervous system depressant/depression; poor equilibrium; cardiac arrhythmias; liver damage. May affect the heart and central nervous system; kidneys and liver; causing cardiac disorders and respiratory failure. Levels above 900 ppm can cause dizziness, mental confusion; drowsiness, loss of coordination, and unconsciousness. Death may result. *Skin:* Contact can cause irritation and rash. Absorption is moderate; may contribute significantly to health hazard. *Eyes:* Contact causes irritation. The vapor has caused irritation at levels of 450 ppm. *Ingestion:* May cause symptoms similar to inhalation. In addition, may cause mouth, throat, and stomach irritation.

Long Term Exposure: High exposures may damage the liver and kidneys. Prolonged contact can cause thickening and cracking of the skin. Repeated or prolonged contact at levels of 450 ppm or above may result in irritation and dry, scaley, fractured skin. Additionally, NIOSH recommends that this chemical be treated in the workplace with caution because of its structural similarity to other chloroethanes shown to be carcinogenic in animals.

Points of Attack: Eyes, skin, central nervous system; cardiovascular system, liver.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), During Exposure; whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-workweek; whole blood (chemical/metabolite), end-of-workweek, expired air, expired air, 16 h following end-of-exposure; expired air, end-of-workweek; expired air, prior to next shift; expired air prior to last shift of workweek; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-shift at end-of-workweek; urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior to next shift. Consider the skin, liver function; cardiac status, especially arrythmias; in preplacement or periodic examinations. Expired air analyses may be useful in monitoring exposure. Persons with heart disease may be at an increased risk of irregular heartbeat from very high exposures.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact: **8 h**: polyvinyl alcohol gloves; Viton™ gloves, suits; 4H™ and Silver Shield™ gloves; Barricade™ coated suits; CPF3™ suits; Responder™ suits; Trychem 1000™ suits; **4 h**: Teflon™ gloves, suits, boots. Also, protective clothing of leather or Neoprene™ may offer some protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 700 ppm:* Sa (APF = 10) (any supplied-air respirator);* or SCBA (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl chloroform must be stored to avoid contact with strong caustics (such as sodium and potassium hydroxide); acetone, strong oxidizers (such as chlorine, chlorine dioxide, and bromine); and chemically active metals (such as potassium, aluminum, zinc, and magnesium); since violent reactions occur. Do not allow vapor near sources of ultraviolet light, such as arc welding, because poisonous gases may be produced. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. Do not use aluminum containers.

Shipping: This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,1,1-Trichloroethane's combustible mixtures with air do not readily ignite, but ignition may occur in conditions of excess oxygen or in the presence of a high-energy ignition sources, such as a furnace; or welding. Use dry chemical, carbon dioxide, or foam extinguishers. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. As an alternative to disposal, trichloroethane may be recovered from waste gases and liquids from various processes and recycled.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to 1,1,1-Trichloroethane (Methyl Chloroform).* NIOSH Document No. 76-184. Washington, DC

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US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC
New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Methyl Chloroform*. Trenton, NJ

1,1,2-Trichloroethane T:0730

Molecular Formula: $C_2H_3Cl_3$
Common Formula: $CH_2ClCHCl_2$
Synonyms: Cement-339; Ethane trichloride; Ethane, 1,1,2-trichloro-; NCI-C04579; β-T; 1,2,2-Trichloroethane; β-Trichloroethane; 1,1,2-Tricloroetano (Spanish); Vinyl trichloride
CAS Registry Number: 79-00-5
RTECS®Number: KJ3150000
UN/NA & ERG Number: UN3082/171
EC Number: 201-166-9 [*Annex I Index No.:* 602-014-00-8]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse; no evidence: rat; NIOSH: Potential occupational carcinogen.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
US EPA Hazardous Waste Number (RCRA No.): U227.
RCRA 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground.
Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.2); 8240 (5).
Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, 0.003 mg/L; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
California Proposition 65 Chemical: Cancer 10/1/90.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: Hazard Symbol: Xn; Risk phrases: R20/21/22; R40; R66; Safety phrases: S2; S9; S36; S37; S46 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: 1,1,2-Trichloroethane is a colorless, nonflammable liquid with a sweet, chloroform-like odor. Molecular weight = 133.40; Specific gravity (H_2O:1) = 1.44 at 25°C; Boiling point = 113.9°C; Freezing/Melting point = −36°C. Vapor pressure = 19 mmHg at 25°C; Explosive limits are: LEL = 6.0%; UEL = 15.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.4%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen, Primary Irritant. 1,1,2-Trichloroethane is used as an intermediate in the production of vinylidine chloride, and a component of adhesives; as a solvent; but is not as widely used as is its isomer 1,1,1-trichloroethane; it is an isomer of 1,1,1-Trichloroethane *but should not be confused with it toxicologically*. 1,1,2-Trichloroethane is comparable to carbon tetrachloride and tetrachloroethane in toxicity.

Incompatibilities: Strong oxidizers, strong caustics; chemically active metals, such as aluminum, magnesium powders, sodium, potassium. Attacks many plastics, rubber, coatings, steel, and zinc.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 5.46 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 10 ppm/45 mg/m^3 TWA [skin].
NIOSH REL: 10 ppm/45 mg/m^3 TWA [skin], Potential occupational carcinogen; limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide* Appendices A & C.
ACGIH TLV®[1]: 10 ppm TWA [skin], animal carcinogen with Unknown Relevance to Humans.
Protective Action Criteria (PAC)
TEEL-0: 10 ppm
PAC-1: 100 ppm
PAC-2: 100 ppm
PAC-3: 100 ppm
DFG MAK: 10 ppm/55 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B.
NIOSH IDLH: 100 ppm.
Arab Republic of Egypt: TWA 10 ppm (40 mg/m^3) [skin], 1993; Australia: TWA 10 ppm (45 mg/m^3) [skin], 1993; Austria: MAK 10 ppm (55 mg/m^3) [skin], Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (55 mg/m^3) [skin], 1993; Denmark: TWA 10 ppm (54 mg/m^3) [skin], 1999; Finland: TWA 10 ppm (54 mg/m^3), STEL 20 ppm (110 mg/m^3) [skin], 1999; Hungary: TWA 10 mg/m^3, STEL 20 mg/m^3 [skin],

1993; the Netherlands: MAC-TGG 45 mg/m^3 [skin], 2003; Norway: TWA 10 ppm (54 mg/m^3), 1999; Russia: TWA 10 ppm, 1993; Switzerland: MAK-W 10 ppm (55 mg/m^3), KZG-W 50 ppm (275 mg/m^3) [skin], 1999; United Kingdom: LTEL 10 ppm (45 mg/m^3), STEL 20 ppm [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for 1,1,2-trichloroethane in ambient air[60] ranging from 0.00 μg/m^3 (Massachusetts) to 7.0 μg/m^3 (Rhode Island) to 27.0 μg/m^3 (Pennsylvania) to 107.143 μg/m^3 (Kansas) to 150.0 μg/m^3 (New York) to 225.0 μg/m^3 (Connecticut and Indiana) to 450.0 μg/m^3 (Florida and North Dakota) to 900.0 μg/m^3 (Virginia) to 1071.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons, OSHA Analytical Method 11.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.35$.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 18,000 μg/L on an acute toxicity basis and 9400 μg/L on a chronic basis. *To protect saltwater aquatic life:* no criteria developed due to insufficient data. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 6.0 μg/L.[6] Several states have set guidelines or standards for 1,1,2-trichloroethane in drinking water[61] ranging from 1.0 μg/L (Arizona) to 6.11 μg/L (Minnesota) to 10.0 μg/L (New Mexico) to 100.0 μg/L (California).

Determination in Water: Inert gas purge followed by gas chromatography with halide-specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation of vapor, absorption through the skin, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure may cause central nervous depression. May affect the kidneys and liver. *Inhalation:* Inhalation may produce headache, lassitude, dizziness, a lack of coordination; low blood pressure; irregular heartbeat; coma and death from respiratory arrest. Exposure to vapor concentrations near 2000 ppm for 5 min causes central nervous system depression and anesthetic effects. Symptoms are nasal irritation, drowsiness an equilibrium disturbances. Death may result from 13,600 ppm for 2 h. *Skin:* Can cause irritation and chemical burns if allowed to remain on the skin for a prolonged period. May be absorbed through the skin to cause or increase the severity of symptoms listed above. *Eyes:* Can cause irritation. *Ingestion:* May cause effects similar to those listed under inhalation. Laboratory studies with animals suggest that the probable lethal dose for humans is about 12 oz. Liver and kidney damage have occurred in animals.

Long Term Exposure: Can destroy the skin's natural oils, causing drying and cracking. Inhalation may cause liver and kidney damage. NIOSH recommends this chemical be treated as a potential occupational carcinogen. Has caused cancer in laboratory animals. Whether it does so in humans is unknown.

Points of Attack: Eyes, respiratory system; central nervous system; liver, kidneys. Cancer site in animals: liver cancer.

Medical Surveillance: NIOSH lists the following tests: Expired Air. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: special 24-h EKG (Holter monitor), to look for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and Teflon™ are recommended as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,1,2-Trichloroethane must be stored to avoid contact with strong oxidizers (such as chlorates, nitrates, peroxides, chlorine, and bromine); strong caustics; and chemically active metals (such as potassium, magnesium, zinc and sodium); because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 1,1,2-trichloroethane is used, handled, or stored in a manner that could create A potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Environmentally hazardous substances, liquid, n.o.s., require a shipping label of "CLASS 9." 1,1,2-Trichloroethane falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable under normal conditions but can be ignited by high-energy ignition sources, such as a furnace or welding. Use dry chemical, carbon dioxide, or foam extinguishers and water to keep fire-exposed containers cool. Poisonous gases, including hydrogen chloride and phosgene, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

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US Public Health Service. (December 1988). *Toxicological Profile for 1,1,2-Trichloroethane*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New York State Department of Health. (May 1986). *Chemical Fact Sheet: 1,1,2-Trichloroethane*. Albany, NY: Bureau of Toxic Substance Assessment (Version 2)

New Jersey Department of Health and Senior Services. (March 2002). *Hazardous Substances Fact Sheet: 1,1,2-Trichloroethane*. Trenton, NJ

Trichloroethylene T:0740

Molecular Formula: C_2HCl_3

Common Formula: $ClCH{=}CCl_2$

Synonyms: Acetylene trichloride; Algylen; Anamenth; Benzinol; Blacosolv; Cecolene; Chlorilen; Chlorylea; Chorylen; Circosolv; Crawhaspol; Densinfluat; Dow-tri; Dukeron; Ethene, trichloro-; Ethinyl trichloride; Ethylene trichloride; Ethylene, trichloro-; Fleck-flip; Fluate; Germalgene; Halocarbon 113; Lanadin; Lethurin; Narcogen; Narkosoid; NCI-C04546; Nialk; Perm-α-chlor; Petzinol; TCE; Threthylen; Threthylene; Trethylene; Tri; Triad; Triasol; Trichloraethen (German); Trichloran; Trichloren; Trichlorethene (French); Trichloroethene; 1,1,2-Trichloroethylene; Trichloroethylene tri (French); Trichlororan; 1,1,2-Trichloro-1,2,2-trifluoroethane; Triclene; Tricloroetileno (Spanish); Trielene; Trielin; Trieline; Trilentrilene; Trimar; Tri-plus; TTE; Vestrol; Vitran; Westrosol

CAS Registry Number: 79-01-6; (*alt.*) 52037-46-4

RTECS®Number: KX4550000

UN/NA & ERG Number: UN1710/160

EC Number: 201-167-4 [*Annex I Index No.:* 602-027-00-9]

Regulatory Authority and Advisory Bodies

IARC: Animal, Sufficient Evidence; Human, Limited Evidence, Group 2A, 1995; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; no evidence: rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Cell transform.—RLV F344 rat embryo; Host-mediated assay; Positive: Mouse spot test; Sperm morphology—mouse; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis; Positive: *S. cerevisiae*—reversion; Positive/limited: Carcinogenicity—mouse/rat; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

US EPA Hazardous Waste Number (RCRA No.): U228; D040.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L.

RCRA 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Safe Drinking Water Act: MCL, 0.005 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 4/1/88.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T, N; Risk phrases: R45; R36/38; R52/53; R67; Safety phrases: S53; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Trichloroethylene, a colorless (often dyed blue), nonflammable, noncorrosive liquid that has the "sweet" odor characteristic of some chlorinated hydrocarbons. The odor threshold is 25−50 ppm. Molecular weight = 131.38; Specific gravity (H_2O:1) = 1.46 at 25°C; Boiling point = 87.2°C; Freezing/Melting point = −72.8°C; Vapor pressure = 58 mmHg at 25°C; Autoignition temperature = 410°C. Explosive limits: LEL = 8.0%; UEL = 10.5% at 25°C; LEL = 7.8%; UEL = 52% at 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.1%.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Trichloroethylene is used as a vapor degreaser of metal parts, as a solvent; and as a drug. It is also used for extracting caffeine from coffee, as a dry-cleaning agent; and as a chemical intermediate in the production of pesticides; in making waxes, gums, resins, tars, paints, varnishes, and specific chemicals, such as chloroacetic acid.

Incompatibilities: Contact with strong caustics causes decomposition and the production of highly toxic and flammable dichloroacetylene. Violent reaction with chemically active metals; powders, or shavings, such as aluminum, barium, lithium, sodium, magnesium, titanium. Violent reaction with aluminum in the presence of dilute hydrochloric acid. Decomposition of trichloroethylene, due to contact with hot metal or ultraviolet radiation, forms hazardous products including chlorine gas, hydrogen chloride; and phosgene. Keep this chemical away from high temperatures, such as arc welding or cutting, unshielded resistance heating; open flames; and high-intensity ultraviolet light. Slowly decomposed by light in presence of moisture, with formulation of hydrochloric acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.37 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 100 ppm TWA; 200 ppm; 300 ppm [5-min maximum peak in any 2 h] Ceiling Concentration.

NIOSH REL: 25 ppm TWA; 2 ppm [60 min when used as a waste anesthetic gas] STEL; Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See the *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 10 ppm TWA; 25 ppm STEL, Suspected Human Carcinogen. BEI: 100 mg[trichloroacetic acid]/g creatinine in urine, end-of-workweek; 300 mg[trichloroacetic acid and trichloroethanol]/g creatinine in urine, end-of-shift, end-of-workweek; 4 mg[trichloroethylene]/g in blood, end-of-shift, end-of-workweek.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)*

TEEL-0: 10 ppm

PAC-1: **130** ppm

PAC-2: **450** ppm

PAC-3: **3800** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category: 1; Germ Cell Mutagen Group: 3B; TRK: 5 mg[trichloroethanol]/L in blood, end-of-exposure, end-of-shift; for long-term exposure, after several shifts; 100 mg[trichloroacetic acid]/L in urine, end-of-exposure, end-of-shift; for long-term exposure, after several shifts.

Australia: TWA 50 ppm (270 mg/m^3), STEL 200 ppm, 1993; Austria: MAK 50 ppm (270 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (269 mg/m^3), STEL 200 ppm (1070 mg/m^3), 1993; Denmark: TWA 10 ppm (55 mg/m^3), 1999; Finland: TWA 30 ppm (160 mg/m^3), STEL 45 ppm (240 mg/m^3) [skin], 1999; France: VME 75 ppm (405 mg/m^3), VLE 200 ppm (1080 mg/m^3), carcinogen, 1999; Hungary: TWA 10 mg/m^3, STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 190 mg/m^3, 2003; Norway: TWA 20 ppm (110 mg/m^3), 1999; the Philippines: TWA 100 ppm (535 mg/m^3), 1993; Poland: MAC (TWA) 50 mg/m^3; MAC (STEL) 400 mg/m^3, 1999; Russia: TWA 50 ppm, STEL 10 mg/m^3, 1993; Sweden: NGV 10 ppm (50 mg/m^3), KTV 25 ppm (140 mg/m^3), carcinogen, 1999; Switzerland: MAK-W 50 ppm (260 mg/m^3), KZG-W 250 ppm (1300 mg/m^3), 1999; Thailand: TWA 100 ppm, STEL 200 ppm, 1993; Turkey: TWA 100 ppm (535 mg/m^3), 1993; United Kingdom: TWA 100 ppm (550 mg/m^3), STEL 150 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm. Russia has set MAC values for ambient air in residential areas of 4.0 mg/m^3 on a momentary basis and 1.0 mg/m^3 on a daily average basis. Several states have set guidelines or standards for trichloroethylene in ambient air[60] ranging from zero (North Carolina) to 0.25 μg/m^3 (Arizona) to 0.8 μg/m^3 (Michigan) to 2.43 μg/m^3 (Kansas) to 6.1 μg/m^3 (Massachusetts) to 900.0 μg/m^3 (New York) to 1350.0 μg/m^3 (Connecticut) to 2675.0 μg/m^3 (Indiana) to 2700.0 μg/m^3 (Florida and South Dakota) to 4500.0 μg/m^3 (Virginia) to 2700.0−10,800.0 μg/m^3 (North Dakota) to 6429 μg/m^3 (Nevada) to 6750 μg/m^3 (South Carolina) to 6840 μg/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method, #1022, Trichloroethylene, by portable GC. #3800; OSHA Analytical Method 1001.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.42$.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 45,000 μg/L on an acute toxicity basis. *To protect saltwater aquatic life:* 2000 μg/L on an acute toxicity basis. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 27 μg/L.[6] EPA more recently has proposed a maximum contaminant level of 5 μg/L for trichloroethylene.[48] Japan has set[35] a maximum permissible concentration in drinking water of 30 μg/L. Russia has set a limit of 60 μg/L and WHO has set 30 μg/L as a guideline.[35] Several states have set standards and guidelines for trichloroethylene in drinking water[61] ranging from 1.0 μg/L (New Jersey) to 2.8 μg/L (New Hampshire) to 3.0 μg/L (Florida) to 5.0 μg/L (California, Maine, and Colorado) to 25 μg/L (Connecticut) to 31.2 μg/L (Minnesota).

Determination in Water: Inert gas purge followed by gas chromatography with halide-specific detection (EPA Method #601) or gas chromatography plus mass spectrometry (EPA Method #624).

Routes of Entry: Inhalation percutaneous absorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure to the vapor irritates the eyes, skin, and respiratory tract. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Inhalation causes headache, sleepiness, nausea, vomiting, dizziness, and coughing have been felt around 100 ppm. Unconsciousness can result at 3000 ppm. Exposure to 8000 ppm can cause death. Can be absorbed through skin. Can cause skin irritation, burning, or redness; blistering can occur. Can cause eye irritation; burning sensation; and/or watering, and can cause permanent damage. Ingestion can cause chemical pneumonitis and diminish kidney action. It can cause drunkenness, vomiting, diarrhea, or abdominal pain. Unconsciousness, liver or kidney damage, vision distortion, and death have been reported at large doses. Exposure to TCE may affect the central nervous system causing lightheadedness, dizziness, visual disturbances; feeling of excitement; nausea, and vomiting. High levels can cause irregular heartbeat; unconsciousness, and death.

Long Term Exposure: Contact with vapor levels near 100 ppm can cause giddiness, nervous exhaustion, increased sensitivity to alcohol including redness in the face (trichloroethylene blush); the ability to become addicted to the vapor; as well as effects of acute exposure listed above. Higher levels can cause irregular heartbeat. Repeated contact with hands can cause excessive dryness, cracking, burning, loss of sense of touch, or temporary paralysis of fingers. Most of these effects seem to go away after exposure has stopped. Trichloroethylene is considered a cancer suspect agent because high levels cause liver cancer in mice. Whether it causes cancer in humans is unknown. May affect the liver and kidney.

Points of Attack: Eyes, skin, respiratory system; heart, liver, kidneys, central nervous system. Cancer site in animals: liver and kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-shift-, end-of-workweek; whole blood (chemical/metabolite), end-of-workweek, expired air, Expired Air, end-of-workweek; Expired Air, prior to next shift; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-shift at end-of-workweek; urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior to next shift. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Consider nerve conduction tests. Urinary trichloroacetic acid level (for repeated exposures) or blood trichloroethylene levels (for acute exposure). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and Silvershield™ are among the recommended materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trichloroethylene must be handled and stored away from operations which generate high temperatures, such as arc welding or cutting; unshielded resistance heating; open flames; and high-intensity ultraviolet light. It must also be handled to avoid contact with hot metals. Poisonous gases, such as phosgene, and hydrogen chloride are formed. Prevent contact of trichloroethylene with strong alkalis, such as sodium hydroxide or potassium hydroxide, because a highly flammable, toxic liquid is produced. Also prevent contact with aluminum in the presence of dilute hydrochloric acid, because a violent reaction will occur. Prevent contact with chemically active metals; powders, or shavings, such as barium, lithium, sodium, or magnesium; and titanium powders or shavings, since an explosion can occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Trichloroethylene requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including hydrogen chloride, chlorine gas, and phosgene, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. An alternative to disposal for TCE is recovery and recycling.

References

National Institute for Occupational Safety and Health. (1973). *Criteria for a Recommended Standard: Occupational Exposure to Trichloroethylene*. NIOSH Document No. 73-11025

National Institute for Occupational Safety and Health. (January 1978). *Special Occupational Hazard Review with Control Recommendations: Trichloroethylene*. NIOSH Document No. 78-130. Washington, DC

US Environmental Protection Agency. (1980). *Trichloroethylene: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (December 1979). *Status Assessment of Toxic Chemicals: Trichloroethylene*, Report EPA-600/2-79-210m. Cincinnati, OH

US Environmental Protection Agency. (April 30, 1980). *Trichloroethylene, Health and Environmental Effects Profile No. 166*. Washington, DC: Office of Solid Waste

US Public Health Service. (January 1988). *Toxicological Profile for Trichloroethylene*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 67−69 (1980), 3, No. 1, 89−94 (1953), 4, No. 3, 30−32 (1984), and 7, No. 1, 83−92 (1987)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Trichloroethylene*. Albany, NY: Bureau of Toxic Substance Assessment (Version 3)

New Jersey Department of Health and Senior Services. (January 2000). *Hazardous Substances Fact Sheet: Trichloroethylene*. Trenton, NJ

Trichloroisocyanuric acid T:0750

Molecular Formula: $C_3Cl_3N_3O_3$

Common Formula: $(ClNCO)_3$

Synonyms: ACL 85; CBD 90; Fichlor 91; FI Clor 91; Isocyanuric chloride; NSC-405124; Symclosen; Symclosene; Trichlorinated isocyanuric acid; Trichlorocyanuric acid; Trichloroisocyanic acid; 1,3,5-Trichloroisocyanuric acid; Trichloroisocyanuric acid; 1,3,5-Trichloro-1,3,5-triazinetrione; Trichloro-*s*-triazine-2,4,6 (1H,3H,5H)-trione; Trichloro-*s*-triazinetrione; 1,3,5-Trichloro-2,4,6-trioxohexahydro-*s*-triazine

CAS Registry Number: 87-90-1

RTECS®Number: XZ1925000

UN/NA & ERG Number: UN2468 (dry)/140

EC Number: 201-782-8 [*Annex I Index No.:* 613-031-00-5]

Regulatory Authority and Advisory Bodies

Cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total.

US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA 40CFR261, Appendix 8 Hazardous Constituents as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): X + CN- where X = H + or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$; Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited.

TRICHLOROISOCYANURIC ACID 87-90-1 European/International Regulations: Hazard Symbol: O, Xn, N; Risk phrases: R8; R22; R31; R36/37; R50/53; Safety phrases: S2;8; S26; S41; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Trichloroisocyanuric acid is a white crystalline solid with a chlorine odor. Molecular weight = 232.41; Freezing/Melting point = 225−230°C (with decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 2 OX.

Potential Exposure: This material is used in household bleaches and detergents.

Incompatibilities: A powerful oxidizer. Violent reaction with reducing agents; combustible materials. Trichloroisocyanuric acid can release poisonous chlorine, nitrogen oxides, and cyanides when heated to high temperatures. Contact with water may also release toxic chemicals.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 30 mg/m^3

PAC-1: 75 mg/m^3

PAC-2: 500 mg/m^3

PAC-3: 500 mg/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides, OSHA Analytical Method ID-120. See also Method #6010, Hydrogen Cyanide.[18]

Permissible Concentration in Water: In 1976 the EPA criterion was 5.0 μg/L for freshwater and marine aquatic life and wildlife. As of 1980, the criteria are: *To protect freshwater aquatic life:* 3.5 μg/L as a 24-h average, never to exceed 52.0 μg/L. *To protect saltwater aquatic life:* 30.0 μg/L on an acute toxicity basis; 2.0 μg/L on a chronic toxicity basis. *To protect human health:* 200 μg/L. The allowable daily intake for man is 8.4 mg/day.[6] On the international scene, the South African Bureau of Standards has set 10 μg/L, the World Health Organization (WHO) 10 μg/L, and Germany 50 μg/L as drinking water standards. Other international limits[35] include an EEC limit of 50 μg/L; Mexican limits of 200 μg/L in drinking water and 1.0 μg/L in coastal waters and a Swedish limit of 100 μg/L. Russia[43] set a MAC of 100 μg/L in water bodies used for domestic purposes and 50 μg/L in water for fishery purposes. The US EPA[49] has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime health advisory of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona at 160 μg/L and Kansas at 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Inhalation, ingestion, eyes, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Trichloroisocyanuric acid can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, skin, nose, throat, and air passages. Contact can cause skin or eye irritation.

Long Term Exposure: Repeated exposure may cause skin irritation. Highly irritating substances may affect the lungs, although it is not known for certain that this chemical causes lung damage.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that: lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: None listed. Following is the information for *cyanide compounds*: *Up to 25 mg/m^3:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from combustibles (such as wood, paper, and oil). Sources of ignition, such as smoking and open flames, are prohibited where trichloroisocyanuric acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: This compound requires a shipping label of "OXIDIZER." It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in

sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trichloroisocyanuric acid may burn, but does not readily ignite. Trichloroisocyanuric acid is a strong oxidizer and a dangerous fire risk on contact with combustibles (like paper, wood, and oil). Poisonous gases are produced in fire, including chorine, nitrogen oxides; and cyanides. Use dry chemical, carbon dioxide, or water spray extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Trichloroisocyanuric Acid*. Trenton, NJ

Trichloronate T:0760

Molecular Formula: $C_{10}H_{12}Cl_3O_2PS$

Common Formula: $C_6H_2(Cl_3)–O–P(S)(CH_2CH_3)OCH_2CH_3$

Synonyms: *o*-Aethyl-*o*-(2,4,5-trichlorphenyl)-aethylthionophosphonat (German); Agrisil; Agritox; Bay 37289; Bayer 37289; Bayer S 4400; Chemagro 37289; ENT 25,712; *o*-Ethyl *o*-2,4,5-trichlorophenyl ethylphosphonothioate; Ethyl trichlorophenylethylphosphonothioate; Fenophosphon; Phytosol; Stauffer N-3049; Trichloronat; 2,4,5-Trichlorophenol *o*-ester with *o*-ethyl ethylphosphonothioate; Wirkstoff 37289

CAS Registry Number: 327-98-0

RTECS® Number: TB0700000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 206-326-1 [*Annex I Index No.*: 015-098-00-0]

Regulatory Authority and Advisory Bodies

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg).

Reportable Quantity (RQ): 500 lb (227 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

US DOT 49CFR172.101, Inhalation Hazard Chemical as organic phosphate.

European/International Regulations: Hazard Symbol: T+, N; Risk phrases: R24; R28; R50/53; Safety phrases: S1/2; S23; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trichloronate is an amber-colored liquid. Molecular weight = 333.60; Boiling point = 108°C at 0.01 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Soluble in water; solubility = 50 mg/L at 20°C.

Potential Exposure: Those involved in the manufacture, formulation, or application of this nonsystemic, organophosphate insecticide which is used for the control of soil insects.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 300 mg/m^3

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 14.47908000 (ppb) (INTERMEDIATE).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Toxic effects are due to action on the nervous system. It has high oral toxicity and death can occur in acute poisonings. Delayed neurotoxicity has been reported. Symptoms of exposure include headache, dizziness, nausea, salivation, vomiting, abdominal pain, diarrhea, chest pain, decreased heart rate, excessive discharge of mucous from the air passages, difficult breathing, contraction of the pupil, blurred vision, profuse perspiration, muscle twitching and spasms, profound weakness, psychotic behavior, uncoordination, unconsciousness, rarely, convulsions. Low level absorption syndrome is similar to influenza. High dosage may cause toxic psychosis similar to alcoholism. Exposures may be misdiagnosed as asthma and heart failure. Organic phosphorus insecticides are absorbed by the skin as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision, nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also, consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

This compound requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous gases, including phosphorus oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Trichloronate*. Washington, DC: Chemical Emergency Preparedness Program

Trichlorophenols T:0770

Molecular Formula: $C_6H_3Cl_3O$
Common Formula: $HOC_6H_2Cl_3$
Synonyms: *25167-82-2:* Omal; Phenachlor; Phenol, trichloro-; Trichlorofenol (Spanish); Triclorofenol
15950-66-0: Phenol, 2,3,4-trichloro-; 2,3,4-Trichlorofenol (Spanish); 2,3,4-Trichlorophenol; Trichlorophenol, 2,3,4-
933-78-8: Phenol, 2,3,5-trichloro-; 2,3,5-Trichlorofenol (Spanish); 2,3,5-Trichlorophenol trichlorophenol, 2,3,5-
933-75-5: Phenol, 2,3,6-trichloro-; 2,3,6-Trichlorofenol (Spanish); 2,3,6-Trichlorophenol; Trichlorophenol, 2,3,6-
88-06-2: Dowicide 2S; NCI-CO2904; Omal; Phenachlor; Phenol, 2,4,6-trichloro-; 2,4,6-Trichlorfenol (Spanish); 1,3,5-Trichloro-2-hydroxybenzene; Trichlorophenol, 2,4,6-; 2,4,6-Trichlorophenos
609-19-8: Phenol, 3,4,5-trichloro-; 3,4,5-Trichlorofenol (Spanish); 3,4,5-Trichlorophenol; Trichlorophenol, 3,4,5-
CAS Registry Number: 25167-82-2 (mixed isomers); 15950-66-0 (2,3,4-); 933-78-8 (2,3,5-); 933-75-5 (2,3,6-); 95-95-4 (2,4,5-); 88-06-2 (2,4,6-); 609-19-8 (3,4,5-)
RTECS® Number: SN1400000 (2,4,5-); SN1575000 (2,4,6-); SN1650000 (3,4,5-); SN1300000 (2,3,6-)
UN/NA & ERG Number: UN2020 (solid)/153
EC Number: 246-694-0 (mixed isomers); 240-083-2 (2,3,4-); 213-272-2 (2,3,5-); 213-271-7 (2,3,6-); 202-467-8 [*Annex I Index No.:* 604-017-00-X] (2,4,5-); 201-795-9 [*Annex I Index No.:* 604-018-00-5] (2,4,6-); 210-183-0 (3,4,5-)
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC[9]: Human Inadequate Evidence, animal Sufficient Evidence, 1982, *possibly carcinogenic to humans*, Group B2, 1987; NTP: Reasonably anticipated to be a human carcinogen.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Mixed isomers-isomer:
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Reportable Quantity (RQ): 10 lb (4.54 kg).
2,3,4-; 2,3,5-; 2,3,6-; 3,4,5-isomers:
Reportable Quantity (RQ): 10 lb (4.54 kg).
2,4,5-isomer:
Carcinogenicity: IARC: Animal Limited Evidence, 1999; Human Limited Evidence, 1986.
US EPA, FIFRA 1998 Status of Pesticides: Canceled.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
US EPA Hazardous Waste Number (RCRA No.): U230.
RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 400.0 mg/L.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.18; Nonwastewater (mg/kg), 7.4.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations (*2,4,5-isomer*): Hazard Symbol: Xn, N; Risk phrases: R22; R36/38; R50/53; Safety phrases: S2; S26; S28; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class) (*2,4,5*): 3—Highly water polluting.
2,4,6-isomer:
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal Limited Evidence, 1999; Human Limited Evidence, 1986.
US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; *S. cerevisiae*—forward mutation; Negative: Mouse spot test; Histidine reversion—Ames test; Negative: *S. cerevisiae* gene conversion; *S. cerevisiae*—homozygosis.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
US EPA Hazardous Waste Number (RCRA No.): U231.
RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 2.0 mg/L.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.035; Nonwastewater (mg/kg), 7.4.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10).
Reportable Quantity (RQ): 10 lb (4.54 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical: Cancer (*2,4,6-*) 1/1/88.
European/International Regulations (*2,4,6-*): Hazard Symbol: Xn; Risk phrases: R22; R36/38; R40; Safety phrases: S2; S36/37 (see Appendix 4).

WGK (German Aquatic Hazard Class) (*2,4,6-*): No value assigned.

Description: Trichlorophenols exists as 6 isomers (2,4,5-; 3,4,5-; 2,4,6-; 2,3,4-; 2,3,5-; and 2,3,6-). The most important (heavily regulated) are the 2,4,5- and 2,4,6-isomers. The 2,4,5-isomer is white powder or needles; 2,3,5- and 2,3,6- are colorless crystals; 2,4,5- is a gray crystalline solid or flakes; 2,4,6- is a colorless to light yellow crystalline solid. They have a phenolic odor. Molecular weight = 197.44; Boiling point = 248−253°C (*2,3,5-*); 253°C (*2,3,6-*); 253°C (2,4,5-); 246°C (2,4,6-); Freezing/Melting point = 84°C (*2,3,4-*); 62°C (2,3,5-); 58°C (*2,3,6-*); 67°C (*2,4,5-*); 70°C (*2,4,6-*); Flash point = 78°C (*2,3,6-*); 61°C (*2,4,6-*). Hazard Identification (based on NFPA-704 M Rating System): (*2,4,5-; 2,4,6-*) Health 2, Flammability 1, Reactivity 0. All isomers are slightly soluble or practically insoluble in water.

Potential Exposure: Compound Description (2,4,5-): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; (2,4,6-): Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant (2,3,6-) Mutagen; Human Data. 2,4,5-TCP is used as antifungal agent in adhesives and as preservative in polyvinyl acetate emulsions. 2,4,6-T is used in manufacturing slime-control agents and as an effective germicide and preservative; to produce defoliant 2,4,5-T and related products. Also used directly as a fungicide, anti-mildew and preservative agent; algicide, bactericide. 2,4,6-TCP is used to produce 2,3,4,6-TCP and PCP. Used directly as germicide, bactericide, glue and wood preservative; and anti-mildew treatment. 2,3,6-TCP is used as intermediate in production of fungicides and plant growth regulators.

Incompatibilities: Perhaps the most notable incompatibility is the reaction of 2,4,5-trichlorophenol in alkaline medium at high temperatures to produce dioxin. (2,3,4-isomer) reacts with oxidizers, acid anhydrides, and acid chlorides. (2,3,5-isomer) Decomposes on heating, on burning, and on contact with strong oxidants, producing toxic and corrosive fumes of hydrogen chloride. The substance is a weak acid. (2,3,6-isomer); the substance is a weak acid. pH = 4.8/4.2-; (2,4,6-isomer); reacts violently with strong oxidants and is incompatible with acid chlorides and acid anhydrides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

2,3,6-

TEEL-0: 1.25 mg/m^3

PAC-1: 4 mg/m^3

PAC-2: 25 mg/m^3

PAC-3: 125 mg/m^3

2,4,5-

TEEL-0: 40 mg/m^3

PAC-1: 125 mg/m^3

PAC-2: 350 mg/m^3

PAC-3: 350 mg/m^3

2,4,6-

TEEL-0: 10 mg/m^3

PAC-1: 30 mg/m^3

PAC-2: 200 mg/m^3

PAC-3: 350 mg/m^3

DFG MAK: No numerical value established. Data may be available.

Denmark: TWA 0.5 mg/m^3, [skin] 1999 (2,4,5- and 2,3,6-isomers).

Sweden: MAC 0.5 mg/m^3; STEL 1.5 mg/m^3. Russia set a MAC of 3.0 μg/m^3 in ambient air in residential areas for the 2,4,6-isomer on a once-daily basis. Several states have set guidelines or standards for the trichlorophenols in ambient air.[60] Massachusetts has set zero for the 2,4,6-isomer and 1.6 μg/m^3 for the 2,4,5-isomer. Pennsylvania has set 3500 μg/m^3 for the 2,4,5-isomer on a 1-year exposure basis.

Determination in Air: Use NIOSH: (*o*-chlorophenol) P&CAM Method #337 (chlorophenols).

Permissible Concentration in Water: For 2,4,6-trichlorophenol, to protect freshwater aquatic life: 970 μg/L on a chronic toxicity basis. *To protect saltwater aquatic life:* no criteria developed due to insufficient data. To protect human health—for 2,4,5-TCP, 2600 μg/L; for 2,4,6-TCP, preferably zero. An additional lifetime cancer risk of 1 in 100,000 occurs at a level of 12 μg/L. These are based on organoleptic effects. A limit based on toxicological effects for 2,4,5-TCP would be 1600 μg/L.[6] Kansas[61] has set a guideline of 1.0 μg/L for the 2,4,5-isomer in drinking water. Values for the 2,4,6-isomer have been set by Kansas at 17.0 μg/L, by Minnesota at 17.5 μg/L, and by Maine at 700.0 μg/L. The WHO[35] has set a limit of 10.0 μg/L for the 2,4,6-isomer in drinking water.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604); or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact may be absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Trichlorophenols irritates the eyes, skin, and the respiratory tract. A central nervous system depressant. High exposures can cause weakness, difficulty in breathing, tremors, convulsions, coma, and possible death. See also *chlorophenols.*

2,3,5-isomer: A mixture of trichlorophenols may cause irritation of the skin, eyes, and respiratory tract. These substances may cause acute metabolic effects resulting in damage in several organs, notably the CNS. Some technical products may contain highly toxic impurities including polychlorinated dibenzo-*p*-dioxins and -furans.

For the 2,4,5-isomer[52]: irritation of the skin, eyes, nose, and pharynx; redness and edema of the skin; dermatitis, corneal injury; iritis; sweating, thirst, nausea, vomiting, diarrhea, abdominal pain; cyanosis, hyperactivity, stupor, decreased activity and motor weakness; increase followed by decrease in respiratory rate and urinary output; fever; increased bowel action; lung, liver, or kidney damage; convulsions, collapse, and coma.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis, drying, and cracking. May affect the liver and kidneys. A related chemical, *phenol*, can cause liver and kidney damage. May be carcinogenic to humans. If any of the trichlorophenols is contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, the following effects may occur: acne-like skin rash; liver damage; nervous system damage with symptoms of weakness, pain in the legs, and numbness.

Points of Attack: *Inhalation:* Human (2,4,5-): lung, thorax, or respiration; structural or functional change in trachea or bronchi; lung, thorax, or respiration: other changes. Animal tests: change in liver weight, changes in spleen weight; other changes. Cancer site in animals (2,4,6-): liver and leukemia.

Medical Surveillance: Liver and kidney function tests. Complete blood count (CBC).

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a slurry of activated charcoal in water. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool dry place or a refrigerator away from oxidizing agents and other incompatible materials listed above. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Chlorophenols, solid, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with 60−70% ethanol to avoid airborne dust, then transfer material to a sealed container. Ventilate the spill area and use absorbent dampened with 60−70% ethanol to pick up remaining material. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trichlorophenols are combustible, but are not easy to ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide, carbon dioxide, hydrogen chloride, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

US Environmental Protection Agency. (1980). *Chlorinated Phenols: Ambient Water Quality Criteria*. Washington, DC

US Environmental Protection Agency. (April 30, 1980). *2,4,6-Trichlorophenol: Health and Environmental Effects Profile No. 168*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: 2,4,6-Trichlorophenol*. Trenton, NJ

1,2,3-Trichloropropane T:0780

Molecular Formula: $C_3H_5Cl_3$
Common Formula: $CH_2ClCHClCH_2Cl$
Synonyms: AI3-26040; Allyl trichloride; Glycerol trichlorohydrin; Glyceryl trichlorohydrin; NCI-C60220; NSC 35403; Propane, 1,2,3-trichloro-; Trichlorohydrin; Trichloropropane; 1,2,3-Tricloropropano (Spanish)
CAS Registry Number: 96-18-4
RTECS® Number: TZ9275000
UN/NA & ERG Number: UN2810/153
EC Number: 202-486-1 [*Annex I Index No.:* 602-062-00-X]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, Insufficient Evidence, Group 2A, 1995; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; EPA: Likely to produce cancer in humans; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.85; Nonwastewater (mg/kg), 30.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5).

Safe Drinking Water Act: Priority List (55 FR 1470).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 10/1/92.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; R60; R20/21/22; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: 1,2,3-Trichloropropane is a colorless liquid with a strong acid odor. Molecular weight = 147.43; Specific gravity (H_2O:1) = 1.39 at 25°C; Boiling point = 156°C; Freezing/Melting point = −14°C; Flash point = 71°C (cc); Autoignition temperature = 304°C. Explosive limits: LEL = 3.2% at 120°C; UEL = 12.6% at 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Poor solubility in water; solubility = 0.1%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Trichloropropane dissolves oils, fats, waxes, chlorinated rubber, and numerous resins; it is used as a paint and varnish remover, a solvent, and a degreasing agent.

Incompatibilities: Violent decomposition with chemically active metals; strong bases. Vigorous reaction with strong oxidizers. Keep away from chlorinated rubber, resins and waxes, and sunlight.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.03 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 50 ppm/300 mg/m^3 TWA.

NIOSH REL: 10 ppm/60 mg/m^3 TWA [skin], Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/60 mg/m^3 TWA [skin] confirmed animal carcinogen with unknown relevance to humans.

NIOSH IDLH: 1000 ppm.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3
PAC-1: 30 mg/m^3
PAC-2: 50 mg/m^3
PAC-3: 100 mg/m^3

DFG MAK: [skin] Carcinogen Category 2.

Australia: TWA 10 ppm (60 mg/m^3), [skin], 1993; Austria: MAK 50 ppm (300 mg/m^3), 1999; Belgium: TWA 10 ppm (60 mg/m^3), [skin], 1993; Denmark: TWA 10 ppm (60 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (300 mg/m^3), STEL 75 ppm (450 mg/m^3), 1999; Norway: TWA 10 ppm (60 mg/m^3), 1999; the Netherlands: MAC-TGG 0.108 mg/m^3, [skin], 2003; Russia: STEL 2 mg/m^3, 1993; Switzerland: carcinogen, 1999; United Kingdom: TWA 50 ppm (306 mg/m^3), STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea; New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans.

Russia[43] set a MAC of 0.05 mg/m^3 for ambient air in residential areas on a daily average basis. Several states have set guidelines or standards for 1,2,3-trichloropropane in ambient air[60] ranging from 3.0–4.5 mg/m^3 (North Dakota) to 5.0 mg/m^3 (Virginia) to 6.0 mg/m^3 (Connecticut) to 7.143 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated; OSHA Analytical Method 7.[18]

Permissible Concentration in Water: Russia[43] has set 0.07 mg/L as a MAC in water bodies used for domestic purposes.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 2.27$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Trichloropropane is highly toxic by inhalation and moderately toxic by skin absorption. It is a local irritant and produces a number of unpleasant sensory effects; irritates the eyes, skin, and respiratory tract. Humans exposed to trichloropropane at 100 ppm found this to be an objectionable level of exposure, and all reported eye and throat irritation as well as an unpleasant odor. Also, according to NIOSH, skin irritation, central nervous system depression, and liver injury may result. Exposure to high concentrations may result in unconsciousness.

Long Term Exposure: Repeated contact can cause dermatitis; drying and cracking of the skin. May affect the heart and damage the liver. Although this chemical has not been adequately evaluated for brain and disturbed sleep, many solvents and petroleum-based products can cause these effects. Symptoms of exposure can include reduced memory, reduced ability to concentrate, personality changes, fatigue, sleep disturbances, reduced coordination, weakness, and/or feeling of "pins and needles" in extremities. A potential occupational carcinogen.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys. Cancer site in animals: forestomach, liver, and mammary glands.

Medical Surveillance: NIOSH lists the following tests: Expired Air. Liver function tests; EKG, evaluation for brain effects and psychological changes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and PVC are among the recommended materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a refrigerator or a cool, dry place and keep away from chemically active metals, oxidizers, strong caustics. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Toxic, liquids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." 1,2,3-Trichloropropane falls in DOT Hazard Class 6.1 and Parking Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal

environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosgene, carbon monoxide, chlorine, and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

National Institute for Occupational Safety and Health. (1977). *Profiles on Occupational Hazards for Criteria Document Priorities*, Report PB-274,073. Cincinnati, OH, pp. 289−291

US Environmental Protection Agency. (April 30, 1980). *1,2,3-Trichloropropane: Health and Environmental Effects Profile No. 169*. Washington, DC: Office of Solid Waste

New Jersey Department of Health and Senior Services. (May 1999). *Hazardous Substances Fact Sheet: 1,2,3-Trichloropropane*. Trenton, NJ

1,1,2-Trichloro-1,2,2-trifluoroethane T:0790

Molecular Formula: $C_2Cl_3F_3$

Common Formula: CCl_2FCClF_2

Synonyms: Arcton 63; Arklone P; Asahifron 113; Daiflon S 3; Distillex DS5; Ethane, 1,1,2-trichloro-1,2,2,-trifluoro-; F 113; FC 113; Fluorocarbon 113; Forane 113; Freon 113TR-T; Freon TF; Frigen 113; Frigen 113A; Frigen 113TR; Frigen 113TR-N; Frigen 113TR-T; Genesolv D solvent; Genetron 113; Isceon 113; Kaiser chemicals 11; Khladon 113; Ledon 113; MS-180 freon TF solvent; R 113; Refrigerant 113; Refrigerant R 113; 1,1,2-Trichloro-1,2,2-trifluoroethane; 1,1,2-Trichlorotrifluoroethane; 1,1,2-Triclorofluoetano (Spanish); 1,1,2-Trifluoro-1,2,2-trichloroethane; 1,1,2-Trifluorotrichloro ethane

CAS Registry Number: 76-13-1

RTECS® Number: KJ4000000

UN/NA & ERG Number: UN3082/171

EC Number: 200-936-1

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 0.8.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 30.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: TTE is a colorless liquid with an odor like carbon tetrachloride at high concentrations. A gas above 48°C. The odor threshold is 45−68 ppm. Molecular weight = 187.37; Specific gravity (H_2O:1) = 1.56 at 25°C; Boiling point = 48°C; Freezing/Melting point = −36°C; Vapor pressure = 285 mmHg at 25°C. Noncombustible liquid at ordinary temperatures, but the gas will ignite and burn weakly at 680°C (autoignition temperature). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: Compound Description: Drug; Reproductive Effector; Human Data; Primary Irritant. TTE is used as a solvent and refrigerant; it is used in fire extinguishers; as a blowing agent and as an intermediate in the production of chlorotrifluoroethylene monomer by reaction with zinc.

Incompatibilities: Violent reaction with chemically active metals (such as powdered aluminum, beryllium, magnesium, and zinc); calcium. Contact with alloys containing more than 2% Mg causes decomposition releasing hydrogen chloride, hydrogen fluoride, and carbon monoxide.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.67 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/7600 mg/m^3 TWA.

NIOSH REL: 1000 ppm/7600 mg/m^3 TWA; 1250 ppm/9500 mg/m^3 STEL.

ACGIH TLV®[1]: 1000 ppm/7670 mg/m^3 TWA; 1250 ppm/9590 mg/m^3 STEL, not classifiable as a human carcinogen.

NIOSH IDLH: 2000 ppm.

Protective Action Criteria (PAC)
TEEL-0: 1000 ppm
PAC-1: 1250 ppm
PAC-2: 1500 ppm
PAC-3: 2000 ppm

DFG MAK: 500 ppm/3900 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Australia: TWA 1000 ppm (7600 mg/m^3), STEL 1250 ppm, 1993; Austria: MAK 500 ppm (3800 mg/m^3), 1999; Belgium: TWA 1000 ppm (7670 mg/m^3), STEL 1250 ppm, 1993; Denmark: TWA 500 ppm (3800 mg/m^3), 1999; Finland: TWA 1000 ppm (7600 mg/m^3), STEL 1250 ppm, 1999; France: VME 1000 ppm (7600 mg/m^3), VLE 1250 ppm, 1999; Hungary: STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 1170 mg/m^3, 2003; Norway: TWA 500 ppm (3800 mg/m^3), 1999; the Philippines: TWA 1000 ppm (7600 mg/m^3), 1993; Russia: TWA 500 ppm, STEL 5000 mg/m^3, 1993; Sweden: NGV 500 ppm (4000 mg/m^3), KTV 750 ppm (6000 mg/m^3), 1999; Switzerland: MAK-W 500 ppm (3800 mg/m^3), 1999; Turkey: TWA 1000 ppm (7600 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (7790 mg/m^3), STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 1250 ppm. Several states have set guidelines or standards for TTE in ambient air[60] ranging from 0.152 mg/m^3 (Connecticut) to 0.225 mg/m^3 (Indiana) to 76.0-95.0 mg/m^3 (North Dakota) to 180.952 mg/m^3 (Nevada) to 950.0 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1020, 1,1,2-Trichloro-1,2,2-trifluoroethane, #2549, Volatile organic compound; OSHA Analytical Method 113.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.30$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes and respiratory tract. May be a central nervous system depressant in high concentrations, causing headache, dizziness, loss of coordination, and unconsciousness; asphyxiation can result. *Inhalation:* No effects may be felt below 1000 ppm. Irregular heartbeat (arrhythmia) can occur at levels above 2000 ppm; may cause unconsciousness and possible death. Levels above 2500 ppm may cause loss of concentration, tiredness, and a feeling of heaviness of the head. Levels above 200,000 ppm may cause irritation of the nose and lungs, tremors, and coma. *Ingestion:* No information is available on human ingestion. However, animal studies show that Freon 113 causes unresponsiveness, facial swelling, diarrhea, and bleeding lungs. *Skin:* May cause irritation and frostbite if TTE is cold from refrigeration.

Long Term Exposure: Skin contact can cause dermatitis, drying, and cracking. Can accumulate in brain and kidneys from exposure below 2000 ppm. Will generally not produce noticeable effects at this level and may pass from the body within a week after exposure stops.

Points of Attack: Skin, heart, central nervous system, cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24-h EKG (Holter monitor) to look for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2000 ppm:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. 1,1,2-Trichloro-1,2,2-trifluoroethane must be stored to avoid contact with chemically active metals, such as calcium, powdered aluminum, zinc, magnesium, and beryllium because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: The name of this material is not in the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, liquid, n.o.s. It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,1,2-Trichloro-1,2,2-trifluoroethane itself does not easily burn. Extinguish fire using agent suitable for type of surrounding fire. The gas will ignite and burn weakly when exposed to high heat or flame. Poisonous gases, including carbonyl fluoride, chlorine, hydrogen chloride, hydrogen fluoride, and phosgene, are produced in fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Trichlorotrifluoroethane*. Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 3, 91−93

New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: 1,1,2-Trichloro-1,2,2-Trifluoroethane*. Trenton, NJ

Tricresyl phosphates T:0800

Molecular Formula: $C_{21}H_{21}O_4P$

Common Formula: $(CH_3C_6H_4O)_3PO$

Synonyms: *o*-Cresyl phosphate; Fosfito de tricresilo (Spanish); Phosflex 179-C; Phosphoric acid, tri-*o*-cresyl ester; Phosphoric acid, tris(methyl phenyl) ester; TCP; TOCP; TOFK; *o*-Tolyl phosphate; TPTP; Tri-*o*-cresyl ester of phosphoric acid; *o*-Tricresyl phosphate; Tri-*o*-cresyl phosphate; Tricresyl phosphate, *o*-; *o*-Trikresylphosphat (German); Tri-2-methylphenyl phosphate; Tris(*o*-cresyl) phosphate; Tris(*o*-methylphenyl) phosphate; Tri-*o*-tolyl phosphate; Tri-2-tolyl phosphate

CAS Registry Number: 78-30-8 (*o*-isomer); 563-04-2 (*m*-isomer); 78-32-0 (*p*-isomer); 1330-78-5 (mixed isomers)

RTECS® Number: TD0350000

UN/NA & ERG Number: UN2574/151

EC Number: 201-103-5 [*Annex I Index No.:* 015-015-00-8] (*o*-isomer); 209-241-8 (*m*-isomer); 201-105-6 [*Annex I Index No.:* 015-016-00-3] (*p*-isomer); 215-548-8 (mixed isomers or tris(methylphenyl) phosphate)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations (*o-o-o; o-o-m; o-o-p; o-m-m; o-m-p; o-p-p*): Hazard Symbol: T, N; Risk phrases: R39; R23/24/25; R51/53; Safety phrases: S1/2; S20/21; S28; S45; S6; (*m-m-m; m-m-p; m-p-p; p-p-p*) Hazard Symbol: Xn, N; Risk phrases: R21/2251/53; Safety phrases: S2; S28; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned (*all isomers*).

Description: Tricresyl phosphates are available as the *o*-isomer (TOCP), the *m*-isomer (TMCP), and *p*-isomer (TPCP). The ortho-isomer is the most toxic of the three; the meta- and para-isomers are relatively inactive. The commercial product may contain the *ortho*-isomer as a contaminant unless special precautions are taken during manufacture. Pure tri-*para*-cresyl phosphate is a solid, and ortho- and meta- are liquids (see below). The *tri-o-cresyl phosphate* will be discussed here as the specific example of these compounds because it is the most toxic of the tricresyl phosphates and specifically regulated by OSHA. TOCP is a colorless to pale yellow, odorless liquid or solid (below 52°F/11°C). Molecular weight = 368.39; Specific gravity (H_2O:1) = 1.20 at 25°C; Boiling point = 410°C (with decomposition); Freezing/Melting point = 11°C; Vapor pressure = 0.00002 mmHg at 25°C; Flash point = 110−225°C; Autoignition temperature = 385°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Mutagen; Reproductive Effector. Tricresyl phosphate is used as an additive in hydraulic fluids; as a plasticizer, pigment dispersant, flame retardant; as a plasticizer for chlorinated rubber, vinyl plastics, polystyrene, polyacrylic and polymethacrylic esters; as an adjuvant in milling of pigment pastes; as a solvent and as a binder in nitrocellulose and various natural resins; and as an additive to synthetic lubricants and gasoline. It is also used in the recovery of phenol in coke-oven wastewaters.

Incompatibilities: Contact with magnesium may cause explosion. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg/m^3 TWA.

NIOSH REL: 0.1 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin], not classifiable as a human carcinogen; BEI_A issued for acetylcholinesterase-inhibiting pesticides.

NIOSH IDLH: 40 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 0.3 ppm

PAC-2: 0.6 ppm

PAC-3: 40 ppm

Australia: TWA 0.1 mg/m^3, [skin], 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, [skin], 1999; France: VME 0.1 mg/m^3, [skin], 1999; Hungary: TWA 0.1 mg/m^3, STEL 0.2 mg/m^3, [skin], 1993; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; the Philippines: TWA 0.1 mg/m^3, 1993; Poland: MAC (TWA) 0.1 mg/m^3; MAC (STEL) 0.3 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, 1999; United Kingdom: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for the compound in ambient air[60] ranging from 1.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Connecticut and Nevada) to 160.0 μg/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) #5037, Triorthocresyl phosphate.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact. The widespread epidemics of poisoning that have occurred have been due to ingested ortho-isomer as a contaminant of foodstuffs. Experimental human studies with labeled phosphorus derivatives show that only 0.4% of the applied dose was absorbed.

Harmful Effects and Symptoms

Short Term Exposure: May affect the central and peripheral nervous systems, causing impaired functions (paralysis). Exposure above exposure limits may cause permanent paralysis. The major effects from inhaling, swallowing, or absorbing tricresyl phosphate through the skin are on the spinal cord and peripheral nervous system; the poison attacking the anterior horn cells and pyramidal tract as well as the peripheral nerves. Gastrointestinal symptoms on acute exposure (nausea, vomiting, diarrhea, and abdominal pain) are followed by a latent period of 3−30 days with the progressive development of muscle soreness and numbness of fingers, calf muscles, and toes; with foot and wrist drop. In chronic intoxication, the gastrointestinal symptoms pass unnoticed, and after a long latent period, flaccid paralysis of limb and leg muscles appears. There are minor sensory changes and no loss of sphincter control.

Long Term Exposure: May affect the nervous system, causing peripheral neuropathy, cramps in calves, paresthesia in feet or hands, weakness in the feet, wrist drop, muscular paralysis.

Points of Attack: Peripheral nervous system, central nervous system.

Medical Surveillance: Preplacement and periodic examinations should include evaluation of spinal cord and neuromuscular function, especially in the extremities; and a history of exposure to other organophosphate esters, pesticides, or neurotoxic agents. Periodic cholinesterase determination may relate to exposure, but not necessarily to neuromuscular effect.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton™, polyvinyl chloride, Nitrile + PVC, butyl rubber, and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *0.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *1 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *40 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place away from oxidizing materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Tricresyl phosphate with >3% ortho-isomer requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: *Solid* (below 52°F/11°C): Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 73−75 (1982) and 2, No. 3, 83−84 (1982)

New Jersey Department of Health and Senior Services. (February 2007). *Hazardous Substances Fact Sheet: Tricresylphosphate (mixed isomers)*. Trenton, NJ

Triethylamine T:0810

Molecular Formula: $C_6H_{15}N$
Common Formula: $(C_2H_5)_3N$
Synonyms: (Diethylamino)ethane; *N,N*-Diethylethaneamine; Ethanamine, *N,N*-diethyl-; TEA; TEN; Triaethylamin (German); Trietilamina (Spanish)
CAS Registry Number: 121-44-8
RTECS® Number: YE0175000
UN/NA & ERG Number: UN1296/132
EC Number: 204-469-4 [*Annex I Index No.:* 612-004-00-5]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): U404.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: F, C; Risk phrases: R11; R20/21/22; R35; Safety phrases: S1/2; S3; S16; S26; S29; S36/37/39; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Triethylamine is a colorless liquid with a strong ammonia-like odor. The odor threshold is 0.48 ppm. Molecular weight = 101.22; Specific gravity (H_2O:1) = 0.73 at 25°C; Boiling point = 89°C; Freezing/Melting point = –115°C; Vapor pressure = 54 mmHg at 25°C; Flash point = −7°C; Autoignition temperature = 249°C; also listed at 230°C. Explosive limits: LEL = 1.2%; UEL = 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Triethylamine is used as a solvent; corrosion inhibitor; in chemical synthesis; and accelerator activators; paint remover; base in methylene chloride or other chlorinated solvents. TEA is used to solubilize 2,4,5-T in water and serves as a selective extractant in the purification of antibiotics. It is used to manufacture quaternary ammonia compounds and octadecyloxymethyltriethylammonium chloride; an agent used in textile treatment.

Incompatibilities: A strong base. Violent reaction with strong acids, halogenated compounds, and strong oxidizers. Attacks some forms of plastics, rubber, and coatings. Corrosive to aluminum, zinc, copper, and their alloys in the presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.14 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 25 ppm/100 mg/m^3 TWA.

NIOSH REL: No established REL; See *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV®[1]: 1 ppm/4.1 mg/m^3 TWA; 3 ppm/12.4 mg/m^3 STEL, not classifiable as a human carcinogen [skin].

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 3 ppm
PAC-2: 3 ppm
PAC-3: 200 ppm

DFG MAK: 1 ppm/4.2 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Europe OEL: 2 ppm/8.4 mg/m^3 TWA; 3 ppm/12.6 mg/m^3 STEL [skin] 2002.

Australia: TWA 10 ppm (40 mg/m^3), STEL 15 ppm, 1993; Austria: MAK 2.5 ppm (10 mg/m^3), 1999; Belgium: TWA 10 ppm (41 mg/m^3), STEL 15 ppm, 1993; Denmark: TWA 10 ppm (40 mg/m^3), 1999; Finland: TWA 10 mg/m^3, STEL 20 mg/m^3, [skin], 1999; France: VLE 10 ppm (40 mg/m^3), 1999; Hungary: TWA 20 mg/m^3, STEL 40 mg/m^3, 1993; the Netherlands: MAC-TGG 20 mg/m^3, [skin], 2003; Norway: TWA 10 ppm (40 mg/m^3), 1999; the Philippines: TWA 25 ppm (100 mg/m^3), 1993; Russia: STEL 10 mg/m^3, [skin], 1993; Sweden: NGV 2 ppm (8 mg/m^3), KTV 10 ppm (40 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (40 mg/m^3), KZG-W 20 ppm (80 mg/m^3), 1999; Turkey: TWA 25 ppm (100 mg/m^3), 1993; United Kingdom: TWA 10 ppm (42 mg/m^3), STEL 15 ppm (63 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 3 ppm [skin]. Russia[43] set a MAC of 0.14 mg/m^3 in ambient air of residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for triethylamine in ambient air[60] ranging from 5.6 μg/m^3 (Massachusetts) to 20.0−200.0 μg/m^3 (Rhode Island) to 400.0−600.0 μg/m^3 (North Dakota) to 660.0 μg/m^3 (Virginia) to 800.0 μg/m^3 (Connecticut) to 952.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (II-3) #S-152, OSHA Analytical Method PV2060.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.45.

Permissible Concentration in Water: Russia[43] set a MAC of 2.0 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin absorption, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Triethylamine can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe eye damage. Breathing the vapor can irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. A central nervous system depressant.

Long Term Exposure: Can irritate the lungs; repeated exposures may cause bronchitis to develop. May cause skin allergy. May damage the kidneys and liver. Similar compounds can cause an asthma-like allergy to develop. Once allergy develops, even very small future exposures can cause wheezing, chest tightness, and shortness of breath. In animals: myocardial, kidney, liver damage.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests; liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; examination of the eyes and vision; evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, Viton™, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Provide: eyewash (>1%), quick drench (>1%).

Respirator Selection: OSHA: *200 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Triethylamine must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) or oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where triethylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of triethylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of triethylamine.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including nitrogen oxides and carbon monoxide, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

US Environmental Protection Agency. (April 1, 1978). *Chemical Hazard Information Profile: Ethylamines*. Washington, DC

Sax, N. I. (Ed.). (1983). *Dangerous Properties of Industrial Materials Report*, 3, No. 6, 81−83

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Triethylamine*. Trenton, NJ

Trifluorobromomethane T:0820

Molecular Formula: $CBrF_3$

Synonyms: Bromofluroform; Bromotrifluormetano (Spanish); Bromotrifluoromethane; Carbon monobromide trifluoride; F 13 B1; FC 13 B1; Flugex 13 B1; Fluorocarbon 1301; Freon 13 B1; Halon 1301; Methane, bromotrifluoro-; R 13 B1; Refrigerant 1301; Trifluoromethyl bromide; Trifluoromonobromomethane

CAS Registry Number: 75-63-8

RTECS® Number: PA5425000

UN/NA & ERG Number: UN1009/126

EC Number: 200-887-6

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 10.0.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Trifluorobromomethane is a colorless gas with a slight ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 148.92; Specific gravity (H_2O:1) = 1.50 at 25°C; Boiling point = −58°C; Freezing/Melting point = −166°C. Slightly soluble in water; solubility = 0.03%.

Potential Exposure: Compound Description: Human Data. This material is used as a fire extinguishing agent, a chemical intermediate, and as a refrigerant.

Incompatibilities: Chemically active metals, such as calcium, powdered aluminum, zinc, magnesium. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.09 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 1000 ppm/6100 mg/m^3 TWA.

NIOSH REL: 1000 ppm/6100 mg/m^3 TWA.

ACGIH TLV®[1]: 1000 ppm/6090 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 1000 ppm

PAC-1: 3500 ppm

PAC-2: 25,000 ppm

PAC-3: 40,000 ppm

DFG MAK: 1000 ppm/6200 mg/m^3 TWA; Peak limitation Category II(8); Pregnancy Group C.

NIOSH IDLH: 40,000 ppm.

Australia: TWA 1000 ppm (6100 mg/m^3), 1993; Austria: MAK 1000 ppm (6100 mg/m^3), 1999; Belgium: TWA 1000 ppm (6090 mg/m^3), 1993; Denmark: TWA 1000 ppm (6100 mg/m^3), 1999; Finland: TWA 1000 ppm (6100 mg/m^3), STEL 1250 ppm (7625 mg/m^3), 1999; France: VME 1000 ppm (6100 mg/m^3), 1999; the Netherlands: MAC-TGG 6100 mg/m^3, 2003; the Philippines: TWA 1000 ppm (6100 mg/m^3), 1993; Russia: STEL 3000 mg/m^3, 1993; Switzerland: MAK-W 1000 ppm (6100 mg/m^3), 1999; Turkey: TWA 1000 ppm (6100 mg/m^3), 1993; United Kingdom: TWA 1000 ppm (6190 mg/m^3), STEL 1200 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1000 ppm. Several states have set guidelines or standards for this compound in ambient air[60] ranging from 61.0 mg/m^3 (North Dakota) to 100 mg/m^3 (Virginia) to 122 mg/m^3 (Connecticut) to 145.238 mg/m^3 (Nevada).

Determination in Air: Absorption on charcoal, workup with methylene chloride; analysis by gas chromatography.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.86.

Routes of Entry: Inhalation, eye and/or skin contact with the liquid.

Harmful Effects and Symptoms

Short Term Exposure: Trifluorobromomethane can affect you when breathed in. Irritates the eyes. Contact with the liquid may cause frostbite. Exposure can cause CNS depression, causing lightheadedness and trouble concentrating. Breathing high concentrations of the vapor may cause the heart to beat irregularly or to stop.

Long Term Exposure: Unknown at this time. However, some related chemicals are known to cause liver damage with high or repeated exposure.

Points of Attack: Central nervous system, heart.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: A special 24-h EKG (Holter monitor) to look for irregular heartbeat; consider liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10,000 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 25,000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 40,000 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Trifluorobromomethane must be stored to avoid contact with chemically active metals (such as calcium, powdered aluminum, zinc, and magnesium) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: This compound requires a shipping label of "NONFLAMMABLE GAS." It falls in Hazard Class 2.2.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Poisonous gases, including phosgene, hydrogen bromide, and hydrogen fluoride, are produced in fire. Extinguish fire using an agent suitable for type of surrounding fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

New Jersey Department of Health and Senior Services. (June 2006). *Hazardous Substances Fact Sheet: Trifluorobromomethane*. Trenton, NJ

Trifluoroethane T:0830

Molecular Formula: $C_2H_3F_3$

Synonyms: *1,1,1-isomer:* Ethane, 1,1,1-trifluoro-; FC143A; Fluorocarbon FC143A; Methylfluoroform; R 143A; 1,1,1-Trifluoroethane; 1,1,1-Trifluoroform

1,1,2-isomer: Ethane, 1,1,2-trifluoro-; R 143

CAS Registry Number: 420-46-2 (1,1,1-isomer); 430-66-0 (1,1,2-isomer); 27987-06-0 (mixed isomers)

RTECS® Number: KJ4100000 (trifluoroethane); KJ4110000 (1,1,1-isomer)

UN/NA & ERG Number: UN2035 (1,1,1-Trifluoroethane, compressed or Refrigerant gas, R 143)/115

EC Number: 206-996-5 (1,1,1-isomer); 207-066-1 (1,1,2-isomer); 248-764-6 (mixed isomers)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*CAS: 420-46-2*).

Description: 1,1,1-Trifluoroethane is a colorless gas or a liquid under pressure. Molecular weight = 84.05; Boiling point = −111°C.

Potential Exposure: The 1,1,1-isomer is used to make other chemicals and may be used as a refrigerant.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

AIHA WEEL: 1000 ppm TWA, as 1,1,1-Trifluoroethane.

Russia: The 1,1,1-isomer has a MAC of 3000 mg/m^3 in work-place air.[43]

No TEEL available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Trifluoroethane can affect you when breathed in. Inhalation may cause central nervous system depression. Higher levels may cause dizziness, lightheadedness, unconsciousness, and asphyxiation. Contact with the liquid may cause frostbite. Exposure may cause cardiac arrhythmia (irregular heartbeat).

Long Term Exposure: No chronic health effects are known at this time.

Points of Attack: Heart, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24-h EKG to look for irregular heartbeats). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquids, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues.

Respirator Selection: Where there is potential for exposure to trifluoroethane, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Outdoor or detached storage is recommended. Sources of ignition, such as smoking and open flames, are prohibited where trifluoroethane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trifluoroethane is a flammable gas. Use dry chemical, CO_2, water spray, or foam extinguishers. Use water spray to keep fire-exposed containers cool. Poisonous gases, including hydrogen fluoride, are produced in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (March 1987). *Hazardous Substances Fact Sheet: Trifluoroethane*. Trenton, NJ

Trifluralin T:0840

Molecular Formula: $C_{10}H_9F_3N_3O_4$

Common Formula: $C_3H_7N{-}C_6H_2(NO_2)_2CF_3$

Synonyms: Agreflan; Agriflan 24; Autumn kite; Benzenamine, 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl-); Benzeneamine, 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethylaniline); Campbell's trifluron; Chandor; Crisalin; Devrinol T; Digermin; 2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)aniline; 2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine; 2,6-Dinitro-*N*,*N*-di-*N*-propyl-α,α,α-trifluro-*p*-toluidine; 2,6-Dinitro-4-trifluormethyl-*N*,*N*-dipropylanilin (German); 4-(Di-*N*-propylamino)-3,5-dinitro-1-trifluoromethylbenzene; *N*, *N*-Di-*N*-propyl-2,6-dinitro-4-trifluoromethylaniline; *N*,*N*-Dipropyl-4-trifluoromethyl-2,6-dinitroaniline; Elancolan; Ethane, trifluoro-; Flint; Ipersan; Janus; L-36352; Lilly 36,352; Linnet; Marksman; Marksman 2, Trigard; M.T.F; NCI-C00442; Nitran; Olitref; Onslaught; Sinflowan; Solo; Su seguro carpidor; Synfloran; *p*-Toluidine, α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-; Trefanocide; Treficon; Treflan®; Treflanocide elancolan; Trifarmon; α,α,α-Trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine; Trifluralina (Spanish); Trifluralina 600; Trifluraline; Triflurex; Trifurex; Trigard; Trikepin; Trilin; Trilin 10G; Trim; Trimaran; Tripart Trifluralin 48 EC; Tristar®

CAS Registry Number: 1582-09-8; *(alt.)* 39300-53-3; *(alt.)* 52627-52-8; *(alt.)* 61373-95-3; *(alt.)* 75635-23-3

RTECS® Number: XU9275000

UN/NA & ERG Number: UN2588/151

EC Number: 216-428-8 [*Annex I Index No.:* 609-046-00-1]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1991; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat; EPA: Possible Human Carcinogen.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

US EPA Gene-Tox Program, Positive: *N. crassa—aneuploidy*; Weakly Positive: *S. cerevisiae*—homozygosis; Positive/limited: Carcinogenicity—mouse/rat; Negative: *D. melanogaster* sex-linked lethal; Negative: *In vitro* UDS—human fibroblast; TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli* polA without S9.

Banned or Severely Restricted (in US) (UN).[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Safe Drinking Water Act: Priority List (55 FR 1470).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations (*containing <0.5 ppm NPDA*): Hazard Symbol: Xi; Risk phrases: R36; R43; Safety phrases: S2; S24; S37 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Trifluralin is an orange crystalline solid. Molecular weight = 335.32; Boiling point = 139°C; Freezing/Melting point = 49°C; Vapor pressure = 0.0001 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector.

Those involved in the manufacture, formulation, and application of this selective preemergence herbicide.

Incompatibilities: Store in temperatures above 4.4°C. Fluorocarbons can react violently with barium, potassium, sodium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 40 mg/m^3
PAC-1: 125 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 150 mg/m^3

The state of Pennsylvania has set a guideline of 1150 μg/m^3 for trifluralin in ambient air.[60]

Permissible Concentration in Water: EPA has set a lifetime health advisory of 2.0 μg/L. The state of Maine has set a guideline of 200.0 μg/L for drinking water.[61]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 5.07$. Fish Tox = 1.57645000 ppb MATC (HIGH).

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Inhalation can cause irritation of the respiratory tract with cough, phlegm, and/or tightness in the chest. The vapor can cause eye and skin irritation. Skin contact can cause irritation and rash which can be exacerbated by sunlight. The majority of reported trifluralin exposure cases were occupational in nature. Other reported symptoms include respiratory involvement, abdominal cramps, nausea, diarrhea, headache, lethargy, and paresthesia following dermal or inhalation exposure.

Long Term Exposure: May cause skin sensitization. High or repeated exposure may affect the liver and kidneys and/or cause anemia. There is some dispute about the actual carcinogenic effect of trifluralin. NCI[9] reports clear evidence of carcinogenicity in mice but not in rats. Some authorities feel that dipropyl nitrosamine formed in trifluralin manufacture and contained in the technical material might be the actual culprit, and the purified trifluralin might not have this problem. Human Tox = 5.00000 ppb (HIGH).

Points of Attack: Skin, eyes, liver, kidneys, blood.

Medical Surveillance: Kidney and liver function tests. Complete blood count (CBC).

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place and protect from prolonged exposure to light.

Shipping: Trifluralin, an organofluorine, can be classed as Pesticides, solid, toxic, n.o.s., which require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 8000.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxide and hydrogen fluoride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Trifluralin does contain fluorine, and therefore incineration presents the increased hazard of HF in the off-gases. Prior to incineration, fluorine-containing compounds should be mixed with slaked lime plus vermiculite, sodium carbonate, or sand-soda ash mixture (90-10).

References

Sax, N. I. (Ed.). (1980). *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 70−71

US Environmental Protection Agency. (August 1987). *Health Advisory: Trifluralin*. Washington, DC: Office of Drinking Water

Triisobutyl aluminum

See entry under "Aluminum alkyls."

Trimellitic anhydride T:0850

Molecular Formula: $C_9H_4O_5$

Synonyms: Anhydrotrimellic acid; 1,2,4-Benzenetricarboxylic acid anhydride; 1,2,4-Benzenetricarboxylic acid, cyclic 1,2-anhydride; 1,2,4-Benzenetricarboxylic anhydride; 4-Carboxyphthalic anhydride; 1,3-Dihydro-1,3-dioxo-5-isobenzofurancarboxylic acid; 1,3-Dioxo-5-phthalancarboxylic acid; Diphenylmethane-4,4′-diisocyanate-trimellic anhydride-ethomid HT polymer; NCI-C56633; TMA; TMAN; Trimellic acid anhydride; Trimellitic acid cyclic-1,2-anhydride

CAS Registry Number: 552-30-7

RTECS® Number: DC2050000

EC Number: 209-008-0 [*Annex I Index No.:* 607-097-00-4]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: Xn; Risk phrases: R37; R41; R42/43; Safety phrases: S2; S22; S26; S36/37/39 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trimellitic anhydride is a crystalline solid. It is the anhydride of trimellitic acid (1,2,4-benzenetricarboxylic acid). Molecular weight = 192.13; Boiling point = 245°C; Freezing/Melting point = 166.7°C; Vapor pressure = 0.000004 mmHg; Flash point = 227°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1₩. Highly soluble; reacts with water.

Potential Exposure: Compound Description: Drug. TMA is used to produce trimellitate plasticizers, poly (amide-imide) polymers; in paints, enamels, and coatings; polymers, polyesters; as a curing agent for epoxy and other resins; in vinyl plasticizers; agricultural chemicals; dyes and pigments; pharmaceuticals, surface active agents; modifiers, intermediates, and specialty chemicals.

Incompatibilities: Dust can cause an explosion. Violent reaction with strong oxidizers. Reacts slowly with water, forming trimellitic acid.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.86 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 0.005 ppm/0.04 mg/m^3 TWA, Should be handled in the workplace as an extremely toxic substance.

ACGIH TLV®[1]: 0.0005 mg/m^3 measured as inhalable fraction and vapor TWA; 0.002 mg/m^3 measured as inhalable fraction and vapor Ceiling Concentration; [skin]; danger of sensitization.

DFG MAK: 0.04 mg/m^3 TWA; Peak Limitation Category I (1); danger of sensitization of the airways.

Australia: TWA 0.005 ppm (0.04 mg/m^3), 1993; Austria: MAK 0.005 ppm (0.04 mg/m^3), 1999; Belgium: TWA 0.005 ppm (0.059 mg/m^3), 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: TWA 0.005 ppm, 1999; Norway: TWA 0.005 ppm (0.04 mg/m^3), 1999; Russia: STEL 0.1 mg/m^3, 1993; Sweden: NGV 0.04 mg/m^3, TGV 0.08 mg/m^3, 1999; Switzerland: MAK-W 0.005 ppm (0.04 mg/m^3), KZG-W 0.01 ppm (0.08 mg/m^3), 1999; United Kingdom: TWA 0.04 mg/m^3, STEL 0.12 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.04 mg/m^3. Several states have set guidelines or standards for trimellitic anhydride in ambient air[60] ranging from 0.4 μg/m^3 (North Dakota) to 0.7 μg/m^3 (Virginia) to 0.8 μg/m^3 (Connecticut) to 1.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5036, Trimellitic anhydride, OSHA Analytical Method 98.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Trimellitic anhydride can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. High exposure may cause runny nose, cough, wheezing and shortness of breath, malaise (vague feeling of discomfort), fever, muscle aches. "TMA-flu" with symptoms of cough, chills, shortness of breath, body aches, weakness, and coughing up blood may be delayed for 4−12 h following overexposure. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated inhalation exposure may cause asthma which may be delayed and is aggravated by physical activity. Allergic asthma occurs sometimes weeks or months after exposure. Trimellitic anhydride can also cause "Pulmonary Disease-Anemia Syndrome" with low blood count, and different lung changes.

Points of Attack: Eyes, skin, respiratory system, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function test—these may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: special tests for trimellitic anhydride allergy (IgE antibodies against TM-HAS). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.005 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid (no flash point can be found in the literature). Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (February 3, 1978). *Trimellitic Anhydride (TMA)*, Current Intelligence Bulletin No. 21. Washington, DC

US Environmental Protection Agency. (March 3, 1978). *Chemical Hazard Information Profile: Trimellitic Anhydride*. Washington, DC

Sax, N. I. (Ed.). (1985). *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 30−31

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Trimellitic Anhydride*. Trenton, NJ

Trimethylamine T:0860

Molecular Formula: C_3H_9N
Common Formula: $(CH_3)_3N$
Synonyms: *N*,*N*-Dimethylmethanamine; Methamine, *N*,*N*-dimethyl-
CAS Registry Number: 75-50-3
RTECS® Number: YH2880000
UN/NA & ERG Number: UN1083 (anhydrous)/118; UN1297 (aqueous solutions)/132
EC Number: 200-875-0 [*Annex I Index No.:* 612-001-00-9]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R12; R20; R37/38; R41; Safety phrases: S2; S16; S26; S39 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Trimethylamine is a strong, fishy, ammoniacal-smelling gas. Flammable gas. Shipped as a compressed gas. It may be present in an aqueous solution. The odor threshold is 0.00011−0.87 ppm. *Warning:* The odor threshold range is so broad that odor alone should not be used as a warning of potentially hazardous exposures. Molecular weight = 59.13; Boiling point = 3°C; Specific gravity (H_2O:1) = 0.58 at 25°C; Freezing/Melting point = −117°C; Vapor pressure = 1454 mmHg at 21°C; Flash point = flammable gas; Autoignition temperature = 190°C. Explosive limits: LEL = 2.0%; UEL = 11.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water; solubility = 48% at 30°C.

Potential Exposure: Compound Description: Reproductive Effector. Trimethylamine is used as a chemical intermediate in organic synthesis of quaternary ammonium compounds, as an insect attractant, as a warning agent in natural gas, as a flotation agent.

Incompatibilities: A medium strong base. Violent reaction with strong oxidizers (such as chlorine, bromine, fluorine), ethylene oxide, nitrosating agents (e.g., sodium nitrite), mercury, strong acids. Corrosive to many metals (e.g., zinc, brass, aluminum, copper, tin, and their alloys).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.42 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 10 ppm/24 mg/m^3 TWA; 15 ppm/36 mg/m^3 STEL.
ACGIH TLV®[1]: 5 ppm/12 mg/m^3 TWA; 15 ppm/36 mg/m^3 STEL.
AIHA WEEL: 1 ppm TWA.
Protective Action Criteria (PAC)*
TEEL-0: 5 mg/m^3
PAC-1: **8.0** mg/m^3
PAC-2: **120** mg/m^3
PAC-3: **380** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 2 ppm/4.9 mg/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Australia: TWA 10 ppm (24 mg/m^3), STEL 15 ppm, 1993; Belgium: TWA 10 ppm (24 mg/m^3), STEL 15 ppm, 1993; Denmark: TWA 10 ppm (24 mg/m^3), 1999; France: VLE 10 ppm (25 mg/m^3), 1999; Hungary: TWA 5 mg/m^3, STEL 10 mg/m^3, 1993; Norway: TWA 10 ppm (24 mg/m^3), 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm. Several states have set guidelines or standards for trimethylamine in ambient air[60] ranging from 57.143 μg/m^3 (Kansas) to 240−360.0 μg/m^3 (North Dakota) to 400.0 μg/m^3 (Virginia) to 480.0 μg/m^3 (Connecticut) to 952.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV2060.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.2$.

Routes of Entry: Inhalation, ingestion (solution), skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Trimethylamine can affect you when breathed in. Exposure can irritate the eyes, skin, and respiratory tract. Very high levels may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. Contact can cause severe irritation and burns to the eyes and skin. May cause blurred vision, corneal necrosis. Contact may cause frostbite.

Long Term Exposure: Long-term effects are not known at this time.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Wear gas-proof goggles, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 10 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trimethylamine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and mercury since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where trimethylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of trimethylamine. Wherever trimethylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Trimethylamine, anhydrous, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1. Trimethylamine, aqueous solutions, requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." Trimethylamine, aqueous solutions, with not >50% trimethylamine by mass falls in DOT Hazard Class 3 and Packing Group I, II, or III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. For a spill of a liquid solution of trimethylamine, absorb liquid with sodium bisulfate, sand, vermiculite, earth, or a similar material. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trimethylamine is a flammable gas or liquid. For a small fire involving trimethylamine gas, use dry chemical or CO_2 extinguishers. For small water solution fires, use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire, including oxides of nitrogen. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 70−73 (1982) and 5, No. 6, 96−98 (1985)

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Trimethylamine*. Trenton, NJ

2,4,6-Trimethylaniline T:0870

Molecular Formula: $C_9H_{13}N$
Common Formula: $C_6H_2(CH_3)_3NH_2$
Synonyms: Aminomesitylene; 2-Amino-1,3,5-trimethylbenzene; Aniline, 2,4,6-trimethyl-; Mesidine; Mesitylamine; Mezidine; 2,4,6-Trimethylbenzenamine
CAS Registry Number: 88-05-1
RTECS® Number: BZ0700000
UN/NA & ERG Number: UN2810/153
EC Number: 201-794-3
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1982.
CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg).
Reportable Quantity (RQ): 500 lb (227 kg).
Canada, WHMIS, Classification D2B. On NDSL list.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.
Description: Aniline, 2,4,6-trimethyl- is a clear liquid. Molecular weight = 135.21; Boiling point = 233°C; Freezing/Melting point = −5°C. Insoluble in water.
Potential Exposure: Used on small scale in organic synthesis.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 0.125 mg/m^3
PAC-1: 0.4 mg/m^3
PAC-2: 2.9 mg/m^3
PAC-3: 40 mg/m^3
Routes of Entry: Ingestion.
Harmful Effects and Symptoms
Short Term Exposure: This material is moderately toxic orally. It is also considered highly toxic by unspecified routes. It is a skin and eye irritant. The danger of acute poisoning is represented by methemoglobinemia leading to adverse effects on the red cells. A number of the amines may act as skin sensitizers. Repeated exposure results in narrowing of peripheral vision, increase in size of blind spot, and decrease in photosensitivity. The LC_{50} inhalation (mouse) is 0.29 mg/L/2 h.
Long Term Exposure: Suspect occupational carcinogen. This material is a suspect carcinogen on the basis of being an aromatic amine but, unlike the 2,4,5-trimethyl-isomer, is not positive for animals.
Points of Attack: Blood, eyes, respiratory system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.
Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area

should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic, liquids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." 1,2,3-Trichloropropane falls in DOT Hazard Class 6.1 and Parking Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Wear positive pressure breathing apparatus and special protective clothing. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. If water pollution occurs, notify appropriate authorities. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Aniline, 2,4,6-Trimethyl*. Washington, DC: Chemical Emergency Preparedness Program.

Trimethylbenzenes T:0880

Molecular Formula: C_9H_{12}

Common Formula: $C_6H_3(CH_3)_3$

See also separate ***Mesitylene*** *108-67-8 (1,3,5-Trimethylbenzene) record*

Synonyms: *1,2,3-isomer:* Hemellitol; Hemimellite; 1,2,3-Trimethylbenzene; 1,2,3-Trimetilbenceno (Spanish)

1,2,4-isomer: Pseudocumene; PSI-Cumene; *asym*-Trimethylbenzene; 1,2,4-Trimethylbenzene; 1,2,4-Trimetilbenceno (Spanish)

1,3,5-isomer: Mesitylene, *sym*-trimethylbenzene; *sym*-Trimethylbenzene; 1,3,5-Trimethylbenzene; 1,3,5-Trimetilbenceno (Spanish)

Mixed isomers: Trimethylbenzene, mixed isomers; Trimetilbenceno (Spanish)

Note: Hemimellitene is a mixture of the 1,2,3-isomer with up to 10% of related aromatics, such as the 1,2,4-isomer.

CAS Registry Number: 526-73-8 (1,2,3-isomer); 95-63-6 (1,2,4-isomer); 108-67-8 (1,3,5-isomer); 25551-13-7 (mixed isomers)

RTECS® Number: OX6825000 (1,3,5-isomer); DC3325000 (1,2,4-isomer); DC3300000 (1,2,3-isomer); DC3225000 (mixed isomers)

UN/NA & ERG Number: UN2325 (1,3,5-isomer)/129; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 208-394-8 (1,2,3-isomer); 202-436-9 [*Annex I Index No.:* 601-043-00-3] (1,2,4-isomer); 203-604-4 [*Annex I Index No.:* 601-025-00-5] (1,3,5-isomer); 247-099-9 (mixed isomers)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

1,2,4-isomer:

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (1,2,4- and 1,3,5-isomers); 1% 1,2,3- and mixed-isomers).

Note: Only the 1,2,4-isomer is regulated by the US EPA. All three isomers are "regulated" by NIOSH. The 1,3,5-isomer was dropped from the EPA's Extremely Hazardous Substance List (EPA-SARA) in 1988.

European/International Regulations (*95-63-6*): Hazard Symbol: Xn; Risk phrases: R10; R20; R36/37/38; Safety phrases S2; S26 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting *95-63-6 (1,2,4-isomer).*

Description: Trimethylbenzenes exists in three isomeric forms. All isomers are clear, colorless liquids with a distinctive, aromatic odor. The odor threshold for the class is 0.55 ppm. Molecular weight = 120.21; Specific gravity (H_2O:1) = 0.89 at 25°C; Boiling point = 176°C (1,2,3-isomer); 169°C (1,2,4-isomer); 164°C (1,3,5-isomer); Freezing/Melting point = −25°C (1,2,3-isomer); Vapor pressure = 1 mmHg at 17°C (1,2,3-); 1 mmHg at 13°C (1,2,4-); Flash points = 44°C (1,2,3- & 1,2,4-isomers); 50°C (1,3,5-isomer); 53°C [1,2,3-isomer (90.5%)]; Autoignition temperature = 470°C (1,2,3-isomer); 479°C [1,2,3-isomer (90.5%)]; 500°C (1,2,4-isomer); 559°C (1,3,5-isomer). Explosive limits: LEL = 0.9%; UEL = 6.4% (1,2,4-isomer); LEL = 0.8%; UEL = 6.6% (1,2,3-isomer). NFPA-704 M Hazard Identification (all isomers): Health 1, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.005% (1,2,3-isomer); 0.006% (1,2,4-isomer).

Potential Exposure: Compound Description (1,2,3- and 1,2,4-isomers): Mutagen, (mixed isomers) Primary Irritant. These materials are used as solvents and in dye and perfume manufacture. The 1,2,3-isomer is used as raw material in chemical synthesis and as an ultraviolet stabilizer. The 1,2,4-isomer is used as the raw material for trimellitic anhydride manufacture. These compounds are found in diesel engine exhaust fumes.

Incompatibilities: Oxidizers (perchlorates, peroxides, permanganates, chlorates, nitrates), strong oxidizers (chlorine, bromine, fluorine), and nitric acid.

Permissible Exposure Limits in Air

All isomers

Conversion factor: 1 ppm = 4.92 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 25 ppm/125 mg/m^3 TWA.

ACGIH TLV®[1] (*mixed isomers*): 25 ppm/123 mg/m^3 TWA.

DFG MAK: (*all isomers*) 20 ppm/100 mg/m^3 TWA; Peak Limitation Category II(2); Pregnancy Group C.

1,2,3-isomer

Austria: MAK 25 ppm (125 mg/m^3), 1999; Denmark: TWA 25 ppm (120 mg/m^3), 1999; Japan; 25 ppm (120 mg/m^3), 1999; Norway: TWA 20 ppm (100 mg/m^3), 1999; United Kingdom: TWA 25 ppm (125 mg/m^3), 2000; the Netherlands: MAC-TGG 100 mg/m^3, 2003.

1,2,4-isomer

Protective Action Criteria (PAC)*

TEEL-0: 25 ppm

PAC-1: **140** ppm

PAC-2: **360** ppm

PAC-3: 400 ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Denmark: TWA 25 ppm (120 mg/m^3), 1999; Japan; 25 ppm (120 mg/m^3), 1999; Norway: TWA 20 ppm (100 mg/m^3), 1999; United Kingdom: TWA 25 ppm (125 mg/m^3), 2000; the Netherlands: MAC-TGG 100 mg/m^3, 2003.

Mixed isomers

Australia: TWA 25 ppm (125 mg/m^3), 1993; Austria: MAK 25 ppm (125 mg/m^3), 1999; Belgium: TWA 25 ppm (123 mg/m^3), 1993; Denmark: TWA 25 ppm (120 mg/m^3), 1999; Finland: TWA 25 ppm (120 mg/m^3), STEL 40 ppm (200 mg/m^3), [skin], 1999; France: VME 25 ppm (125 mg/m^3), 1999; Norway: TWA 20 ppm (100 mg/m^3), 1999; the Netherlands: MAC-TGG 100 mg/m^3, 2003; Sweden: NGV 25 ppm (120 mg/m^3), KTV 35 ppm (170 mg/m^3), 1999; Switzerland: MAK-W 25 ppm (125 mg/m^3), 1999; United Kingdom: LTEL 25 ppm (125 mg/m^3), STEL 35 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 25 ppm. Several states have set guidelines or standard for Trimethyl benzenes in ambient air[60] ranging from 1.25−1.70 mg/m^3 (North Dakota) to 2.1 mg/m^3 (Virginia) to 2.5 mg/m^3 (Connecticut) to 2.976 mg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2091.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.7 (1,2,3-).

Routes of Entry: Inhalation, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Trimethyl benzene can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Symptoms of exposure can also include headache, drowsiness, fatigue, dizziness, nausea, a lack of coordination, vomiting, nervousness, tenseness, confusion. Liquid deposition in lungs causes bronchitis or chemical pneumonitis.

Long Term Exposure: Repeated exposures can cause headaches, tiredness, and a feeling of nervous tension. Can affect the blood cells and the blood's clotting ability; hypochromic anemia. Delayed or chronic health hazard is possible including asthmatic bronchitis with coughing and/or shortness of breath. The use of alcoholic beverages enhances the effect. May cause liver damage. The liquid destroys the skin's natural oils, causing drying and cracking.

Points of Attack: Eyes, skin, respiratory system, central nervous system, blood, liver.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. Complete blood count and platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Complete blood count (CBC) and platelet count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 25 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full-face-piece respirator than by a half-mask respirator, and even greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trimethylbenzene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Flammable liquids, toxic, n.o.s., require a shipping label of "FLAMMABLE LIQUID, POISONOUS/TOXIC MATERIALS." The 1,2,3-, 1,2,4-, and mixed isomers fall in DOT Hazard Class 3 and Packing Group II. 1,3,5-Trimethylbenzene requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. *Small fires:* dry chemical, carbon dioxide, water spray, or alcohol-resistant foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (October 31, 1985). *Chemical Hazard Information Profile: Mesitylene*. Washington, DC: Chemical Emergency Preparedness Program

New Jersey Department of Health and Senior Services. (May 2003). *Hazardous Substances Fact Sheet: Trimethylbenzene (mixed isomers)*. Trenton, NJ

Trimethylchlorosilane T:0890

Molecular Formula: C_3H_9ClSi

Synonyms: Chlorotrimethylsilane; Monochloro-trimethylsilicon; NSC 15750; Silane, chlorotrimethyl-; Silane, trimethylchloro-; Silicane, chlorotrimethyl-; Silylium, trimethyl-, chloride; STCC 4907680; TL 1163; Trimethylsilyl chloride; Trimetilclorosilano (Spanish)

CAS Registry Number: 75-77-4

RTECS® Number: VV2710000

UN/NA & ERG Number: UN1298/132

EC Number: 200-900-5

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Trimethylchlorosilane is a colorless, fuming liquid with an irritating odor. Molecular weight = 108.66; Specific gravity (H_2O:1) = 0.85 at 25°C; Boiling point = 57°C; Freezing/Melting point = −58°C; Flash point = −15°C (cc); Vapor pressure = 200 mmHg at 18°C; Autoignition temperature = 395°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts with water.

Potential Exposure: Compound Description: Tumorigen, Mutagen. Primary Irritant. Trimethylchlorosilane is used as an intermediate to make silicone products, including lubricants.

Incompatibilities: Moisture and air contact forms hydrochloric acid. Violent reaction with moisture forming corrosive chloride gases, including hydrogen chloride. Vigorous reaction with aluminum. Store in temperatures below 21°C.

Permissible Exposure Limits in Air

AIHA WEEL: 5 ppm, ceiling.

Protective Action Criteria (PAC)*

TEEL-0: 0.6 ppm

PAC-1: **1.8** ppm

PAC-2: **22** ppm

PAC-3: **100** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the respiratory tract causing coughing and wheezing. Contact can cause severe skin and eye irritation and burns with possible permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Can irritate the lungs; bronchitis may develop with coughing, phlegm, and/or shortness of breath. There is limited evidence that trimethylchlorosilane causes cancer in animals.

Points of Attack: Cancer site in animals: lungs.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear-splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool (below 70°F/21°C), well-ventilated area away from moisture of any form and strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Trimethylchlorosilane requires a shipping label of "FLAMMABLE LIQUID, CORROSIVE." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

When spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.7/1.2

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including hydrogen chloride, are produced in fire. Use dry chemical or carbon dioxide. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (June 2003). *Hazardous Substances Fact Sheet: Trimethylchlorosilane*. Trenton, NJ

Trimethyl phosphite T:0900

Molecular Formula: $C_3H_9O_3P$
Common Formula: $(CH_3O)_3P$
Synonyms: Methyl phosphite; Phosphorus acid, trimethyl ester; TMP; Trimethoxyphosphine; Trimethyl ester of phosphorous acid
CAS Registry Number: 121-45-9
RTECS® Number: TH1400000
UN/NA & ERG Number: UN2329/130
EC Number: 204-471-5

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 220 (≥80.00% concentration).

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Trimethyl phosphite is a colorless liquid with a distinctive pungent, pyridine-like odor. The odor threshold is 0.0001 ppm. Molecular weight = 124.09; Specific gravity (H_2O:1) = 1.05 at 25°C; Boiling point = 111°C; Freezing/Melting point = −78°C; Vapor pressure = 24 mmHg at 25°C; Flash point = 28°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Reproductive Effector; Primary Irritant. Trimethyl phosphite is a flame retardant and used as an intermediate in the manufacture of a number of pesticides and organophosphorus additives.

Incompatibilities: Reacts (hydrolyzes) with water. Violent reaction with magnesium perchlorate. Incompatible with air, moisture, oxidizers, strong bases. Store and handle under a nitrogen blanket.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.08 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 2 ppm/10 mg/m^3 TWA.

ACGIH TLV®[1]: 2 ppm TWA.

Protective Action Criteria (PAC)*

TEEL-0: 2 ppm

PAC-1: **6.1** ppm

PAC-2: **61** ppm

PAC-3: **310** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

Australia: TWA 2 ppm (10 mg/m^3), 1993; Belgium: TWA 2 ppm (10 mg/m^3), 1993; Denmark: TWA 0.5 ppm (2.6 mg/m^3), 1999; Finland: TWA 0.5 ppm (2.6 mg/m^3), STEL 10 ppm (52 mg/m^3), [skin], 1999; France: VME 2 ppm (10 mg/m^3), 1999; the Netherlands: MAC-TGG 10 mg/m^3, 2003; United Kingdom: TWA 2 ppm (10 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 2 ppm. Several states have set guidelines or standards for Trimethyl phosphite in ambient air[60] ranging from 100 μg/m^3 (North Dakota) to 160 μg/m^3 (Virginia) to 200 μg/m^3 (Connecticut) to 238 μg/m^3 (Nevada).

Determination in Air

DFG MAK: No numerical value established. Data may be available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Trimethyl phosphite can affect you when breathed in and by passing through your skin. The vapor irritates the eyes, skin, and upper respiratory tract. Contact can severely irritate and may permanently damage the eyes. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Trimethyl phosphite can severely irritate the skin and can cause a rash and skin allergy. Exposure may damage the liver and kidneys.

Long Term Exposure: Can cause lung irritation; bronchitis may develop. Exposure may cause emphysema. May damage the liver and kidneys. In animals: teratogenic effects.

Points of Attack: Eyes, skin, respiratory system, reproductive system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy; and liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 2 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full-face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from magnesium diperchlorate. Sources of ignition, such as smoking and open flames, are prohibited where trimethyl phosphite in handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of trimethyl phosphite should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Shipping: Trimethyl phosphite requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including carbon monoxide, phosphine, and phosphorus oxides, are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Trimethyl Phosphite*. Trenton, NJ

Trinitrobenzene T:0910

Molecular Formula: $C_6H_3N_3O_6$

Common Formula: 1,3,5-$C_6H_3(NO_2)_3$

Synonyms: Benzene, 1,3,5-trinitro-; TNB; 1,3,5-Trinitrobenceno (Spanish); *sym*-Trinitrobenzene; *symmetrical*-Trinitrobenzene; Trinitrobenzene; Trinitrobenzene, dry; Trinitrobenzol (German)

CAS Registry Number: 99-35-4

RTECS® Number: DC3850000

UN/NA & ERG Number: UN0214 (dry or wetted with <30% water, by mass)/112; UN1354 (wetted with not <30% water, by mass)/113

EC Number: 202-752-7 [*Annex I Index No.:* 609-005-00-8]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Explosive Substance (World Bank).[15]

Reportable Quantity (RQ): 10 lb (4.54 kg).

US EPA Hazardous Waste Number (RCRA No.): U234.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trinitrobenzene is a yellow crystalline solid. Molecular weight = 213.12; Freezing/Melting point = 122−123°C. Hazard Identification (based on NFPA-704 M Rating System): (*wetted or with <30% water*) Health 2, Flammability 4, Reactivity 4; (wetted with >30% water) Health 2, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: Trinitrobenzene is used as an explosive, and as a vulcanizing agent for natural rubber. Trinitrobenzene may be more powerful than TNT; and it is reported to be less sensitive to impact than TNT. However it is difficult to produce and is not used as widely as TNT.

Incompatibilities: Sensitive to shock and heat. Incompatible with initiating explosives, combustible materials, oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 3 mg/m^3

PAC-1: 7.5 mg/m^3

PAC-2: 60 mg/m^3

PAC-3: 125 mg/m^3

Permissible Concentration in Water: Russia[43] has set a MAC of 0.4 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract.

Long Term Exposure: Information on the carcinogenicity, mutagenicity, teratogenicity, or adverse reproductive effects of trinitrobenzene was not found in the available literature. Trinitrobenzene has been reported to produce liver damage, central nervous system damage, and methemoglobin formation in animals. Breathing difficulties have also been reported.

Points of Attack: Liver, central nervous system, respiratory system.

Medical Surveillance: Lung function tests. Liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Treat as an explosive. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, explosives, oxidizable materials. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Trinitrobenzene, dry or wetted with <30% water, by mass, requires a shipping label of "EXPLOSIVE." It falls in Hazard Class 1.1D and Packing Group II. Trinitrobenzene, wetted with not <30% water, by mass, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive solid. If material is on fire and conditions permit, do not extinguish. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a combustible solvent and spray into an incinerator equipped with afterburner and scrubber.

References

US Environmental Protection Agency. (April 30, 1980). *Trinitrobenzene, Health and Environmental Effects Profile No. 171*. Washington, DC: Office of Solid Waste

Trinitrotoluene T:0920

Molecular Formula: $C_7H_5N_3O_6$

Synonyms: Entsufon; 1-Methyl-2,4,6-trinitrobenzene; NCI-C56155; α-TNT; TNT; TNT-tolite (French); Tolit; Tolite; Toluene, 2,4,6-trinitro,-(wet); *sym*-Trinitrotoluene; 2,4,6-Trinitrotoluene; Trinitrotoluene; Trinitrotoluene, wet; *s*-Trinitrotoluol; *sym*-Trinitrotoluol; 2,4,6-Trinitrotoluol (German); Trinitrotoluol; Tritol; Trotyl; Trotyl oil

CAS Registry Number: 118-96-7

RTECS® Number: XU0175000

UN/NA & ERG Number: UN1356 (wetted with not <30% water, by mass)/113; UN0209 (TNT, dry or wetted with <30% water, by mass)/112

EC Number: 204-289-6 [*Annex I Index No.*: 609-008-00-4]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Carcinogenicity: IARC: Animal, Inadequate Evidence; Human, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: E, T, N; R2; R23/24/25; R33; R51/53; Safety phrases: S1/2; S35; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: TNT exists in five isomers; the most commonly used is 2,4,6-trinitrotoluene. It is a colorless to pale yellow odorless solid (pellets, cast blocks, and cast slabs) or crushed flakes. Molecular weight = 227.15; Specific gravity (H_2O:1) = 1.65 at 25°C; Boiling point = (explodes) 240°C; Freezing/Melting point = 80°C; Vapor pressure = 0.0002 mmHg at 25°C; Ionization potential = 10.59 eV. It explodes at 232°C (also reported at 240°C and 297°C) but burns at 295°C when not confined. TNT is a relatively stable high explosive. Practically insoluble in water; solubility = 0.01% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant. TNT is used as an explosive, i.e., as a bursting charge in military explosive shells, bombs, grenades, and mines; and an intermediate in dyestuffs and photographic chemicals.

Incompatibilities: Strong oxidizers, ammonia, strong alkalis, combustible materials, heat. Violent reaction with reducing agents. Rapid heating will result in detonation. Explodes when heated to 232°C. May explosively decompose from shock, friction, or concussion. Reacts with heavy metals.

Permissible Exposure Limits in Air

OSHA PEL: 1.5 mg/m^3 TWA [skin].

NIOSH REL: 0.5 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg/m^3 TWA [skin].

DFG MAK: 0.011 ppm/0.1 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B; Pregnancy Risk Group D.

NIOSH IDLH: 500 mg/m^3.

Arab Republic of Egypt: TWA 0.5 mg/m^3, 1993; Australia: TWA 0.5 mg/m^3, [skin], 1993; Austria: MAK 0.01 ppm (0.1 mg/m^3), [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.5 mg/m^3, [skin], 1993; Denmark: TWA 0.1 mg/m^3, [skin], 1999; Finland: TWA 0.5 mg/m^3, STEL 3 mg/m^3, [skin], 1999; France: VME 0.5 mg/m^3, [skin], 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, [skin], 2003; Norway: TWA 0.1 mg/m^3, 1999; the Philippines: TWA 1.5 mg/m^3, [skin], 1993; Poland: MAC (TWA) 1 mg/m^3; MAC (STEL) 3 mg/m^3, 1999; Russia: TWA 0.1 mg/m^3, STEL 0.5 mg/m^3, [skin], 1993; Sweden: NGV 0.1 mg/m^3, KTV 0.2 mg/m^3, [skin], 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; Turkey: TWA 1.5 mg/m^3, [skin], 1993; United Kingdom: TWA 0.3 mg/m^3, [skin]; TWA 0.2 ppm (0.89 mg/m^3), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3 [skin]. Several states have set guidelines or standards for TNT in ambient air[60] ranging from 5.0 $\mu g/m^3$ (North Dakota) to 8.0 $\mu g/m^3$ (Virginia) to 10.0 $\mu g/m^3$ (Connecticut) to 12.0 $\mu g/m^3$ (Nevada).

Determination in Air: Use OSHA Analytical Method 44.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.60$

Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation of dust, fume, or vapor; ingestion of dust; percutaneous absorption from dust; skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Exposure to trinitrotoluene may cause irritation of the eyes, nose, and throat with sneezing, cough, and sore throat. It may cause skin irritation, dermatitis, and may give the skin, hair, and nails a yellowish color. Numerous fatalities have occurred in workers exposed to TNT from toxic hepatitis or aplastic anemia. TNT exposure may also cause methemoglobinemia with cyanosis, weakness, drowsiness, dyspnea, and unconsciousness. Ingestion may cause hallucinations or distorted perceptions, cyanosis (blue color to the skin, lips, and fingertips), and gastrointestinal changes.

Long Term Exposure: May affect the liver, causing hepatitis and jaundice. May affect the blood, causing hemolysis, formation of methemoglobin. Cyanosis may also occur. May affect vision, causing cataracts. In addition, it may cause muscular pains, heart irregularities, renal irritation, menstrual irregularities, and peripheral neuritis.

Points of Attack: Blood, liver, eyes, cardiovascular system, central nervous system, kidneys, skin.

Medical Surveillance: NIOSH lists the following tests: complete blood count; aplastic anemia; liver function tests; urine (chemical/metabolite); urinalysis (routine). Placement or periodic examinations should give special considerations to history of allergic reactions, blood dyscrasias, reactions to medications, and alcohol intake. The skin, eyes, blood, and liver and kidney function should be followed. Urine may be examined for TNT using the Webster test or for the urinary metabolite 2,6-dinitro-4-aminotuluene; however, both may be negative if there is liver injury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The Webster skin test (colorimetric tests with alcoholic sodium hydroxide) or indicator soap should be used to make sure workers have washed all TNT off their skins.

Respirator Selection: NIOSH: *Up to 5 mg/m^3:* Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 25 mg/m^3:* SCBAF (APF = 50) (any self-contained breathing apparatus with a full-face-piece; or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: TNT is an explosive. Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in an explosion-proof refrigerator and keep away from reducing agents.[52] Keep material wet with water or treat as an explosive. Keep away from heat, sources of ignition, metal, nitric acid, and reducing materials. Protect containers from shock. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Trinitrotoluene, wetted with not <30% water, by mass, requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group I.

Trinitrotoluene or TNT, dry or wetted with <30% water, by mass, requires a shipping label of "EXPLOSIVE." It falls in Hazard Class 1.1D and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a dangerously explosive solid. If material is on fire and conditions permit, do not extinguish. Evacuate area and let burn. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: TNT is dissolved in acetone and incinerated. The incinerator should be equipped with an afterburner and a caustic soda solution scrubber.

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: 2,4,6-Trinitrotoluene*. Washington, DC

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 93−96 (1982) and 8, No. 4, 75−80 (1988)

Triphenylamine T:0930

Molecular Formula: $C_{18}H_{15}N$

Common Formula: $(C_6H_5)_3N$

Synonyms: *N*,*N*-Diphenylaniline; *N*,*N*-Diphenylbenzenamine

CAS Registry Number: 603-34-9

RTECS® Number: YK2680000

EC Number: 210-035-5

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Triphenylamine is a colorless crystalline solid. Molecular weight = 245.34; Specific gravity (H_2O:1) = 0.77 at 25°C; Boiling point = 365°C; also reported at 195°C at 10 mmHg; Freezing/Melting point = 127°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Triphenylamine is used as a primary photoconductor and in making photographic film coated on photographic film bases.

Incompatibilities: Aldehydes, ketones, nitrates, oxidizers, oxygen, and peroxides.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 5 mg/m^3 TWA.

ACGIH TLV®[1]: Withdrawn due to insufficient data.

Australia: TWA 5 mg/m^3, 1993; Belgium: TWA 5 mg/m^3, 1993; Denmark: TWA 5 mg/m^3, 1999; Finland: TWA 5 mg/m^3, STEL 10 mg/m^3, [skin], 1999; France: VME 5 mg/m^3, 1999; Norway: TWA 5 mg/m^3, 1999; IN Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg/m^3. Several states have set guidelines or standards for triphenylamine in ambient air[60] ranging from 8.0 μg/m^3 (Virginia) to 50.0 μg/m^3 (North Dakota) to 100.0 μg/m^3 (Connecticut).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Triphenylamine can affect you when breathed in and by passing through your skin. Contact can irritate the skin.

Long Term Exposure: No known long-term effects are known although some related aromatic amines can cause skin and lung allergies and have been shown to be carcinogenic to the human bladder, ureter, prostate, intestines, lung, and liver.

Points of Attack: Skin.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 5 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from aldehydes, ketones, nitrates, oxidizers, oxygen, and peroxides. Where possible, automatically transfer material from storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. The powdered material may be dampened with 60−70% acetone to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Triphenylamine*. Trenton, NJ

Triphenyl phosphate T:0940

Molecular Formula: $C_{18}H_{15}O_4P$

Common Formula: $(C_6H_5O)_3PO$

Synonyms: Celluflex TPP; Disflamoll-TP; Fosfato de trifenilo (Spanish); Phenyl phosphate; Phiosflex-TPP; Phosphoric acid, triphenyl ester; TP; TPP; Triphenoxyphosphine oxide; Triphenyl ester of phosphoric acid

CAS Registry Number: 115-86-6

RTECS® Number: TC8400000

UN/NA & ERG Number: UN3077/171

EC Number: 204-112-2

Regulatory Authority and Advisory Bodies

US EPA TSCA Section 8(e) Risk Notification, 8EHQ-0892-9169; 8EHQ-0892-8839; 8EHQ-0892-9290.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Triphenyl phosphate is a colorless crystalline powder with a faint, phenol-like odor. Molecular weight = 326.30; Specific gravity (H_2O:1) = 1.29 at 25°C; Boiling point = 413.3°C; Freezing/Melting point = 49°C; Vapor pressure = 1 mmHg at 193°C; Flash point = 220°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility 0.002% at 54°C.

Potential Exposure: Triphenyl phosphate is used to impregnate roofing paper and as a fire-resistant plasticizer in plastics; for cellulose esters in lacquers and varnishes. Used in making adhesives, gasoline additives, flotation agents, insecticides, surfactants, antioxidants, and stabilizers. A substitute for camphor.

Incompatibilities: Contact with strong oxidizers, strong acids, and nitrates may cause fire or explosions. Phosphates are incompatible with antimony pentachloride, magnesium, silver nitrate, zinc acetate.

Permissible Exposure Limits in Air

OSHA PEL: 3 mg/m^3 TWA.

NIOSH REL: 3 mg/m^3 TWA.

ACGIH TLV®[1]: 3 mg/m^3 TWA, not classifiable as a human carcinogen.

NIOSH IDLH: 1000 mg/m^3.

Australia: TWA 3 mg/m^3, 1993; Belgium: TWA 3 mg/m^3, 1993; Denmark: TWA 3 mg/m^3, 1999; Finland: TWA 3 mg/m^3, STEL 6 mg/m^3, [skin], 1999; France: VME 3 mg/m^3, 1999; Norway: TWA 3 mg/m^3, 1999; the Netherlands: MAC-TGG 3 mg/m^3, 2003; Switzerland: MAK-W 3 mg/m^3, 1999; United Kingdom: LTEL 3 mg/m^3, STEL 6 mg/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for triphenyl phosphate in ambient air[60] ranging from 1.6 μg/m^3 (Virginia) to 30.0 μg/m^3 (North Dakota) to 60.0 μg/m^3 (Connecticut) to 71.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5038, Triphenyl phosphate.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 4.59$.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Slowly absorbed by the skin.

Harmful Effects and Symptoms

Short Term Exposure: Slowly absorbed by the skin. May cause eye and skin irritation.

Long Term Exposure: Minor changes in blood enzymes. In animals: muscular weakness, paralysis. May be a cholinesterase inhibitor, but not a potent one.

Points of Attack: Blood, peripheral nervous system.

Medical Surveillance: Consider the blood in preplacement and periodic physical examinations. Examination of the peripheral nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 15 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 30 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 75 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 150 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full-face-piece) or SaF (APF = 50) (any supplied-air respirator with a full-face-piece). *Up to 1000 mg/m^3:* SA: PD,PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place away from antimony pentachloride, magnesium, silver nitrate, zinc acetate.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including oxides of phosphorus. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure,

explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in furnace equipped with alkaline scrubber.

References

Sax, N. I. (Ed.). (1986). *Dangerous Properties of Industrial Materials Report*, 6, No. 4, 91−100

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Triphenyl Phosphate*. Trenton, NJ

Triphenyltin compounds T:0950

Molecular Formula: $C_{20}H_{18}O_2Sn$; $C_{18}H_{15}ClSn$; $C_{18}H_{16}OSn$

Common Formula: $(C_6H_5)_3SnOOCCH_3$; $(C_6H_5)_3SnCl$; $(C_6H_5)_3SnOH$

Synonyms: *acetate:* Acetate de triphenyl-etain (French); Acetotriphenylstannine; Acetoxy-triphenyl-stannan (German); Acetoxytriphenylstannane; Acetoxytriphenyltin; (Acetyloxy)triphenyl-stannane; Batasan; Brestan; ENT 25,208; Fenolovo acetate; Fentin acetat (German); Fentin acetate; Fentine acetate (French); GC 6936; HOE-2824; Liromatin; Lirostanol; Phentin acetate; Phentinoacetate; Stannane, acetoxytriphenyl-; Suzi; Tinestan; Tinestan 60 WP; Tin triphenyl acetate; TPTA; TPZA; Triphenylacetostannane; Triphenyltin acetate; Triphenylzinnacetat (German); Tubotin

Chloride: AI3-25207; Aquatin 20 EC; Brestanol; Chlorotriphenylstannane; Chlorotriphenyltin; Fentin chloride; GC 8993; General chemicals 8993; HOE 2872; LS 4442; NSC 43675; Phenostat-C; Stannane, chlorotriphenyl-; Tinmate; TPTC; Triphenylchlorostannane; Triphenylchlorotin; Triphenyltin chloride (EPA)

Hydroxide: AI3-28009; Brestan H 47.5 WP fungicide; Dowco 186; Duter; Du-Ter; Duter extra; Du-Ter fungicide; Du-Ter fungicide wettable powder; Du-Ter PB-47 fungicide; Du-Ter W-50; Du-Tur flowable-30; ENT 28,009; Fentin; Fentin hydroxide; Fintine hydroxyde (French); Fintin hydroxid (German); Flo tin 4L; Haitin; Haitin WP 20 (fentin hydroxide 20%); Haitin WP 60 (fentin hydroxide 60%); Hydroxyde de triphenyl-etain (French); Hydroxytriphenylstannane; Hydroxytriphenyltin; IDA, IMC Flo-tin 4L; K19; NCI-C00260; NSC 113243; Phenostat-H; Stannane, hydroxytriphenyl-; Stannol, triphenyl-; Super tin; Super tin 4l gardian flowable fungicide; Suzu H; Tin, hydroxytriphenyl-; TN IV; TPTH; TPTH technical; TPTOH; Triphenylstannanol; Triphenylstannium hydroxide; Triphenyltin(IV) hydroxide; Triphenyltin hydroxide (EPA); Triphenyltin hydroxide organotin fungicide; Triphenyltin oxide; Triphenyl-zinnhydroxid (German); Triple-tin; Triple tin 4l; Tubotin; Vancide KS; Vito spot fungicide; Wesley technical triphenyltin hydroxide

CAS Registry Number: 900-95-8 (acetate); 639-58-7 (chloride); 76-87-9 (hydroxide); 752-74-9 [Tris(triphenylstannyl) isocyanurate]

RTECS® Number: WH6650000 (acetate); WH6860000 (chloride); WH8575000 (hydroxide)

UN/NA & ERG Number: UN2786 (organotin pesticides, solid, toxic)/153; UN3020 (organotin pesticides, liquid, toxic)/153

EC Number: 212-984-0 [050-003-00-6] (fentin acetate); 211-358-4 (fentin chloride); 200-990-6 [050-004-00-1] (fentin hydroxide)

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Acetate:

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as triphenyltin compounds.

European/International Regulations (*900-95-8*): Hazard Symbol: T + , N; Risk phrases: R24/25; R26; R36/38; R43; R50/53; Safety phrases: S1/2; S36/37; S45; S60; S61.

Chloride:

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg) (chloride).

Reportable Quantity (RQ): 1 lb (0.454 kg) (chloride).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as triphenyltin compounds.

European/International Regulations: not listed in Annex I.

Hydroxide:

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

US EPA Gene-Tox Program, Negative: Carcinogenicity—mouse/rat.

US EPA, FIFRA, 1998 Status of Pesticides: Supported.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as triphenyltin compounds.

California Proposition 65 Chemical: (*Triphenyltin hydroxide*) Cancer 1/1/92; Developmental/Reproductive toxin 3/18/02.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% (acetate and hydroxide); 1% (chloride).

European/International Regulations (*76-87-9*): Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R37/38; R40; R41; R48/23; R63; R50/53; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*acetate, chloride, hydroxide*).

Description: Triphenyltin acetate is a white solid. Molecular weight = 409.07; Freezing/Melting point = 122°C. Practically insoluble in water. Triphenyltin chloride is a colorless to yellow crystalline solid with a characteristic odor. Molecular weight = 385.47; Boiling point = 240°C at 13.5 mmHg; Freezing/Melting point = 106°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water. *Triphenyltin hydroxide* is a white crystalline solid. Molecular weight = 367.03; Freezing/Melting point = 118−120°C (decomposes). Practically insoluble in water.

Potential Exposure: Compound Description (hydroxide): Agricultural Chemical; Tumorigen, Mutagen, Organometallic; Reproductive Effector; Human Data; Primary Irritant. The hydroxide is used in vinyl products to protect against mildew growth and stiffening by bacteria and fungi. At risk are those engaged in the manufacture, formulation, and application of insecticides used for fungus, algae, and mollusk control; as a chemosterilant.

Incompatibilities: Triphenyltin chloride: violent reaction with strong oxidizers. Keep away from moisture.

Permissible Exposure Limits in Air

OSHA PEL: 0.1 mg[Sn]/m^3 TWA.

NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin].

ACGIH TLV®[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin].

NIOSH IDLH: 25 mg[Sn]/m^3.

Protective Action Criteria (PAC) (chloride)

TEEL-0: 0.325 mg/m^3

PAC-1: 0.65 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 81.2 mg/m^3

DFG MAK: 0.1 mg[Sn]/m^3, inhalable fraction Peak Limitation Category II(2); [skin]; Pregnancy Risk Group D.

Hydroxide

Australia: TWA 0.1 mg[Sn]/m^3, [skin], 1993; Austria: MAK 0.1 mg[Sn]/m^3, [skin], 1999; Belgium: TWA 0.1 mg [Sn]/m^3, [skin], 1993; Denmark: TWA 0.1 mg[Sn]/m^3, [skin], 1999; Finland: TWA 0.1 mg[Sn]/m^3, STEL 0.3 mg [Sn]/m^3, 1999; France: VME 0.1 mg[Sn]/m^3, VLE 0.2 mg [Sn]/m^3, 1999; Hungary: STEL 0.1 mg[Sn]/m^3, [skin], 1993; Norway: TWA 0.1 mg[Sn]/m^3, 1999; the Philippines: TWA 0.1 mg[Sn]/m^3, 1993; Switzerland: MAK-W 0.1 mg [Sn]/m^3, KZG-W 0.2 mg[Sn]/m^3, [skin], 1999; Thailand: TWA 0.1 mg[Sn]/m^3, 1993; United Kingdom: TWA 0.1 mg [Sn]/m^3, STEL 0.2 mg[Sn]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Not classifiable as a human carcinogen.

Determination in Air: Use NIOSH Analytical Method (IV) #5504, Organotin compounds.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: These chemicals are strong poisons. Toxic and irritating to the eyes, skin, and respiratory system. Dermal exposure may lead to severe skin burns as well as renal failure, and possible death in the case of the chloride. Symptom of exposure include headache, vertigo (an illusion of movement), psycho-neurologic disturbance, sore throat, cough, abdominal pain, vomiting, urine retention, paresis, focal anesthesia.

Long Term Exposure: Exposure may affect the nervous system causing headache, nausea, vomiting, dizziness, decreased coordination, muscle weakness, and visual changes. Triphenyltin chloride can irritate the lungs; bronchitis may develop. In animals: hemolysis; hepatic necrosis; kidney damage.

Points of Attack: Kidneys, liver.

Medical Surveillance: Kidney and liver function tests. Evaluation of the nervous system. Lung function tests.

First Aid: *For triphenyltin hydroxide: Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *[Tin, organic compounds as (Sn)]*: *Up to 1 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOvHie (APF = 25) (any air-purifying full-face-piece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 mg/m^3:* CcrFOv100 (APF = 50) [any air-purifying full-face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter] or GmFOv100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge (s) in combination with a high-efficiency particulate filter] or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 25 mg/m^3*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials. Where possible, automatically transfer material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: Organotin compounds, solid, n.o.s., and Organotin pesticides, liquid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in DOT Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Small fires:* dry chemical, carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area is you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases are produced in fire, including tin oxides and hydrogen chloride (triphenyltin chloride). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Acetoxytriphenyl Stannane*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Triphenyltin Chloride*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 92−94

Tris(2-chloroethyl)amine (Agent HN-3, WMD) T:0960

Molecular Formula: $C_6H_{12}Cl_3N$
Common Formula: $(ClCH_2CH_2)_3N$

Synonyms: AI3-16198; 2-Chloro-*N*,*N*-bis(2-chloroethyl)ethanamine; HN-3 (military designation); Nitrogen Mustard-3; TL 145; Trichlormethine; Tri-(2-chloroethyl)amine; 2,2′,2″-Trichlorotriethylamine; Tris(2-chloroethyl)amine; Tris (β-chloroethyl)amine; TS160

CAS Registry Number: 555-77-1

RTECS® Number: YE2625000

UN/NA & ERG Number: UN2810/153

EC Number: None assigned.

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

HN-3 is a suspected carcinogen, developmental toxin, and reproductive toxin.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: HN-3, a nitrogen mustard blister agent (vesicants), is a colorless to pale yellow liquid. Pure material is odorless; otherwise it has a faint fish- or soap-like odor. Density: 1.2347 at 25°C; Molecular weight = 204.53; Boiling point = 256°C (HN-3 decomposes before its boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion[NIOSH]); Freezing/Melting point = −3.9°C; Vapor pressure = 0.0106 mmHg at 20°C; 0.0109 mmHg at 25°C. Volatility: 0.120 mg/L at 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Sparingly soluble in water; solubility = 160 mg/L at 25°C.

Incompatibilities: HN-3 is not stable; it undergoes slow but steady polymerization. Avoid contamination with oxidizing agents, e.g., nitrates, oxidizing acids, chlorine bleaches, pool chlorine, which may result in ignition. Unstable in the presence of light and heat and forms dimers at temperatures above 50°C. HN-3 decomposes before its boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion. Polymerizes slowly, so munitions would be effective for several years. Heated to decomposition emits hydrogen chloride and nitrogen oxide.

Note: Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine vigorously chlorinate nitrogen mustards to the carbon chain giving low-toxicity products. In the presence of water, this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Potential Exposure: Sulfur mustards were formerly used as a gas warfare agent. Nitrogen mustards have not previously been used in warfare.[NIOSH] Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal.[NIOSH]

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) HN-3*

TEEL-0: 0.001 mg/m^3

PAC-1: 0.003 mg/m^3

PAC-2: **0.022** mg/m^3

PAC-3: **0.37** mg/m^3

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

AEL (US Military): 0.003 mg/m^3.

Determination in Water: A water contaminant. Octanol–water coefficient: Log K_{ow} = (estimated) 2.27.[NIOSH]

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Nitrogen mustards are extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although these agents cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Thus, patients/victims arriving immediately from the scene of nitrogen mustard exposure are not likely to have signs and symptoms. The sooner after exposure that symptoms occur, the more likely they are to progress and become severe.[NIOSH]

Short Term Exposure: Extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although these agents cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Most toxic of the nitrogen mustards. The median lethal dose for inhalation is 1500 mg-min/m^3; for skin absorption (masked personnel) is 10,000 mg-min/m^3. The medium incapacitating dose for eye injury is 200 mg-min/m^3; for skin absorption is 2500 mg-min/m^3. Irritates the eyes in quantities which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. After mild vapor exposure, there may be no skin lesions. After severe vapor exposures, or after exposure to the liquid, erythema may appear. Irritation and itching may occur. Later, blisters may appear in the erythematous areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and a persistent cough. Fever, labored respiration, and moist rales develop. Bronchial pneumonia may appear after the first 24 h. Following ingestion or systemic absorption, material causes inhibition of cell mitosis, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and nercosis in the mucous membranes. Ingestion of 2–6 mg causes nausea and vomiting.

Long Term Exposure: Chronic or repeated exposure to HN-3 may cause bone marrow suppression resulting in damage to the blood-forming (hematopoietic) system, lymph node damage, weakening of the immune system, kidney damage, and reproductive system damage.[NIOSH] Early signs of bone marrow suppression include: a low white blood cell count; an increased risk for developing infections; a tendency for easy bruising and bleeding. May cause lymph node damage and a weakened immune system. It also causes liver and kidney damage, damage to the reproductive systems of both men and women leading to decreased fertility. It is mutagenic, toxic to the developing embryo, and carcinogenic.

First Aid: There is no antidote for nitrogen mustard toxicity.

Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 h. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear Totally Encapsulating Chemical Protective (TECP) suit that provides protection against CBRN agents; Chemical-resistant inner and outer gloves; Chemical-resistant boots with a steel toe and shank; Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items. Take all necessary precautions to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage.[NIOSH] Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first 2 min following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/health-care providers or the health-care facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing.

(2) Patients exposed to liquid should be decontaminated by (a) Washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes, or open wounds with sterile saline or water.

(3) The health-care provider should (a) Check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process. (b) Be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time-consuming process. The health-care provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Where a potential exposure to the chemical exists, use a NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus (SCBA) with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Toxic liquids, organic, n.o.s. [Inhalation hazard, Packing Group I, Zone B] require a shipping label of "POISONOUS/TOXIC MATERIALS." Inhalation Hazard. It falls in Hazard Class 6.1 and Packing Group 1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation and skin contact. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

HN-3, when used as a weapon

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Fire Extinguishing: Poisonous gases, including nitrogen oxides and hydrogen chloride, are produced in fire. Use dry chemical, carbon dioxide, or foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Tris(2-Chloroethyl)Amine*. Washington, DC: Chemical Emergency Preparedness Program

Tris(2,3-dibromopropyl)-phosphate T:0970

Molecular Formula: $C_9H_{15}Br_6O_4P$

Common Formula: $[BrCH_2CH(Br)CH_2O]_3P = O$

Synonyms: 3PBR; Anfram 3PB; Apex 462-5; Bromkal P 67-6HP; 2,3-Dibromo-1-propanol phosphate; ES 685; Firemaster LV-T 23P; Firemaster T 23; Firemaster T 23P; Firemaster T 23P-LV; Flacavon R; Flammex AP; Flammex LV-T 23P; Flammex T 23P; Fosfato de tris(2,3-dibromopropilo) (Spanish); Fyrol HB 32; NCI-C03270; Phoscon PE 60; Phoscon UF-S; Phosphoric acid tris(2,3-dibromopropyl) ester; 1-Propanol, 2,3-dibromo-, phosphate (3:1); T 23P; TDBP; TDBPP; Tris; Tris BP; Tris(dibromopropyl) phosphate; Tris(2,3-dibromopropyl) phosphoric acid ester; Tris (flame retardant); Zetofex ZN

CAS Registry Number: 126-72-7

RTECS® Number: UB0350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-799-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A, 1999; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *D. melanogaster*—reciprocal translocation; Positive: Host-mediated assay; Histidine reversion—Ames test; Positive: Sperm morphology—mouse; *D. melanogaster* sex-linked lethal; Positive/dose response: *In vitro* SCE—nonhuman; *In vivo* SCE—nonhuman.

Banned or Severely Restricted (many countries) (UN).[13]

US EPA Hazardous Waste Number (RCRA No.): U235.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 0.10.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

California Proposition 65 Chemical: Cancer 1/1/88.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: TDBP is a crystalline solid. Molecular weight = 697.67; Flash point ≥112°C.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Tris-BP is used as a flame retardant additive for synthetic textiles and plastics. It was applied to fabrics used for children's clothes (sleepwear in particular) with some used as a flame retardant in other materials, such as urethane foams. Commercial preparations of tris-BP can be obtained in two grades, viz, HV (high in volatiles) and LV (low in volatiles). A typical LV sample has been reported to contain the following impurities[1]: 0.05% 1,2-dibromo-3-chloropropane ($BrCH_2CHBrCH_2Cl$); 0.05% 1,2,3-tribromopropane ($BrCH_2CHBrCH_2Br$); and 0.20% 2,3-dibromopropanol ($BrCH_2CHBrCH_2OH$). Use and exposure have greatly decreased after a ruling by the Consumer Product Safety Commission in April 1977.

Incompatibilities: Acids, bases.

Permissible Exposure Limits in Air

No numerical OELs have been set.

Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999.

Routes of Entry: TDBP was added to fabrics used for children's garments to the extent of 5−10% by weight. A child wearing such garment and chewing on a sleeve or collar could easily ingest some TDBP, particularly if the garment had not been laundered before use.

Harmful Effects and Symptoms

Short Term Exposure: May cause nausea, vomiting, gastrointestinal irritation. May cause central nervous system depression, headaches, dizziness.

Long Term Exposure: May cause skin sanitization and allergy; chronic lung disease; kidney damage, such as renal tubular necrosis; liver damage; testicular atrophy; and sterility. Suspected mutagenesis and carcinogenesis.

Points of Attack: Lungs, kidneys, liver, central nervous system, reproductive system.

Medical Surveillance: Lung function tests. Liver and kidney function tests. Examination of the nervous system.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eye well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in a cool, dry place and keep away from acids and bases. Where possible, automatically transfer material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s., require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60−70% acetone, then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including phosphorus oxides and bromine, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (April 1976). *Summary Characterization of Selected Chemicals of Near-Term Interest*, Report EPA 560/4-76-004. Washington, DC: Office of toxic Substances

US Environmental Protection Agency. (December 1979). *Status Assessment of Toxic Chemicals: Tris(2,3-Dibromopropyl) Phosphate*, Report EPA-600/2-79-210n. Cincinnati, OH

US Environmental Protection Agency. (August 1976). *Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates*, Report EPA-560/2-76-007. Washington, DC

Trypan blue T:0980

Molecular Formula: $C_{32}H_{24}N_6Na_4O_{14}S_4$

Common Formula: $C_{32}H_{24}N_6O_{14}S_4 \cdot 4Na$

Synonyms: AI3-26698; Amanil sky blue; Amanil sky blue R; Amidine blue 4B; Azidinblau 3B; Azidine blue 3B; Azirdinblau 3B; Azurro diretto 3B; Bencidal blue 3B; Benzaminblau 3B; Benzamine blue; Benzamine blue 3B; Benzanil blue 3BN; Benzanil blue R; Benzoblau 3B; Benzo blue; Benzo blue 3B; Benzo blue 3BS; Bleu diamine; Bleu diazole N 3B; Bleu directe 3B; Bleue diretto 3B; Bleu trypane N; Blue 3B; Blue EMB; Brasilamina blue 3B; Brasilazina blue 3B; Centraline blue 3B; Chloramiblau 3B; Chloramine blue; Chloramine blue 3B; Chlorazol blue 3B; Chrome leather blue 3B; C.I. 23850; C.I. Direct blue 14; C. I. Direct blue 14, tetrasodium salt; Congoblau 3B; Congo blue; Congo blue 3B; Cresotine blue 3B; Diaminblau 3B; Diamine blue; Diamine blue 3B; Diamineblue; Dianilblau; Dianilblau H3G; Dianil blue; Dianil blue H3G; Diaphtamine blue TH; Diazine blue 3B; Diazol blue 3B; 3,3′-[(3,3′-Dimethyl(1,1′-biphenyl)-4,4′-diyl]bis(azo)bis(5-amino-4-hydroxynaphthalene-2,7-disulphonate); Diphenyl blue 3B; Directakol blue 3BL; Directblau 3B; Direct blue 14; Direct blue 3B; Direct blue D3B; Direct blue FFN; Direct blue H3G; Direct blue M3B; Hispamin blue 3B; Naphtamine blue 2B; Naphtamine blue 3B; 2,7-Naphthalenedisulfonic acid, 2-57-13,3′-([3,3′-dimethyl(1,1′-biphenyl)-4,4′-diyl]bis(azo))bis(5-amino-4-hydroxy-, tetrasodium salt; 2,7-Naphthalenedisulfonic acid, 3,3′-([3,3′-dimethyl(1,1′-biphenyl)-4,4′-diyl]bis(azo))bis(5-amino-4-hydroxy-), tetrasodium salt; 2,7-Naphthalenedisulfonic acid, 3,3′-[(3,3′-dimethyl-4,4′-biphenylylene)bis(azo)]bis(5-amino-4-hydroxy-), tetrasodium salt; Naphthaminblau 3B; Naphthamine blue 3B; Naphthylamine blue; NCI: C61289; Niagara blue; Niagara blue 3B; NSC 11247; Orion blue 3B; Paramine blue 3B; Parkibleu; Parkipan; Pontamine blue 3B; Pyrazol blue 3B; Pyrotropblau; Renolblau 3B; Sodium ditolyl-diazobis-8-amino-1-naphthol-3,6-disulfonate; Sodium ditolyldisazobis-8-amino-1-naphthol-3,6-disulfonate; Sodium ditolyldisazobis-8-amino-1-naphthol-3,6-disulphonate; TB; Tetrasodium; Trianol direct blue 3B; Triazolblau 3B; Tripan blue; Trypan blue BPC; Trypan blue sodium salt; Trypane blue

CAS Registry Number: 72-57-1

RTECS® Number: QJ6475000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

EC Number: 200-786-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence*, possibly carcinogenic to humans*, Group 2B, 1987.

US EPA Hazardous Waste Number (RCRA No.): U236.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/89.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Trypan blue is a dark blue crystalline solid or powder. Molecular weight = 964.88. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used in dyeing textiles; leather and paper; as a biological stain.

Incompatibilities: Strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 2 mg/m^3

PAC-1: 6 mg/m^3

PAC-2: 40 mg/m^3

PAC-3: 500 mg/m^3

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* No symptoms reported. *Skin:* may stain skin. *Eyes:* application of 0.2 mL (0.007 oz) of a 1% solution caused no eye irritation. *Ingestion:* moderately toxic. Probable lethal dose between 1 oz and 1 lb for a 150-lb person.

Long Term Exposure: A potential occupational carcinogen, mutagen, and teratogen. Has been shown to cause birth defects, cancer, and liver injury in laboratory animals.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Avoid creating dust. Where possible, automatically pump material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." Tris(2,3-dibromopropyl) phosphate falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguisher appropriate for burning material. Poisonous gases are produced in fire, including oxides of sodium, nitrogen, and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

New York State Department of Health. (July 1986). *Chemical Fact Sheet: Trypan Blue*. Albany, NY: Bureau of Toxic Substance Assessment

Tungsten & insoluble compounds T:0985

Common Formula: W; WC; WCCo; WCNi; WCTi

Synonyms: *metal:* Tungsten, elemental; Tungsten metal; Wolfram

Tungsten carbide (cemented): Cemented tungsten carbide; Cemented WC; Hard metal

Tungsten other insoluble compounds: Tungsten(IV) oxide 12036-22-5; Tungsten trioxide 1314-35-8; Tungstic acid (7783-03-1); 12070-12-1 (tungsten carbide)

CAS Registry Number: 7440-33-7 (elemental); 12718-69-3 (92% W, 8% Co); 11107-01-0 (85% W, 15% Co); 37329-49-0 (78% W: 14% Co: 8% Ti)

RTECS® Number: YO7175000 (elemental); YO7525000 (92% W: 8% Co); Y07350000 (85% W, 15% Co); YO7700000 (78% W: 14% Co: 8% Ti)

UN/NA & ERG Number: UN3189 (metal powder, self-heating, n.o.s.)/135

EC Number: 231-143-9 (tungsten)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NIOSH (tungsten carbide containing >0.3% Ni) NIOSH: Potential occupational carcinogen.

Air in Pollutant Standard Set. See below, "Permissible Exposure Limits Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, for tungsten and its compounds.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Tungsten is a hard, brittle, steel-gray to tin-white metal or fine powder. Molecular weight = 183.85; Boiling point = 5927°C; Freezing/Melting point = 3410°C. Insoluble in water. Tungsten carbide is a gray powder; Freezing/Melting point = 2780°C. Cemented tungsten carbide is a mixture, generally consisting of 85−95% tungsten carbide (WC) and 5−15% cobalt (Co). Physical properties vary depending upon the specific mixture. Insoluble in water. Tungsten carbide is a gray powder. Molecular weight = 195.86; Boiling point: 6000°C at 760 mmHg; Melting point = 2730−2830°C; solubility in water = <1 mg/mL at 18°C.[NTP] Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0.

Potential Exposure: Compound Description (tungsten): Reproductive Effector; Primary Irritant. Tungsten is used in ferrous and nonferrous alloys, and for filaments in incandescent lamps. It has been stated that the principal health hazards from tungsten and its compounds arise from inhalation of aerosols during mining and milling operations. The principal compounds of tungsten to which workers are exposed are ammonium paratungstate, oxides of tungsten (WO_3, W_2O_5, WO_2), metallic tungsten, and tungsten carbide. In the production and use of tungsten carbide tools for machining, exposure to the cobalt used as a binder or cementing substance may be the most important hazard to the health of the employees. Since the cemented tungsten carbide industry uses such other metals as tantalum, titanium, niobium, nickel, chromium, and vanadium in the manufacturing process, the occupational exposures are generally to mixed dust.

Incompatibilities: *Tungsten:* The finely divided powder is combustible and may ignite spontaneously in air. Incompatible with bromine trifluoride, chlorine trifluoride, fluorine, iodine pentafluoride. *Tungsten carbide:* Incompatible with strong oxidizers: fluorine (may cause ignition), chlorine trifluoride, iodine pentafluoride, mercuric iodine, oxides of nitrogen, lead dioxide, strong acid mixtures (i.e., HNO_3/HCl mixture).

Permissible Exposure Limits in Air

Tungsten and insoluble compounds

OSHA PEL: None.

NIOSH REL: 5 mg[W]/m^3 TWA; 10 mg[W]/m^3 STEL [also applies to other insoluble compounds (as W)].

ACGIH TLV®[1]: 5 mg[W]/m^3 TWA; 10 mg[W]/m^3 STEL [also applies to other insoluble compounds (as W)].

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 150 mg/m^3

PAC-3: 500 mg/m^3

Denmark: TWA 5 mg[W]/m^3, 1999; Norway: TWA 5 mg [W]/m^3, 1999; Poland: MAC (TWA) fume and dust 5 mg [W]/m^3, 1999; Russia: STEL 2 mg[W]/m^3, 1993; Sweden: NGV 5 mg[W]/m^3, 1999; United Kingdom: TWA 5 mg [W]/m^3, STEL 10 mg[W]/m^3, 2000.

Tungsten soluble compounds

OSHA PEL: None.

NIOSH REL: 1 mg[W]/m^3 TWA; 3 mg[W]/m^3 STEL.

ACGIH TLV®[1]: 1 mg[W]/m^3 TWA; 3 mg[W]/m^3 STEL.

Tungsten carbide containing >2% Co

NIOSH REL: 0.05 mg[W]/m^3 TWA; See *NIOSH Pocket Guide*, Appendix C.

Tungsten carbide containing >0.3% Ni

NIOSH REL: 0.015 mg[W]/m^3 TWA; Potential occupational carcinogen; Reduce exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A & C.

Tungsten carbide

Protective Action Criteria (PAC)

For 12070-12-1 (92% W, 8% Co)

TEEL-0: 5.33 mg/m^3
PAC-1: 10.7 mg/m^3
PAC-2: 26.6 mg/m^3
PAC-3: 125 mg/m^3

Cemented tungsten carbide (example: 85%: 15%) or *tungsten carbide, mixed with cobalt and titanium* (example: 78% W: 14% Co: 8% Ti) also known as "hard metal" refers to a mixture of tungsten carbide, cobalt, and sometimes metal oxides or carbides and other metals (including nickel). When the *cobalt* (Co) content exceeds 2%, its contribution to the potential hazard is judged to exceed that of tungsten carbide. Therefore, the NIOSH REL (10-h TWA) for cemented tungsten carbide containing >2% Co is 0.05 mg [Co]/m^3; the applicable OSHA PEL is 0.1 mg[Co]/m^3 (8-h TWA). *Nickel* (Ni) may sometimes be used as a binder rather than cobalt. NIOSH considers cemented tungsten carbide containing nickel to be a potential occupational carcinogen and recommends a REL of 0.015 mg [Ni]/m^3 (10-h TWA). The OSHA PEL for *insoluble nickel*, 1 mg (Ni)/m^3 8-h TWA applies to mixtures of tungsten carbide and nickel.

Tungsten carbide

Australia: TWA 5 mg[W]/m^3, STEL 10 mg[W]/m^3, 1993; Austria: MAK 5 mg[W]/m^3, 1999; Belgium: TWA 5 mg [W]/m^3, STEL 10 mg[W]/m^3, 1993; Denmark: TWA 5 mg [W]/m^3, 1999; Finland: TWA 5 mg[W]/m^3, 1999; Norway: TWA 5 mg[W]/m^3, 1999; the Philippines: TWA 1 mg[W]/m^3, 1993; Poland: MAC (TWA) 5 mg[W]/m^3, 1999; Sweden: NGV 5 mg[W]/m^3, 1999; Switzerland: MAK 5 mg [W]/m^3, 1999; United Kingdom: TWA 5 mg[W]/m^3, STEL 10 mg[W]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 5 mg[W]/m^3; STEL 10 mg[W]/m^3.

For both tungsten and tungsten carbide, Russia[43] set a MAC of 6.0 mg[W]/m^3 in work-place air. Several states have set guidelines and standards for tungsten in ambient air[60] ranging from 16.0 μg/m^3 (Virginia) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada).

Determination in Air: *For tungsten metal and tungsten soluble compounds:* Use NIOSH Analytical Method (IV) #7074, #7301, OSHA Analytical Method ID-213. See also Method #7300, Elements. There is no specific method for *cemented tungsten carbide.*

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 14 μg/L based on health effects. Russia[43] set a MAC of 0.1 mg [W]/L in water bodies used for domestic purposes.

Determination in Water: By neutron activation analysis.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Tungsten* can affect you when breathed in. Irritates the eyes, skin, and respiratory system. Some tungsten compounds can cause lung and skin problems. *Tungsten carbide* can affect you when breathed in. There is no health effects from exposure to pure tungsten carbide alone. However, tungsten carbide is often combined with nickel or cobalt to make cemented tungsten carbide (hard metal). Exposure to *tungsten carbide combined with cobalt or nickel* can cause skin irritation.

Long Term Exposure: Long-term exposure to *tungsten metal* and *cemented tungsten carbide* may cause diffuse pulmonary fibrosis (lung scarring), loss of appetite, nausea, cough. May cause blood changes. Exposure to *tungsten carbide combined with cobalt or nickel* can cause skin sensitization, lung allergy, with wheezing, coughing, and shortness of breath. Repeated exposure can cause pulmonary fibrosis. Long-term exposure to *tungsten-soluble compounds:* in animals: central nervous system disturbances; diarrhea; respiratory failure; behavioral, body weight, and blood changes.

Points of Attack: *Metal* and *cemented tungsten carbides:* Eyes, skin, respiratory system, blood. *Soluble compounds:* Eyes, skin, respiratory system, central nervous system, gastrointestinal tract.

Medical Surveillance: If you are exposed to tungsten alone, no medical tests are necessary. If you are exposed to cemented tungsten carbide (hard metal), the following are recommended before beginning employment and at regular times after that: lung function tests; chest X-ray every 2−3 years after five or more years of exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield when working with powders or dust unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *(tungsten metal and insoluble compounds)*: *Up to 50 mg[W]/m^3*: 100XQ (APF = 10) [Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Respirator for Tungsten carbide (cemented) containing Cobalt.

NIOSH/OSHA, for cobalt metal dust and fume: *0.25 mg/m^3: if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 mg/m^3*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (APF = 10) (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *20 mg/m^3:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Respirator for Tungsten carbide (cemented) containing Nickel.

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Tungsten must be stored to avoid contact with fluorine and chlorine compounds since violent reactions occur. Store in a tightly closed container in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where tungsten is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Tungsten carbide must be stored to avoid contact with fluorine, chlorine trifluoride, iodine pentafluoride, lead dioxide, nitrous oxide, nitrogen dioxide, and mercurium iodine since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area.

Shipping: Metal powder, self-heating, n.o.s. requires a label of “SPONTANEOUSLY COMBUSTIBLE.” Tungsten powdered metal falls in Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers; do not sweep in the case of tungsten carbide. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tungsten is a flammable powder. Use dry chemicals appropriate for extinguishing metal fires. In the case of tungsten carbide, extinguish fire using an agent suitable for type of surrounding fire. Tungsten carbide itself does not burn. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery of tungsten from sintered metal carbides, scrap, and spent catalysts has been described as an alternative to disposal.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Tungsten*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 442−453

National Institute for Occupational Safety and Health. (September 1977). *Criteria for a Recommended Standard: Occupational Exposure to Tungsten and Cemented Tungsten Carbide*, NIOSH Document No. 77-127

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Tungsten*. Trenton, NJ

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Tungsten Carbide*. Trenton, NJ

Tungsten hexafluoride T:0990

Molecular Formula: F_6W
Common Formula: WF_6
Synonyms: Tungsten fluoride
CAS Registry Number: 7783-82-6
RTECS® Number: YO7720000
UN/NA & ERG Number: UN2196/125
EC Number: 232-029-1

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥7.10% concentration).

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Tungsten hexafluoride is a toxic, colorless gas or a light yellow liquid. Molecular weight = 297.85; Freezing/Melting point = 2.5°C. Boiling point = 17.5−19.5°C. Reacts with water (decomposes).

Potential Exposure: A strong halogenating agent. Used to apply tungsten coatings to other surfaces by vapor deposition process; making electronics and components; in the manufacture of other chemicals.

Incompatibilities: Decomposes on contact with water and moist air, forming corrosive hydrofluoric acid. Violent reaction on contact with methyl silicate.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)
TEEL-0: 1.62 mg/m^3
PAC-1: 4.86 mg/m^3
PAC-2: 15 mg/m^3
PAC-3: 150 mg/m^3

Determination in Air: NIOSH Analytical Method (IV) #7074. See also Method #7300; NIOSH Analytical Method (IV) #7902, Fluorides.

Permissible Concentration in Water: The EPA has set a standard of 4 mg/L for fluoride[61] and the state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Tungsten hexafluoride is a corrosive chemical. Irritates the eyes, skin, and respiratory tract. Contact with liquid may cause frostbite. Tungsten hexafluoride can affect you when breathed in. Exposure to tungsten hexafluoride may expose you to both tungsten and fluorides. Exposure to very high levels of fluorides may cause symptoms of nausea, vomiting, abnormal pain, convulsions, and kidney damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite, diarrhea, or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Eyes, respiratory system, central nervous system, skeleton, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. Fluoride level in urine (for fluoride in urine, use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full face-piece respiratory protection is worn. Wear gas-proof goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic fluorides*.

Respirator Selection:

Fluorides

NIOSH/OSHA *12.5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *25 mg/m^3:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa* (any supplied-air respirator). *62.5 mg/m^3:* Sa:Cf (APF = 25)*† (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 mg/m^3:* 100F (APF = 50) + [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *250 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) + [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

†May need acid gas sorbent.

Tungsten (insoluble compounds)

NIOSH *(tungsten metal)*: *Up to 50 mg/m^3*: 100XQ (APF = 10) [Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Poison gas. Color Code—White Stripe: Contact Hazard; Store separately, not compatible with materials in solid white category. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed container in a cool well-ventilated area away from water. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: Tungsten hexafluoride requires a shipping label of "POISON GAS, CORROSIVE." It falls in Hazard Class 2.3.

Special precautions: Cylinders must be transported in a secure upright position, in a well-ventilated truck. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with self-contained breathing apparatus to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.8/2.8

Fire Extinguishing: Tungsten hexafluoride may burn but does not readily ignite. For small fires, use dry chemical or CO_2 extinguishers. Poisonous gases, including fluorine, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Tungsten Hexafluoride*. Trenton, NJ

Turpentine T:1000

Molecular Formula: $C_{10}H_{16}$ (approx.)

Synonyms: Gum spirits; Gum turpentine; Oil of turpentine; Spirits of turpentine; Steam distilled turpentine; Sulfate wood turpentine; Terebenthine (French); Terpentin oel (German); Turpentine steam distilled; Turps; Wood turpentine

CAS Registry Number: 8006-64-2; selected monoterpenes: 80-56-8 (α-Pinene); 127-91-3; 13466-78-9 (Carene); 498-15-7 (Carene)[CHRIS Manual]

RTECS® Number: YO8400000

UN/NA & ERG Number: UN1299/128

EC Number: 232-350-7 [*Annex I Index No.:* 650-002-00-6]

Regulatory Authority and Advisory Bodies

FDA—over-the-counter drug.

US EPA, FIFRA 1998 Status of Pesticides: Canceled/New AI.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*8006-64-2*): Hazard Symbol: Xn, N; Risk phrases: R10; R20/21/22; R36/38; R43; R51/53; R65; Safety phrases: S2; S36/37; S46; S61; S62 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*CAS: 8006-64-2*).

Description: Turpentine is the oleoresin from species of *Pinus* (Pinaceae) trees. The crude oleoresin (gum turpentine) is a yellowish, sticky, opaque mass, and the distillate (oil of turpentine) is a colorless, volatile liquid with a characteristic odor. Chemically, it contains: *alpha*-pinene; *beta*-pinene; camphene, monocyclic terpene; and terpene alcohols. Molecular weight = 136 (approx.); Specific gravity (H_2O:1) = 0.86 at 25°C; Boiling point = 153.8−170°C; Freezing/Melting point = −50 to −60°C; Vapor pressure = 4 mmHg; Flash point = 35°C (cc), also listed at 30−46°C (cc); Autoignition temperature = 253°C, also listed at 220−255°C. Explosive limit: LEL = 0.8%; UEL = 6%. Hazard Identification (based on NFPA-704 M

Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen, Human Data; Natural Product; Primary Irritant. Turpentines have found wide use as chemical feedstock for the manufacture of floor, furniture, shoe, and automobile polishes, camphor, cleaning materials, inks, putty, mastics, cutting and grinding fluids, paint thinners, resins, and degreasing solutions. Recently, *alpha*- and *beta*-pinenes, which can be extracted, have found use as volatile bases for various compounds. The components *d*-α-pinene and 3-carene, or their hydroperoxides, may be the cause of eczema and toxic effects of turpentine.

Incompatibilities: Forms an explosive mixture with air. Violent reaction with strong oxidizers, especially chlorine; chromic anhydride; stannic chloride; chromyl chloride.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.56 mg/m^3 (approx.) at 25°C & 1 atm.

OSHA PEL (8006-64-2): 100 ppm/560 mg/m^3 TWA.

NIOSH REL (8006-64-2): 100 ppm/560 mg/m^3 TWA (Intended change).

ACGIH TLV®[1] (*terpentine and selected monoterpenes*): 20 ppm/112 mg/m^3 TWA, sensitizer; not classifiable as a human carcinogen.

NIOSH IDLH: 200 ppm.

Protective Action Criteria (PAC)

8006-64-2

TEEL-0: 20 ppm

PAC-1: 20 ppm

PAC-2: 20 ppm

PAC-3: 800 ppm

DFG MAK (8006-64-2): 100 ppm/560 mg/m3; danger of skin sensitization.

Australia: TWA 100 ppm (560 mg/m^3), 1993; Austria: MAK 100 ppm (560 mg/m^3), 1999; Belgium: TWA 100 ppm (556 mg/m^3), 1993; Denmark: TWA 25 ppm (140 mg/m^3), 1999; Finland: TWA 100 ppm (560 mg/m^3), STEL 150 ppm, [skin], 1999; France: VME 100 ppm (560 mg/m^3), 1999; Hungary: TWA 300 mg/m^3, STEL 600 mg/m^3, 1993; the Netherlands: MAC-TGG 560 mg/m^3, 2003; the Philippines: TWA 100 ppm (560 mg/m^3), 1993; Poland: MAC (TWA) 300 mg/m^3; MAC (STEL) 840 mg/m^3, 1999; Russia: STEL 300 mg/m^3, 1993; Sweden: NGV 25 ppm (150 mg/m^3), KTV 50 ppm (300 mg/m^3), [skin], 1999; Turkey: TWA 100 ppm (560 mg/m^3), 1993; United Kingdom: TWA 100 ppm (566 mg/m^3), STEL 150 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen.

Russia[35, 43] set a MAC of 2.0 mg/m^3 for ambient air in residential areas on a momentary basis and 1.0 mg/m^3 on a daily average basis. Several states have set guidelines or standards for turpentine in ambient air[60] ranging from 5.6−8.4 mg/m^3 (North Dakota) to 9.3 mg/m^3 (Virginia) to 11.2 mg/m^3 (Connecticut and New York) to 13.333 mg/m^3 (Nevada).

α-Pinene (80-56-8)

Protective Action Criteria (PAC)

TEEL-0: 20 ppm

PAC-1: 20 ppm

PAC-2: 60 ppm

PAC-3: 300 ppm

Determination in Air: Use NIOSH Analytical Method #1551, Terpentine, #2549, Volatile organic compound.[18]

Permissible Concentration in Water: Russia[43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation of vapor and percutaneous absorption of liquid are the usual paths of occupational exposure. However, symptoms have been reported to develop from percutaneous absorption alone. Ingestion and/or skin and/or eye contact are also routes of entry.

Harmful Effects and Symptoms

Short Term Exposure: Turpentine can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. Higher levels can affect the CNS, causing headache, vertigo, dizziness, abdominal pain, nausea, vomiting, diarrhea, confusion, and rapid pulse. Swallowing the liquid may cause chemical pneumonia to develop. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Still higher levels can cause hematuria (blood in the urine), albuminuria, kidney damage, convulsions, and death.

Long Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. The liquid destroys the skin's natural oils, causing dryness and cracking. May damage the kidneys, bladder, and the nervous system. Can irritate the lungs; bronchitis may develop. Various kinds of products are in use as turpentine oil. Their respective toxicities and tendency to cause eczema, which probably arise from their content of δ-α-pinene and 3-carene, vary considerably. However, systematic comparative investigations for these products are lacking.

Points of Attack: Eyes, skin, respiratory system, central nervous system, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, give plenty of water to drink and get medical attention. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™ and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *800 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or CcrFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Sources of ignition, such as smoking and open flames, are prohibited where turpentine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of turpentine should be grounded and bonded. Drums must be equipped with self-closing values, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of turpentine.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Toxic fumes and gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 75−76

New Jersey Department of Health and Senior Services. (October 1996). *Hazardous Substances Fact Sheet: Turpentine*. Trenton, NJ

U

Uranium & compounds U:0100

Molecular Formula: U

Synonyms: *Metal:* Uranium 1; Uranium metal

Acetate: Acetato de uranilo (Spanish); Uranium acetate; Uranium bis(aceto-*o*)dioxo-; Uranium oxyacetate; Uranyl acetate

Uranium(IV)oxide: Black uranium oxide; Uranium dioxide; Uranous oxide (UO_2)

Uranyl nitrate, solid (10102-06-4): Bis(nitrato-*O*,*O*′)dioxo uranium; Nitrato de uranilo (Spanish); Uranium bis(nitrato-*o*)dioxo-, (T-4); Uranyl nitrate (EPA)

Uranyl nitrate (36478-76-9): Uranium, bis(nitrato-*O*,*O*′) dioxo, (OC-6-11)-

Nitrate hexahydrate: Bis(nitrato)dioxouranium hexahydrate; Dinitratodioxouranium, hexahydrate

Uranium sulfate (1314-64-3): Uranium (soluble compounds, as U); Uranium sulfate trihydrate; Uranyl sulfate trihydrate ($UO_2SO_4 \cdot 3H_2O$)

CAS Registry Number: 7440-61-1 (elemental); *(alt.)* 24678-82-8; 541-09-3 (acetate); 1344-57-6 (dioxide); 10102-06-4 (nitrate); 36478-76-9 (uranyl nitrate); 13520-83-7 (uranyl nitrate hexahydrate); 6159-44-0 (uranyl acetate dihydrate)

RTECS® Number: YR3490000 (elemental); YR3850000 (nitrate); YR4705000 [uranium(IV)oxide]

UN/NA & ERG Number: UN2979 (uranium metal, pyrophoric)/162; UN2979 [Radioactive Materials (Low to Moderate Level Radiation)]/162; UN2909 (Radioactive material, excepted package, articles manufactured from depleted Uranium)/161; UN2910 (Radioactive material, excepted package, articles manufactured from depleted Uranium)/161; UN2980 (uranyl nitrate hexahydrate solution)/162; UN2981 (uranyl nitrate, solid)/162

EC Number: 231-170-6 (elemental)

Regulatory Authority and Advisory Bodies

Carcinogenicity: NIOSH (*uranium, insoluble and soluble compounds*): Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 100 lb (45.4 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations (*uranium and compounds*): Hazard Symbol: T+; Risk phrases: R26/28; R33; R53; Safety phrases: S1/2; S20/21; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*uranyl acetate dihydrate*).

Description: Uranium is a silver-white, malleable, ductile, lustrous solid. Weakly radioactive but must be handled with caution. A combustible solid in the form of powder or turnings. Insoluble in water. Molecular weight = 238.00; Specific gravity (H_2O:1) = 19.05 at 25°C (metal); Boiling point = 3813°C; Freezing/Melting point = 1147°C; Autoignition temperature = 20°C (dust cloud); Ignition temperature of dust cloud = 20°C; Minimum Explosive concentration = 0.060 oz/ft^3.[USBM] Relative explosion hazard of dust: Severe. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0; Minimum explosive concentration (MEC) = 60 g/m^3.

In the natural state, uranium consists of three isotopes: ^{238}U (99.28%), ^{234}U (0.006%), and ^{235}U (0.714%). There are over 100 uranium minerals; those of commercial importance are the oxides and oxygenous salts. The processing of uranium ore generally involves extraction then leaching either by an acid or by a carbonate method. The metal may be obtained from its halides by fused salt electrolysis.

Uranium(IV)oxide is a black to brown crystalline solid or powder. Molecular weight = 270.03; Freezing/Melting point = 2865°C. Insoluble in water.

Uranyl chloride (7791-26-6) is a bright yellow crystalline solid. Molecular weight = 349.90; Freezing/Melting point = 578°C. Highly soluble in water (unstable).

Uranyl nitrate, solid (10102-06-4) is a yellow crystalline solid. Molecular weight = 394.02; Boiling point = 118°C; Freezing/Melting point = 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2 (Oxidizer).

Uranyl nitrate, hexahydrate

Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1.

Uranyl sulfate: Molecular weight = 420.2. Soluble in water.

Potential Exposure: The primary use of natural uranium is in nuclear energy as a fuel for nuclear reactors, in plutonium production, and as feeds for gaseous diffusion plants. It is also a source of radium salts. Uranium compounds are used in staining glass, glazing ceramics, and enameling; in photographic processes; for alloying steels; and as a catalyst for chemical reactions; radiation shielding; and aircraft counterweights. Uranium presents both chemical and radiation hazards, and exposures may occur during mining, processing of the ore, and production of uranium metal.

Incompatibilities: *Uranium:* Metal powder is radioactive, pyrophoric (ignites spontaneously in air), and a strong reducing agent. Keep away fromchlorine, fluorine, nitric acid, nitric oxide, selenium, sulfur, carbon dioxide, carbon tetrachloride. Complete coverage of uranium metal scrap or turnings with oil is essential for prevention of fire.

Uranium(IV)oxide: May spontaneously ignite on contact with air when heated above 700°C.

Uranium hydride: Keep away from strong oxidizers, water, halogenated hydrocarbons.

DOI: 10.1016/B978-1-4377-7869-4.00020-5

Uranyl chloride: Aqueous solutions are chemically unstable.
Uranyl nitrate(s): Keep away from combustible materials; reducing agents; Uranium hexafluoride: water.
Uranium hexafluoride: Water.

Permissible Exposure Limits in Air
OSHA PEL: (*natural & insoluble compounds*) 0.25 mg[U]/m^3 TWA; (*soluble*) 0.05 mg[U]/m^3 TWA.
NIOSH REL: (*natural & insoluble compounds*) 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL; (*soluble*) 0.05 mg[U]/m^3 TWA; Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL, Confirmed Human Carcinogen; BEI issued.
NIOSH IDLH: 10 mg[U]/m^3.
Protective Action Criteria (PAC)*
Uranium metal and some insoluble compounds
TEEL-0: 0.25 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 2.5 mg/m^3
PAC-3: 10 mg/m^3
1344-57-6 (uranium oxide)
TEEL-0: 0.284 mg/m^3
PAC-1: 0.681 mg/m^3
PAC-2: **10** mg/m^3
PAC-3: **30** mg/m^3
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.
36478-76-9 (uranyl nitrate)
TEEL-0: 0.0828 mg/m^3
PAC-1: 0.993 mg/m^3
PAC-2: 3 mg/m^3
PAC-3: 16.6 mg/m^3
Uranium, soluble compounds
TEEL-0: 0.05 mg/m^3
PAC-1: 0.6 mg/m^3
PAC-2: 2 mg/m^3
PAC-3: 10 mg/m^3
DFG MAK (uranium compounds): 0.25 mg[U]/m^3, measured as the inhalable fraction.
Australia: TWA 0.2 mg[U]/m^3, STEL 0.6 mg[U]/m^3, 1993; Belgium: TWA 0.2 mg[U]/m^3, STEL 0.5 mg[U]/m^3, 1993; Belgium: TWA 0.2 mg[U]/m^3, STEL 0.6 mg[U]/m^3, 1993; Denmark: TWA 0.2 mg[U]/m^3, 1999; Finland: TWA 0.2 mg[U]/m^3, 1999; Norway: TWA 0.2 mg[U]/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg[U]/m^3, 2003; the Philippines: TWA 0.25 mg[U]/m^3, 1993; Poland: MAC (TWA) 0.015 mg[U]/m^3; MAC (STEL) 0.12 mg[U]/m^3, 1999; Poland: MAC (TWA) 0.075 mg[U]/m^3, 1993; Russia: STEL 0.015 mg[U]/m^3, 1993; Russia: STEL 0.075 mg[U]/m^3, 1993; Switzerland: MAK-W 0.2 mg[U]/m^3, 1999; Turkey: TWA 0.05 mg[U]/m^3, 1993; United Kingdom: LTEL 0.2 mg [U]/m^3, STEL 0.6 mg[U]/m^3, 1993.
Uranium, soluble compounds
OSHA PEL: 0.05 mg[U]/m^3 TWA.
NIOSH REL: TWA 0.05 mg[U]/m^3, Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL, Confirmed Human Carcinogen.
DFG MAK (uranium compounds): 0.25 mg[U]/m^3, measured as the inhalable fraction.
NIOSH IDLH: 10 mg[U]/m^3.
Russia[43] sets a MAC of 0.015 mg[U]/m^3 in work-place air for soluble uranium compounds and 0.075 mg[U]/m^3 for insoluble compounds. Several states have set guidelines or standards for uranium in ambient air[60] ranging from 2.0 to 6.0 μg/m^3 (North Dakota) to 3.5 μg/m^3 (Virginia) to 4.0 μg/m^3 (Connecticut) to 5.0 μg/m^3 (Nevada).

EPA Limits and advisory levels:
United States, annual radiation exposure limits are found in Title 10, part 20 of the Code of Federal Regulations, and in equivalent state regulations.
Public dose limits due to licensed activities (NRC) 100 mRem (0.01 Sv)/year.
Air: Radium NESHAP = 10 mRem (0.1 Sv)*
Water: ^{226}Ra & ^{228}Ra (combined radium) MCL = 5 pCi/L; ^{224}Ra = 15 picocuries/liter (5 pCi/L)*
Indoor Air (advisory "action level"): 4 pCi/L radon (Rn)
*Both the air and water standards limit the increased lifetime cancer risk to about 2 in 10,000.

Guidance Matrix for Radiological Dispersal Device (RDD) Incidents

OSHA Occupational Exposure Limits for Ionizing Radiation 29 CFR 1910.1096	Rem (Sv)/calendar quarter
Whole body, head and trunk, active blood-forming organs, lens of eye, or gonads	1.25 (0.0125 Sv)
Hands and forearms, feet, and ankles	18.75 (0.1875 Sv)
Skin of whole body	7.5 (0.075 Sv)
Minors (workers under 18 yrs)	10% of above limits
Majors (workers over 18 yrs)	ADVANCE \d43 Rem (0.3 Sv) may be permitted under conditions specified in 29 CFR 1910.1096(b)(2)

Note: The Department of Homeland Security is currently chairing an interagency workgroup which is in the process of assessing the protective action guidance for response to an RDD event.

Determination in Air: No method is available.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 3 μg/L based on health effects. Several states have set guidelines and standards for uranium in drinking water ranging from 10 μCi/L (Massachusetts) to 30 μCi/L (California) to 35 μCi/L (Arizona) to 15 μg/L (Colorado).

Routes of Entry: Inhalation of fume, dust, or gas; ingestion; skin and/or eye contact. The following uranium salts are reported to be capable of penetrating intact skin: uranyl nitrate, $UO_2(NO_3)_2 \cdot 6H_2H$; uranyl fluoride, UO_2F_2; uranium pentachloride, UCl_5; uranium trioxide (uranyl oxide), UO_3; sodium diuranate [sodium uranate (VI), $Na_2U_2O_7$]; uranium hexafluoride, UF_6.

Harmful Effects and Symptoms

Short Term Exposure: Prolonged contact with skin should be avoided to prevent radiation injury.

Uranium and its compounds are highly toxic substances. The compounds which are soluble in body fluids possess the highest toxicity. Poisoning has generally occurred as a result of accidents. Acute chemical toxicity produces damage primarily to the kidneys. Kidney changes precede in time and degree the effects on the liver. Chronic poisoning with prolonged exposure gives chest findings of pneumoconiosis, pronounced blood changes, and generalized injury.

It is difficult to separate the toxic chemical effects of uranium and its compounds from their radiation effects. The chronic radiation effects are similar to those produced by ionizing radiation. Reports now confirm that carcinogenicity is related to dose and exposure time. Cancer of the lung, osteosarcoma, and lymphoma have all been reported.

For soluble compounds: lacrimation, conjunctivitis, shortness of breath, coughing, chest rales, nausea, vomiting, skin burns, casts in urine, albuminuria, high blood urea nitrogen, lymphatic cancer. *For insoluble compounds:* dermatitis; cancer of lymphatic and blood-forming tissues.

Long Term Exposure: Can cause dermatitis, kidney damage, blood changes. A potential occupational carcinogen. Potential for cancer is a result of *alpha*-emitting properties and radioactive decay products (e.g., radon).

Points of Attack: *For soluble compounds:* respiratory system, blood, liver, kidneys, lymphatic system, skin, bone marrow. *Cancer site:* lungs. *For metal and insoluble compounds:* skin, kidneys, bone marrow, lymphatic system. *Cancer site:* lungs.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); complete blood count; chest X-ray; urine (chemical/metabolite); urinalysis (routine). Special attention should be given to the blood, lung, kidney, and liver in preemployment physical examinations. In periodic examinations, tests for blood changes, changes in chest X-rays, or for renal injury and liver damage are advisable. Uranium excretion in the urine has been used as an index of exposure. Whole body counting may also be useful. Blood Urea Nitrogen (BUN) for soluble compounds.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Soluble compounds*, especially UF_6: Wear appropriate clothing to prevent any possibility of skin contact with UF_6. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated with UF_6 and daily at the end of each work shift. Work clothing should be changed daily if it is possible that clothing is contaminated with UF_6. Remove nonimpervious clothing immediately if wet or contaminated UF_6. Provide emergency showers and eyewash if UF_6 is involved.

Insoluble compounds: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection:

Soluble Uranium Compounds: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape (halides):* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Escape (nonhalides):* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Insoluble Uranium Compounds: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Radioactive. (1) Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. (2) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Uranium metal, pyrophoric, requires a shipping label of “RADIOACTIVE, SPONTANEOUSLY COMBUSTIBLE.” It falls in Hazard Class 7.

Uranyl nitrate, solid, requires a shipping label of “RADIOACTIVE, OXIDIZER.” It falls in Hazard Class 7.

Uranyl nitrate, hexahydrate solution, requires a shipping label of “CORROSIVE.” It falls in Hazard Class 7.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Uranium chips or turnings should be covered with oil to prevent fires, and collected in sealed containers for later disposal. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the US EPA’s Environmental Response Team (ERT), Edison, NJ. Telephone 24-h hotline: 908-548-8730.

Fire Extinguishing: Uranium is an explosion hazard as dust or solid when exposed to flame. In case of fire, contact the local, state, or department of energy radiological response team. *Do not use water*. Use graphite, soda ash, powdered sodium chloride, or suitable dry powder. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of wastes containing uranium (uranium and compounds) should follow guidelines set forth by the nuclear regulatory commission. Contact the nuclear regulatory commission regarding disposal notification. Recovery for reprocessing is the preferred method. Processes are available for uranium recovery from process wastewaters and process scrap. Burial at an authorized radioactive burial site.

References

US Environmental Protection Agency. (May 1977). *Toxicology of Metals, Vol. II: Uranium*, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 454−472

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Bentor, Y. (November 2, 2010). *Chemical Element.com—Radium*. <http://www.chemicalelements.com/elements/ra.html>

29 CFR 1910.1096. *Ionizing Radiation*. OSHA Standard.

Environmental Protection Agency (EPA), Office of Radiation Programs. (May 1992). *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*. 16 MB PDF, 274 p.

US Department of Energy (DOE). (May 2001). *Radiological Emergency Response Health and Safety Manual*, Report DOE/NV/11718-440. 1 MB PDF, 103 p.

US Army Medical Research Institute of Chemical Defense (USAMRICD), Chemical Casualty Care Division (USAMRICD) MCMR-UV-ZM. (July 2000). *Field Management of Chemical Casualties* (2nd ed.). Aberdeen Proving Grounds, MD

Urea U:0110

Molecular Formula: CH_4N_2O

Common Formula: H_2NCONH_2

Synonyms: Carbamide; Carbamide resin; Carbamimidic acid; Carbonyl diamide; Carbonyldiamine; Isourea; NCI-C02119; Prespersion, 75 Urea; Pseudourea; Supercel 3000; Ureaphil; Ureophil; Urevert; Varioform II

CAS Registry Number: 57-13-6

RTECS® Number: YR6250000

EC Number: 200-315-5

Regulatory Authority and Advisory Bodies

US EPA Gene-Tox Program, Positive: *In vitro* cytogenetics—human lymphocyte; Negative: Sperm morphology—mouse; Inconclusive: *E. coli* polA without S9.

US EPA, FIFRA 1998 Status of Pesticides: Canceled.

FDA—over-the-counter and proprietary drug.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Urea is a white crystalline solid. Molecular weight = 60.07; Boiling point = (decomposes); Freezing/Melting point = 133°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Drug, Mutagen; Reproductive Effector; Human Data; Primary Irritant. Urea is used in ceramics, cosmetics, paper processing, resins, adhesives, animal feeds; in the manufacture of isocyanurates, resins, and plastics; as a stabilizer in explosives; in medicines; and others.

Incompatibilities: Violent reaction with strong oxidizers, chlorine, permanganates, dichromates, nitrites, inorganic chlorides, chlorites, and perchlorates. Contact with hypochlorites can result in the formation of explosive compounds.

Permissible Exposure Limits in Air

AIHA WEEL: 10 mg/m^3 TWA.

Protective Action Criteria (PAC)

TEEL-0: 10 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

The state of New York[61] has set a guidelines of 0.03 μg/m^3 for urea in ambient air.

Russia set a MAC of 0.2 mg/m^3 in ambient air in residential areas on a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC of 80.0 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Causes irritation of the respiratory tract. Dust may cause difficult breathing especially if the person has asthma. *Skin:* May cause irritation, burning, or stinging. *Eyes:* Causes irritation. *Ingestion:* There have been no reported cases of human toxicity. However, some toxic effects have been seen in sheep with impaired liver function.

Long Term Exposure: Prolonged skin contact may cause dermatitis.

Points of Attack: Skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration in equipment containing a scrubber or thermal unit to reduce nitrogen oxide emissions.

References

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Urea*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency, Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

Urethane U:0120

Molecular Formula: $C_3H_7NO_2$

Common Formula: $H_2NCOOC_2H_5$

Synonyms: A 11032; Aethylcarbamat (German); Aethylurethan (German); Carbamic acid, ethyl ester; Carbamidsaeure-aethylester (German); Estane 5703; Ethyl carbamate; Ethylurethan; *o*-Ethylurethane; Ethyl urethane; Leucethane; Leucothane; NSC 746; Pracarbamin; Pracarbamine; U-Compound; Uretano (Spanish); Urethan; Urethane

CAS Registry Number: 51-79-6

RTECS® Number: FA8400000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-123-1[*Annex I Index No.:* 607-149-00-6]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NTP: Carcinogenesis studies; on test (2-year study), October 2000; NTP: Toxicity studies, RPT#TOX-52, October 2000.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; SHE—clonal assay; Positive: Cell transform.—mouse embryo; Positive: Cell transform.—RLV F344 rat embryo; Positive: *D. melanogaster*—whole sex chrom. loss; Positive: *D. melanogaster*—reciprocal translocation; Positive: *Mammalian micronucleus*; *N. crassa—reversion*; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive/dose response: *In vitro* SCE—nonhuman; Negative: *D. melanogaster*—nondisjunction; Host-mediated assay; Negative: *E. coli* polA with S9; Histidine reversion—Ames test; Negative: Sperm morphology—mouse; TRP reversion; Negative: *S. cerevisiae*—homozygosis; Inconclusive: *E. coli* polA without S9; *In vitro* UDS—human fibroblast.

Banned or Severely Restricted (many countries) (UN).[13]

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

US EPA Hazardous Waste Number (RCRA No.): U238.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

California Proposition 65 Chemical: Cancer 1/1/88; Developmental/Reproductive toxin 10/1/94.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R45; Safety phrases: S53; S45 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Urethane is a colorless, almost odorless crystalline solid or powder. Molecular weight = 89.11; Specific gravity (H_2O:1) = 1.11 at 25°C; Boiling point = 183°C; Freezing/Melting point = 49°C; Flash point = 92°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Agricultural Chemical; Drug, Tumorigen, Mutagen; Reproductive Effector. Urethane is used as a chemical intermediate in the manufacture of pharmaceuticals, pesticides, and fungicides; in the preparation of amino resins. It may be reacted with formaldehyde to give cross-linking agents that impart wash-and-wear properties to fabrics. It has also been used as a solubilizer and cosolvent in the manufacture of pesticides, fumigants, and cosmetics. It was formerly used in the treatment of leukemia. It occurs when diethylpyrocarbonate, a preservative used in wines, fruit juices, and soft drinks, is added to aqueous solutions.

Incompatibilities: Gallium, perchlorate, and strong oxidizers.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)

TEEL-0: 500 mg/m^3

PAC-1: 500 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 3A, *as carbamic acid ethyl ester*.
Austria: carcinogen, 1999; Finland: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999. Several states have set guidelines or standards for urethane in ambient air[60] ranging from zero (North Dakota) to 0.03 μg/m^3 (New York) to 5000.0 μg/m^3 (South Carolina).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.15$

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Urethane can affect you when breathed in and by passing through your skin. High exposures may affect the CNS, causing dizziness, lightheadedness, and unconsciousness. Very high exposures can cause damage to the liver, brain, and blood-forming organs.

Long Term Exposure: Urethane is a carcinogen and may be a teratogen. Handle with extreme caution. Repeated exposures can damage the liver, brain, and blood-forming organs.

Points of Attack: Liver, brain, blood.

Medical Surveillance: Before beginning employment, and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: liver function tests. Complete blood count. If symptoms develop or overexposure suspected, the following may be useful: examination of the nervous system.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that this airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water or milk to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Urethane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), strong bases, camphor, menthol, salol, or thymol since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s. require a label of "POISONOUS/TOXIC MATERIALS." Urethane falls in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

US Environmental Protection Agency. (1979). *Chemical Hazard Information Profile: Urethane*. Washington, DC

New Jersey Department of Health and Senior Services. (May 2001). *Hazardous Substances Fact Sheet: Urethane*. Trenton, NJ

V

Valeraldehyde V:0100

Molecular Formula: $C_5H_{10}O$
Common Formula: $CH_3(CH_2)_3CHO$
Synonyms: Amyl aldehyde; Butyl formal; *n*-Pentanal; Pentanal; Valeral; *n*-Valeraldehyde; Valerianic aldehyde; Valeric acid aldehyde; *n*-Valeric aldehyde; Valeric aldehyde
CAS Registry Number: 110-62-3
RTECS® Number: YV3600000
UN/NA & ERG Number: UN2058/129
EC Number: 203-784-4
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Valeraldehyde is a colorless liquid with a strong acrid, pungent odor. The odor threshold is 0.028 ppm. Molecular weight = 86.15; Specific gravity (H_2O:1) = 0.81 at 25°C; Boiling point = 103°C; Freezing/Melting point = −92°C; Vapor pressure = 26 mmHg; Flash point = 12°C (oc); Autoignition temperature = 222°C. Explosive limits in air = LEL = 1.4%; UEL = 7.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Moderately soluble in water; solubility = 1.4% at 20°C.

Potential Exposure: Compound Description: Mutagen, Primary Irritant. Valeraldehyde is used in food flavorings and in resin chemistry. It is also used in the acceleration of rubber vulcanization.

Incompatibilities: Strong oxidizers, caustics, amines.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.53 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 50 ppm/175 mg/m^3 TWA, See Appendix C (Aldehydes) of the *NIOSH Pocket Guide*. Limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde.
ACGIH TLV®[1]: 50 ppm/176 mg/m^3 TWA.
No TEEL available.
Australia: TWA 50 ppm (175 mg/m^3), 1993; Belgium: TWA 50 ppm (176 mg/m^3), 1993; Denmark: TWA 50 ppm (175 mg/m^3), 1999; Finland: TWA 50 ppm (175 mg/m^3), STEL 75 ppm (265 mg/m^3), 1999; France: VME 50 ppm (175 mg/m^3), 1999; Norway: TWA 0.3 mg/m^3, 1999; Switzerland: MAK-W 50 ppm (175 mg/m^3), 1999; the Netherlands: MAC-TGG 175 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV®: TWA 50 ppm. Several states have set guidelines or standards for valeraldehyde in ambient air[60] ranging from 1.75 mg/m^3 (North Dakota) to 2.9 mg/m^3 (Virginia) to 3.5 mg/m^3 (Connecticut) to 4.167 mg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV), #2018, #2536, valeraldehyde, OSHA Analytical Method 85.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.31. See also NIOSH (IV) #2539, aldehydes, screening.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Valeraldehyde can affect you when breathed in. Contact can severely irritate the eyes, skin, nose, and throat. Exposure to very high levels can cause you to feel dizzy and lightheaded. Poisonous if swallowed.

Long Term Exposure: Testing has not been completed to determine the carcinogenicity of *n*-valeraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: See Long Term Exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00021-7

Respirator Selection: Where there is potential for exposures *over 50 ppm*, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full-face-piece powered air-purifying respirators. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full-face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where valeraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of valeraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of valeraldehyde.

Shipping: This compound requires a shipping label of “FLAMMABLE LIQUID.” It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Valeraldehyde*. Trenton, NJ

Vanadium & inorganic compounds V:0110

Molecular Formula: V

Synonyms: Elemental vanadium; Vanadio (Spanish); Vanadium-51; Vanadium, elemental

CAS Registry Number: 7440-62-2; 12070-10-9 (Vanadium carbide); *(alt.)* 11130-21-5

RTECS® Number: YW1355000

UN/NA & ERG Number: UN3285/151 (vanadium compound, n.o.s.)

EC Number: 231-171-1; 235-122-5 (vanadium carbide); 235-122-5 (vanadium carbide)

Regulatory Authority and Advisory Bodies

Carcinogenicity: DFG MAK: Carcinogen Category 2.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Except when contained in an alloy:

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 4.3; Nonwastewater (mg/L), 0.23.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (80); 7910 (2000); 7911 (40).

Safe Drinking Water Act: Priority List (55 FR 1470) as vanadium.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, elemental.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): Nonwater polluting agent.

Description: Vanadium is a light-gray or silver-white ductile solid, lustrous powder, or fused hard lump. Molecular weight = 50.94; Boiling point = 3380°C; Freezing/Melting point = 1917°C. Hazard Identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water. It is produced by roasting the ores, thermal decomposition of the iodide; or from petroleum residues; slags from ferrovanadium production; or soot from oil burning.

Vanadium carbide (CV) is a dark-gray powder. Insoluble in water.

Potential Exposure: Most of the vanadium produced is used in ferrovanadium and of this the majority is used in high speed and other alloy steels with only small amounts in tool or structural steels. It is usually combined with chromium, nickel, manganese, boron, and tungsten in steel alloys. Vanadium carbide is used in cutting tool bits. Melting point 2750−2810°C.

Incompatibilities: Violent reaction with strong oxidizers: chlorine, bromine trifluoride, lithium, nitryl fluoride, chlorine trifluoride.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.06 mg/m^3

PAC-1: 1.5 mg/m^3

PAC-2: 12.5 mg/m^3

PAC-3: 35 mg/m^3

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2.

Dust and fume: see vanadium pentoxide V:0120.

Determination in Air: Use NIOSH Analytical Method #7300, Elements, #7504, Vanadium oxides.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes. There is no US standard for vanadium in drinking water, but EPA[32] has suggested a permissible ambient goal of 7 μg/L based on health effects. The lack of data on acute or chronic oral toxicity is not surprising because of the extremely low absorption of vanadium from the gastrointestinal tract. Inhaled vanadium can produce adverse health effects.

Determination in Water: Russia set a limit of 0.1 mg/L for vanadium as a maximum permissible limit for water basins.

Routes of Entry: *For dust and fume:* Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vanadium can affect you when breathed in. Exposure may irritate the eyes, nose, throat, and air passages, with cough and phlegm. Eye contact may cause irritation. See also "Vanadium Pentoxide." *Ingestion:* acute poisoning in animals by ingestion of vanadium compounds has been shown to cause nervous disturbances, leg paralysis, respiratory failure, convulsions, bloody diarrhea, coma, and death.

Long Term Exposure: Can cause greenish-black coloration of the tongue and metallic taste. May cause eczema. Dust and/or fume may cause respiratory irritation; bronchitis may develop, with cough, fine rales, wheezing, dyspnea (breathing difficulty). See also "Vanadium Pentoxide."

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the workplace if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporarily removed from risk. See also "Vanadium Pentoxide."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 mg/m^3:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators) or SA* (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Vanadium must be stored to avoid contact with oxidizers (such as chlorates, nitrates, chlorine, and bromine trifluoride), since violent reactions occur. Store the powder in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Use only nonsparking tools and equipment, especially when opening and closing containers of the powder.

Shipping: Vanadium compound, n.o.s. requires a shipping label of “POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 6.1 and can fall into Packing Groups I, II, or III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Large pieces of vanadium are not combustible. The fine powder can burn. Use dry chemicals appropriate for extinguishing metal fires. *Do not use water.* Poisonous gases are produced in fire, including vanadium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1977). *Criteria for a Recommended Standard: Occupational Exposure to Vanadium*, NIOSH Document No. 77-222

National Academy of Sciences. (1974). *Medical and Biologic Effects of Environmental Pollutants: Vanadium*. Washington, DC

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Vanadium*. Trenton, NJ

Vanadium pentoxide V:0120

Molecular Formula: O_5V_2

Common Formula: V_2O_5

Synonyms: Anhydride vanadique (French); C.I. 77938; Divanadium pentoxide; Pentoxido de vanadilo (Spanish); UN2862; Vanadic acid anhydride; Vanadic anhydride; Vanadium oxide; Vanadium(5+) oxide; Vanadium(V) oxide; Vanadiumpentoxid (German); Vanadium pentoxide; Vanadium, pentoxyde de (French)

CAS Registry Number: 1314-62-1

RTECS® Number: YW2450000 (*dust*); YW2460000 (fume)

UN/NA & ERG Number: UN2862/151

EC Number: 215-239-8 [*Annex I Index No.:* 023-001-00-8]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (*dust*): (inhalation); clear evidence: mouse; rat; NTP: Carcinogenesis studies (fume); on test (2-year study), October 2000.

An OSHA specifically regulated substance.

US EPA Gene-Tox Program, Positive: *B. subtilis* rec assay.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

US EPA Hazardous Waste Number (RCRA No.): P120.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (80); 7910 (2000); 7911 (40).

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Reportable Quantity (RQ): 1000 lb (454 kg).

California Proposition 65 Chemical 2/11/05.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1% pentoxide.

European/International Regulations: Hazard Symbol: T, Xn; Risk phrases: R20/22; R37; R48/23; R51/53; R63; R68; Safety phrases: S1/2; S36/37; S38; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Vanadium pentoxide dust is an odorless, yellow to red crystal, or powder; or a fume when vanadium is heated. Vanadium pentoxide fume is a finely divided particulate dispersed in air. Molecular weight = 181.88; Specific gravity (H_2O:1) = 3.36 at 25°C; Boiling point = 1750°C (decomposes); Freezing/Melting point = 690°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.8%.

Potential Exposure: Compound Description (*dust*): Mutagen; Reproductive Effector; Human Data; Primary Irritant; (fume) Tumorigen. Vanadium pentoxide [V_2O_5] is an industrial catalyst in oxidation reactions, used in glass and ceramic glazes, a steel additive, and used in welding electrode coatings.

Incompatibilities: Strong acids, lithium, chlorine trifluoride, peroxyformic acid, combustible substances.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[V_sO_5]/m^3 (*dust*), respirable fraction; 0.1 mg[V_sO_5]/m^3 (fume) Ceiling Concentration.

NIOSH REL: 0.05 mg[V]/m^3 Ceiling Concentration [15 min, except vanadium metal and vanadium carbide].

ACGIH TLV®[1]: withdrawn.

NIOSH IDLH = 35 mg[V]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.179 mg/m^3

PAC-1: 1 mg/m^3

PAC-2: 7 mg/m^3

PAC-3: 125 mg/m^3

DFG MAK: Carcinogen Category: 2; Germ cell mutagen group: 2; (DFG 2005).

Listed under "dust"

Austria: MAK 0.05 mg/m^3, 1999; Denmark: TWA 0.03 mg [V]/m^3, 1999; Japan; 0.5 mg[V_2O_5]/m^3, 1999; Poland: MAC (TWA) 0.05 mg/m^3; MAC (STEL) 0.5 mg/m^3, 1999; Switzerland: MAK-W 50 ppm (175 mg/m^3), 1999; United Kingdom: TWA 0.5 mg[V]/m^3, total inhalable (*dust*); TWA 0.04 mg[V]/m^3, (fume and respirable dust), 2000.

Listed under "fume"

Austria: MAK 0.05 mg/m^3, 1999; Japan; 0.1 mg [V_2O_5]/m^3, 1999; Poland: MAC (TWA) 0.05 mg/m^3; MAC (STEL) 0.1 mg/m^3, 1999; Sweden: NGV 0.2 mg[V]/m^3, 1999; Switzerland: MAK-W 50 ppm (175 mg/m^3), 1999; United Kingdom: TWA 0.04 mg[V]/m^3, (fume and respirable dust); TWA 5 mg/m^3, 2000. Russia[43] set a MAC of 0.002 mg/m^3 in ambient air in residential areas on a daily average basis. Several states have set guidelines or standards for vanadium pentoxide in ambient air[60] ranging from 0.14 μg/m^3 (Massachusetts) to 0.8 μg/m^3 (Virginia) to 1.0 μg/m^3 (Connecticut and Nevada) to 5.0 μg/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements by ICP, #7301; #7303; #7504, Vanadium oxides; #9102, OSHA Analytical Method ID-185.

Determination in Water: Russia set a limit of 0.1 mg/L for vanadium as a maximum permissible limit for water basins.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vanadium pentoxide is irritating to the skin, eyes, and mucous membranes. Blindness and epistaxis (bloody nose) are further complications. Headache, dry mouth, dizziness, nervousness, insomnia, and tremor may be found. Probable oral lethal dose for humans is between 5 and 50 mg/kg or between 7 drops and 1 teaspoon for a 70-kg (150-lb) person. Toxicity is about the same magnitude as pentavalent arsenic. Acute exposure to vanadium pentoxide may result in pulmonary irritation, bronchospasm, hemoptysis (coughing up of blood), emphysema, anorexia, black stools, and pulmonary edema. Pulmonary edema is a medical emergency that can be delayed for several hours, and can cause death.

Long Term Exposure: May cause dermatitis, eczema, skin allergy. Lungs may be affected by repeated inhalation of dust or fumes; bronchitis may develop, with cough, fine rales, wheezing, dyspnea (breathing difficulty). May cause a green staining of the tongue and skin.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Test for urine level of vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the workplace if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporarily removed from risk.

An OSHA specifically regulated substance. See NIOSH Publication No. 2005-110, December 2004.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 mg/m*^{3}*:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators) or SA* (any supplied-air respirator). *1.25 mg/m*^{3}*:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m*^{3}*:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Vanadium pentoxide must be stored to avoid contact with chlorine trifluoride, lithium, and peroxyformic acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: Vanadium pentoxide, nonfused form, requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled materials; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but will increase the intensity of an existing fire. Extinguish fire using an agent suitable for type of surrounding fire. Vanadium pentoxide itself does not burn, but dust may increase the intensity of fire when in contact with combustible materials. Poisonous gases are produced in fire, including oxides of vanadium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Vanadium pentoxide may be salvaged or disposed of in a sanitary landfill.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Vanadium Pentoxide*. Washington, DC: Chemical Emergency Preparedness Program

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 83−84 (1982) and 8, No. 4, 81−92 (1988)

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Vanadium Pentoxide*. Trenton, NJ

Vanadium tetrachloride V:0130

Molecular Formula: Cl_4V
Common Formula: VCl_4
Synonyms: Vanadium chloride; Vanadium(IV) chloride
CAS Registry Number: 7632-51-1
RTECS® Number: YW2625000
UN/NA & ERG Number: UN2444/137
EC Number: 231-561-1
Regulatory Authority and Advisory Bodies

Carcinogenicity: DFG MAK: Carcinogen Category 2.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Vanadium tetrachloride is a thick, reddish-brown liquid that gives off fumes on exposure to moist air. Molecular weight = 192.74; Boiling point = 148.5°C at 75 mmHg; Freezing/Melting point = –28 ± 2°C. Hazard Identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 3, Flammability 0, Reactivity 2₩. Decomposes in water.

Potential Exposure: Vanadium tetrachloride is used as a fixative in textile dyeing and in the manufacture of other vanadium compounds.

Incompatibilities: Water, lithium, chlorine, trifluoride, combustible materials. Vanadium tetrachloride is a reactive chemical and is an explosion hazard. See storage and handling section.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3.

Protective Action Criteria (PAC)
TEEL-0: 0.6 mg/m^3
PAC-1: 2 mg/m^3
PAC-2: 12.5 mg/m^3
PAC-3: 60 mg/m^3

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2; (DFG 2005).

Determination in Air: Use Method #7300, Elements, #7504, Vanadium oxides.

Permissible Concentration in Water: Russia set a limit of 0.1 mg/L for vanadium as a maximum permissible limit for water basins.

Determination in Water: Russia set a limit of 0.1 mg/L for vanadium as a maximum permissible limit for water basins.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vanadium tetrachloride can affect you when breathed in and by passing through your skin. Vanadium tetrachloride is a corrosive chemical and eye contact can cause irritation and possible damage. Exposure can irritate the eyes, nose, throat, and lungs, with cough and shortness of breath. Higher exposures can cause pneumonia or pulmonary edema (fluid in the lungs). Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. Test for urine level of vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the workplace if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporarily removed from risk.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 mg/m^3:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators) or SA* (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Vanadium tetrachloride must be stored to avoid contact with water, heat, and poisonous gases since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from radiant heat and flammable and combustible materials, lithium, chlorine, and trifluoride. Vanadium tetrachloride decomposes slowly to vanadium trichloride and chloride. Open containers in dry oxygen-free atmosphere or in inert gas, wearing appropriate personal protective equipment. Chill to below 20°C before opening.

Shipping: Vanadium tetrachloride requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Do not use water* or wet method. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep out of sewers because of the possibility of fire and explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vanadium tetrachloride itself does not burn, but it may increase the intensity of fire since it is an oxidizer. Use dry chemical or CO_2 extinguishers on surrounding fire. *Do not use water* on material. Poisonous gases, including hydrogen chloride, vanadium oxides, and vanadium, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Use water spray to keep fire-exposed containers cool and to reduce vapors but do not get water inside containers of vanadium tetrachloride or on spilled material. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Vanadium Tetrachloride*. Trenton, NJ

Vanadyl sulfate V:0140

Molecular Formula: O_5SV

Common Formula: $VOSO_4$

Synonyms: C.I. 77940; Oxysulfatovanadium; Vanadium, oxysulfato (2-)-*o*-; Vanadium oxysulfide

CAS Registry Number: 27774-13-6

RTECS$^®$ Number: YW1925000

UN/NA & ERG Number: UN2931/151

EC Number: 248-652-7

Regulatory Authority and Advisory Bodies

Carcinogenicity: DFG MAK: Carcinogen Category 2.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Vanadyl sulfate is an odorless pale blue powder. Molecular weight = 163.1; Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Highly soluble in water.

Potential Exposure: Vanadyl sulfate is used as a fixative for textile dyes, a colorant for glass and ceramics, a reducing agent, and a catalyst.

Incompatibilities: Sulfates react with aluminum, magnesium. Incompatible with strong oxidizers.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 3 mg/m^3

PAC-2: 20 mg/m^3

PAC-3: 112 mg/m^3

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2; (DFG 2005).

Determination in Air: Use Method #7300, Elements, #7504, Vanadium oxides.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Toxic when ingested. Vanadyl sulfate can affect you when breathed in. Contact can irritate the skin. Exposure can irritate the eyes, nose, throat, and lungs with cough and phlegm. Higher exposures can cause pneumonia and/or pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long Term Exposure: Lungs may be affected by repeated inhalation; bronchitis may develop. May cause a greenish-black discoloration of the tongue and skin.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the workplace if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporarily removed from risk. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 mg/m^3:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering face-pieces) except quarter-mask respirators) or SA* (any supplied-air respirator). *1.25 mg/m^3:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 mg/m^3:* 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter) or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full-face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color Code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Vanadyl sulfate requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Use water spray to reduce vapors. Poisonous gases are produced in fire, including oxides of sulfur and vanadium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Vanadyl Sulfate*. Trenton, NJ

Vinyl acetate V:0150

Molecular Formula: $C_4H_6O_2$

Common Formula: $CH_3COOCH{=}CH_2$

Synonyms: Acetate de vinyle (French); Acetic acid, ethenyl ester; Acetic acid, vinyl ester; Aceto de vinilo (Spanish); 1-Acetoxyethylene; Ethenyl acetate; Ethenyl ethanoate; Ethonic acid, ethenyl ester; Everflex 811; Plyamul 40305-00; Unocal 76 RES 6206; Unocal 76 RES S-55; VAC; VAM; Vinnapas A 50; Vinylacetat (German); Vinyl acetate H.Q.; Vinyl acetate monomer; Vinyl A monomer; Vinyle (acetate de) (French); Vinyl ethanoate; VYAC; Zeset T

CAS Registry Number: 108-05-4; *(alt.)* 61891-42-7; *(alt.)* 82041-23-4

RTECS® Number: AK0875000

UN/NA & ERG Number: UN1301 (stabilized)/129

EC Number: 203-545-4 [*Annex I Index No.:* 607-023-00-0]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1995.

US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Positive/limited: Carcinogenicity—mouse/rat; Negative: Histidine reversion—Ames test.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6825 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Priority Pollutants (40CFR PART 423); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5).

CERCLA Section 302, Extremely Hazardous Substances, TPQ = 1000 lb (455 kg).

Reportable Quantity (RQ): 5000 lb (2270 kg).

CERCLA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+; Risk phrases: R11; Safety phrases: S2; S16; S23; S29; S33 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Vinyl acetate is a colorless, flammable liquid. The odor threshold is 0.12 ppm,[41] 0.3 ppm (NY, NJ). Molecular weight = 86.10; Specific gravity (H_2O:1) = 0.93 at 25°C; Boiling point = 72.2°C; Freezing/Melting point = −93.3°C; Vapor pressure = 83 mmHg at 25°C; Flash point = −8°C (cc); Autoignition temperature = 402°C. Explosive limits: LEL = 2.6%; UEL = 13.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble (2%) in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. Vinyl acetate is used primarily in polymerization processes to produce polyvinyl acetate, polyvinyl alcohol, and vinyl acetate copolymer. The polymers usually made as emulsions, suspensions, solutions, or resins are used to prepare adhesives, paints, paper coatings, and textile finishes. Low-molecular-weight vinyl acetate is used as a chewing gum base.

Incompatibilities: Violent reaction with strong oxidizers. The vapor may react vigorously with silica gel or aluminum. Acids, bases, silica gel, alumina, oxidizers, azo compounds. Ozone readily polymerizes in elevated temperatures, under the influence of light or peroxides. Usually contains a stabilizer [e.g., hydroquinone (limit to 2 months) or diphenylamine (for longer term)] to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.52 mg/m^3 at 25°C & 1 atm.

OSHA PEL: None.

NIOSH REL: 4 ppm/15 mg/m^3 [15 min] Ceiling Concentration.

ACGIH TLV®[1]: 10 ppm/35 mg/m^3 TWA; 15 ppm/53 mg/m^3 STEL, confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)*

TEEL-0: 6.7 ppm

PAC-1: **6.7** ppm

PAC-2: **180** ppm

PAC-3: **610** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 3A.

Australia: TWA 10 ppm (30 mg/m^3), STEL 20 ppm, 1993; Austria: MAK 1 ppm (35 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (35 mg/m^3), STEL 20 ppm, 1993; Denmark: TWA 10 ppm (30 mg/m^3), 1999; Finland: TWA 10 ppm (35 mg/m^3), STEL 20 ppm (70 mg/m^3), 1993; France: VME 10 ppm (30 mg/m^3), 1999; the Netherlands: MAC-TGG 18 mg/m^3, 2003; Poland: MAC (TWA) 10 mg/m^3; MAC (STEL) 30 mg/m^3, 1999; Sweden: NGV 5 ppm (18 mg/m^3), KTV 10 ppm (35 mg/m^3), 1999; Switzerland: MAK-W 10 ppm (35 mg/m^3), KZG-W 20 ppm (70 mg/m^3), 1999; Turkey: TWA 10 ppm (30 mg/m^3), 1993; United Kingdom: TWA 10 ppm (36 mg/m^3), STEL 20 ppm (72 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 15 ppm.

Russia[43] set a MAC of 0.15 mg/m^3 in ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for vinyl acetate in ambient air[60] ranging from 5.0 μg/m^3 (Virginia) to 9.6 μg/m^3 (Massachusetts) to 300.0−600.0 μg/m^3 (North Dakota) to 600.0 μg/m^3 (Connecticut) to 714.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1453, vinyl acetate; OSHA Analytical Method 51.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <0.8.

Permissible Concentration in Water: Russia[43] set a MAC of 0.2 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the eyes, skin, and respiratory tract, causing hoarseness, cough, loss of smell. A CNS depressant; high levels of exposure can cause fatigue, dizziness, lightheadedness, and disturbed sleep. *Inhalation:* Irritates the nose and throat, causing coughing and/or shortness of breath. Levels of 19 ppm for 4 h have caused slight throat irritation. The characteristic odor may not be recognized after about 2 h. Levels of 71 ppm for 1/2 h may cause definite throat irritations. May cause lesions of the lung tissue. *Skin:* Contact can cause irritation, dryness. Prolonged contact can cause rash, burns, and blisters. *Eyes:* Levels of 22 ppm and above may produce eye reddening and irritation. Contact can cause burns.

Long Term Exposure: May affect the heart, central nervous system, and liver. Levels above 22 ppm for 1 year may cause reversible irritation to eyes, throat, and lungs, sometimes accompanied by skin irritation or rash. Vinyl acetate has been related to reproductive abnormalities. Exposure caused gradual deterioration of heart muscles.

Points of Attack: Liver, eyes, heart, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following is recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Examination of the nervous system. EKG. Specific engineering controls are recommended for this chemical. Refer to NIOSH Criteria Document #78-205, Occupational Exposure to Vinyl Acetate.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon™, polyethylene and ethylene vinyl alcohol are recommended as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *40 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *200 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge (s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *400 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl acetate must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and direct sunlight. Sources of ignition, such as smoking and open flames, are prohibited where vinyl acetate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of vinyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinyl acetate. Wherever vinyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Water may be ineffective. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

National Institute for Occupational Safety and Health. (1978). *Criteria for a Recommended Standard: Occupational Exposure to Vinyl Acetate*, NIOSH Publication No. 78-205. Washington, DC

US Environmental Protection Agency. (April 23, 1984). *Chemical Hazard Information Profile Draft Report: Vinyl Acetate*. Washington, DC

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Vinyl Acetate Monomer*. Washington, DC: Chemical Emergency Preparedness Program

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Vinyl Acetate* (Version 2). Albany, NY: Bureau of Toxic Substance Assessment

Sax, N. I. (Ed.). (1989). *Dangerous Properties of Industrial Materials Report*, 9, No. 2, 89−106

New Jersey Department of Health and Senior Services. (April 2002). *Hazardous Substances Fact Sheet: Vinyl Acetate*. Trenton, NJ

Vinyl bromide V:0160

Molecular Formula: C_2H_3Br
Common Formula: $CH_2{=}CHBr$
Synonyms: Bromoethene; Bromoethylene; Bromure de vinyle (French); Bromuro de vinilo (Spanish); Ethene, bromo-; Ethylene, bromo-; Monobromoethylene; Vinylbromid (German); Vinyle (bromure de) (French)
CAS Registry Number: 593-60-2
RTECS® Number: KU8400000
UN/NA & ERG Number: UN1085 (stabilized)/116
EC Number: 209-800-6 [*Annex I Index No.:* 602-024-00-2]
Regulatory Authority and Advisory Bodies
Carcinogenicity: IARC: Animal, Sufficient Evidence; Human, No Adequate Data, Group 2A, 1999 NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential Occupational carcinogen.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical 10/1/88.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations: Hazard Symbol: F+, T; Risk phrases: R45; R12 (Carc/Cat. 2); Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Vinyl bromide is a colorless gas or liquid with a pleasant odor. Shipped as a liquefied compressed gas with 0.1% phenol added to prevent polymerization. Molecular weight = 106.96; Specific gravity (H_2O:1) = 1.49 (liquid at 15.6°C); Boiling point = 15.6°C; Freezing/Melting point = −139.4°C; Vapor pressure = 1.4 atm; Relative vapor density (air = 1) = 3.97; Flash point = flammable gas; Autoignition temperature = 530°C. Explosive limits: LEL = 9.0%; UEL = 15.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 1. Insoluble in water.
Potential Exposure: Compound Description: Tumorigen, Mutagen. Vinyl bromide is used as an intermediate in organic synthesis and for the preparation of plastics by polymerization and copolymerization; as a comonomer with acrylonitrile and other vinyl monomers in modacrylic fibers; in the production of flame-retardant synthetic fibers.
Incompatibilities: Strong oxidizers (e.g., perchlorates, peroxides, chlorates, permanganates, and nitrates). May polymerize in heat, light, especially sunlight. Add 0.1% phenol to gas to prevent polymerization.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.38 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 0.5 ppm/2.2 mg/m^3 TWA, Suspected Human Carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 3500 ppm
PAC-2: 6000 ppm
PAC-3: 6000 ppm
Australia: TWA 5 ppm (20 mg/m^3), carcinogen, 1993; Belgium: TWA 5 ppm (22 mg/m^3), carcinogen 1993; Denmark: TWA 5 ppm (20 mg/m^3), 1999; Finland: TWA 5 ppm (20 mg/m^3), STEL 10 ppm (40 mg/m^3), carcinogen, 1999; Norway: TWA 1 ppm (4 mg/m^3), 1999; Switzerland: MAK-W 5 ppm (22 mg/m^3), 1999; United Kingdom: LTEL 5 ppm (20 mg/m^3), 1993; the Netherlands: MAC-TGG 0.012 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Suspected Human Carcinogen. Several states have set guidelines or standards for vinyl bromide in ambient air[60] ranging from zero (North Dakota) to 2.0 μg/m^3 (Virginia) to 44.0 μg/m^3 (Connecticut) to 48.07 μg/m^3 (Pennsylvania) to 66.7 μg/m^3 (New York) to 100.0 μg/m^3 (South Carolina) to 200.0 μg/m^3 (Florida) to 476.0 μg/m^3 (Nevada).
Determination in Air: Charcoal tube; Ethanol; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1009, Vinyl bromide, OSHA Analytical Method 08.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.6.
Routes of Entry: Inhalation, ingestion (liquid), skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Vinyl bromide can affect you when breathed in. Contact can irritate the eyes. A nervous system depressant; exposures may cause dizziness, lightheadedness, confusion, a lack of coordination, narcosis, nausea, vomiting. Contact with the liquid can cause frostbite.
Long Term Exposure: Potential occupational carcinogen.
Points of Attack: Eyes, skin, central nervous system, liver. Cancer site in animals: liver and lymph node.
Medical Surveillance: There are no special tests. However, medical attention is recommended if overexposure is suspected.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is NO REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl bromide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and heat or flame, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where vinyl bromide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: This compound requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vinyl bromide is a flammable gas. For small fires, use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

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New Jersey Department of Health and Senior Services. (June 2000). *Hazardous Substances Fact Sheet: Vinyl Bromide*. Trenton, NJ

Vinyl chloride V:0170

Molecular Formula: C_2H_3Cl
Common Formula: $CH_2{=}CHCl$
Synonyms: Chloroethene; Chloroethylene; Chlorure de vinyle (French); Cloruro de vinilo (Spanish); Ethene, chloro-; Ethylene, chloro-; Ethylene monochloride; Monochloroethene; Monochloroethylene; Troviduer; Trovidur; UN1086; VC; VCL; VCM; Vinylchlorid (German); Vinyl chloride monomer; Vinyl C monomer; Vinyle (chlorure de) (French)
CAS Registry Number: 75-01-4
RTECS® Number: KU9625000
UN/NA & ERG Number: UN1086 (stabilized)/116
EC Number: 200-831-0 [*Annex I Index No.*: 602-023-00-7]
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA: Known human carcinogen; NIOSH: Potential occupational carcinogen; OSHA: Potential human carcinogen; US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Positive: *In vivo* cytogenetics—human lymphocyte; *E. coli* polA with S9; Positive: Histidine reversion—Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; *S. pombe*—forward mutation; Negative: *D. melanogaster*—reciprocal translocation; Negative: Rodent dominant lethal; Mouse spot test; Negative: *S. cerevisiae*—homozygosis.
Banned or Severely Restricted (several countries) (UN).[13]
OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR 1910.1017).
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/92); 40CFR401.15 Section 307 Toxic Pollutants.
US EPA Hazardous Waste Number (RCRA No.): U043; D043.
RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.2 mg/L.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.27; Nonwastewater (mg/kg), 6.0.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8240 (10).
Safe Drinking Water Act: MCL, 0.002 mg/L; MCLG, zero; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 1 lb (0.454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
California Proposition 65 Chemical 2/27/87.
Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.
European/International Regulations (as chloroethylene): Hazard Symbol: F+, T; Risk phrases: R45; R12; Safety phrases: S53; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Vinyl chloride is a flammable gas at room temperature, and is usually encountered as a cooled liquid. The colorless liquid forms vapors which have a pleasant, ethereal odor. The odor threshold is variously given as 260 ppm,[41] 3000 ppm (NJ fact sheet), 4000 ppm (NY fact sheet) in air and 3.4 ppm in water (EPA Toxicological profile). Shipped as a liquefied compressed gas. Molecular weight = 62.50; Specific gravity (H_2O:1) = 0.88 (Liquid) at 25°C; Boiling point = −14°C; Freezing/Melting point = −160°C; Relative vapor density (air = 1) = 2.21; Flash point = flammable gas at −75°C (cc); Autoignition temperature = 472°C. Explosive limits: LEL = 3.6%; UEL = 33.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. Insoluble in water; 0.1% at 25°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Vinyl chloride is used as a vinyl monomer in the manufacture of polyvinyl chloride (vinyl chloride homopolymer) and other copolymer resins. It is also used as a chemical intermediate and as a solvent.

Incompatibilities: Copper, oxidizers, aluminum, peroxides, iron, steel. Polymerizes in air, sunlight, heat, and on contact with a catalyst, strong oxidizers, and metals, such as aluminum and copper, unless stabilized by inhibitors, such as phenol. Attacks iron and steel in the presence of moisture.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.56 mg/m^3 at 25°C & 1 atm.
OSHA PEL: 1 ppm/2.56 mg/m^3 TWA; 5 ppm [Avg not exceeding any 15 min period STEL].
NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV®[1]: 1 ppm/2.6 mg/m^3 TWA, Confirmed Human Carcinogen.
Protective Action Criteria (PAC)*
TEEL-0: 1 ppm
PAC-1: **250** ppm
PAC-2: **1200** ppm
PAC-3: **4800** ppm
*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: Carcinogen Category 1; TRK: 2 mL/m^3/5.2 mg/m^3; 2.4 mg[thioglycolic acid]/24 h, in urine; after several shifts.

Arab Republic of Egypt: TWA 2.5 mg/m^3, 1993; Australia: TWA 5 ppm (10 mg/m^3), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 5 ppm (13 mg/m^3), carcinogen 1993; Denmark: TWA 1 ppm (3 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (15 mg/m^3), STEL 10 ppm (30 mg/m^3), carcinogen, 1993; Hungary: STEL 10 mg/m^3, carcinogen, 1993; Japan 2.5 ppm (6.5 mg/m^3), carcinogen, 1999; the Netherlands: MAC-TGG 7.77 mg/m^3, 2003; Norway: TWA 1 ppm (3 mg/m^3), 1999; the Philippines: TWA 50 ppm (100 mg/m^3), 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 30 mg/m^3, 1999; Russia: TWA 1 mg/m^3, STEL 2.5 ppm (5 mg/m^3), 1993; Sweden: NGV 1 ppm (2.5 mg/m^3), KTV 5 ppm (13 mg/m^3), [skin], carcinogen, 1999; Switzerland: MAK-W 2 ppm (5.2 mg/m^3), carcinogen, 1999; Thailand: TWA 1 ppm (2.8 mg/m^3), 1993; Turkey: TWA 500 ppm (1300 mg/m^3), 1993; United Kingdom: TWA 7 ppm, carcubigen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. MAC values have been set for ambient air in residential areas[35] by Russia at 0.005 mg/m^3 on a momentary basis and by the Czech Republic at 0.3 mg/m^3 on a momentary basis and 0.1 mg/m^3 on a daily average basis. Several states have set guidelines or standards for vinyl chloride in ambient air[60] ranging from zero (North Dakota) to 0.038 μg/m^3 (North Carolina) to 0.4 μg/m^3 (Michigan and New York) to 1.0 μg/m^3 (Virginia) to 3.846 μg/m^3 (Kansas) to 3.9 μg/m^3 (Massachusetts) to 5.0 μg/m^3 (Pennsylvania) to 50.0 μg/m^3 (Connecticut, South Carolina, South Dakota) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1007, vinyl chloride, OSHA Analytical Method 04.

Permissible Concentration in Water: No criteria have been determined for the protection of freshwater or saltwater aquatic life due to insufficient data. For the protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 20 μg/L.[6] A long-term health advisory for vinyl chloride of 46 μg/L has been set by EPA.[48] Several states have set guidelines or standards for vinyl chloride in drinking water[61] ranging from zero (Rhode Island) to 0.15 μg/L (Minnesota) to 1.0 μg/L (Arizona, Florida, Kansas, Massachusetts, New Mexico, Vermont) to 2.0 μg/L (California, Maine, New Jersey, Colorado) to 5.0 μg/L (New York).

Determination in Water: Inert gas purge followed by gas chromatography with halide-specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 0.62$.

Routes of Entry: Inhalation, skin, and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* May affect the central nervous system. High exposures can cause dizziness, lightheadedness, sleepiness. Even higher levels can cause headache, nausea, weakness, unconsciousness, and possible death. Exposure at 8000 ppm for 5 min can cause a feeling of intoxication, tiredness, drowsiness, abdominal pain, numbness and tingling in fingers and toes, pains in joints, coughing, sneezing, irritability, loss of appetite and weight. *Skin:* Contact with liquid may cause frostbite; contact with vapor may cause irritation and rash. Absorption is possible through the skin. *Eyes:* Can cause severe and immediate irritation. Contact with the liquid may cause frostbite. *Ingestion:* Moderately toxic.

Long Term Exposure: May cause "scleroderma" a disease that causes the skin to become smooth, tight and shiny and causes the bones in the fingers to erode (resulting in club-like swelling and shortening of finger tips) and damage the blood vessels in the hands (Raynaud's syndrome). This causes the hands or feet to turn numb, pale or blue with even mild cold exposure. Connective tissue, bones, and joints of arms and legs may suffer damage. Repeated exposure can permanently damage the liver, spleen, kidneys, nervous system, and blood cells. Vinyl chloride can cause symptoms such as stomach ulcers and skin allergy. Not all symptoms disappear after exposure stops. Vinyl chloride has caused liver cancer in occupationally exposed individuals. It may damage the developing fetus and there is limited evidence that it is a teratogen in animals. An excess of spontaneous abortions has been reported among spouses of workers who have been exposed to vinyl chloride. Increased rates of birth defects have been reported in areas where vinyl chloride processing plants are located. Vinyl chloride's role in this increased risk is unknown at this time.

Points of Attack: Liver, central nervous system, blood, respiratory system, lymphatic system. Cancer site in humans: liver. Cancer site in animals: liver, brain, lung.

Medical Surveillance: OSHA mandates the following tests: blood serum; alkaline phosphatase; bilirubin, gamma glutamyl transpeptidase; serum glutamic oxaloacetic transaminase; serum glutamic pyruvic transaminase. NIOSH lists the following tests: alkaline phosphatase; blood serum: lactic dehydrogenase; chest X-ray; expired air; liver function tests: alkaline phosphatase, bilirubin, gamma glutamyl transpeptidase, serum glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase; pulmonary function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); red blood cell count; urine (chemical/metabolite); urinalysis (routine): albumin, whole blood (chemical/metabolite), ultrasonography of the liver. Complete examination of the skin and nervous system. If symptoms develop or overexposure is suspected, the following may be useful: X-rays of the fingers. Test for "urinary thiodiglycolic acid" (normal level is usually less than 2 mg/L). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton™, Silvershield™, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is NO REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Vinyl Chloride (1910.1017) $\leq$10 ppm: (1) Combination Type C supplied-air respirator, demand type, with half face-piece, and auxiliary self-contained air supply; (2) Type C supplied-air respirator, demand type, with half face-piece; or (3) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 h for concentrations of vinyl chloride *Up to 10 ppm*. *$\leq$25 ppm*: (1) Powered air-purifying respirator with hood, helmet, full or half face-piece, and a canister which provides a service life of at least 4 h for concentrations of vinyl chloride up to 25 ppm; or (2) Gas mask with front- or back-mounted canister which provides a service life of at least 4 h for concentrations of vinyl chloride *Up to 25 ppm*. *$\leq$100 ppm*: (1) Combination Type C supplied-air respirator, demand type, with full face-piece, and auxiliary self-contained air supply; or (2) Open-circuit self-contained breathing apparatus with full face-piece, in demand mode; or (3) Type C supplied-air respirator, demand type, with full face-piece. *$\leq$1000 ppm*: Type C supplied-air respirator, continuous-flow type, with full or half face-piece, helmet, or hood. *$\leq$3600 ppm*: (1) Combination Type C supplied-air respirator, pressure demand type, with full or half face-piece, and auxiliary self-contained air supply; or (2) Combination type continuous-flow supplied-air respirator with full or half face-piece and auxiliary self-contained air supply. *>3600 ppm*: or unknown concentration Open-circuit self-contained breathing apparatus, pressure-demand type, with full face-piece.

Storage: Flammable gas. Color Code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials. Color Code—Blue: Health Hazard/ Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl chloride must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where vinyl chloride is handled, used, or stored. Metal containers involving the transfer of 5 gallons of vinyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinyl chloride. Wherever vinyl chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Vinyl chloride requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to

clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vinyl chloride is a flammable gas. Use dry chemical or CO_2 extinguishers. Poisonous gases are produced in fire, including phosgene, hydrogen chloride, and carbon monoxide. Fire may restart after it has been extinguished. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22] A variety of techniques have been described for vinyl chloride recovery from PVC latexes.

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New Jersey Department of Health and Senior Services. (June 2001). *Hazardous Substances Fact Sheet: Vinyl Chloride*. Trenton, NJ

4-Vinyl-1-cyclohexene V:0180

Molecular Formula: C_8H_{12}

Common Formula: $C_6H_9CH{=}CH_2$

Synonyms: Butadiene dimer; Cyclohexenylethylene; 1-Ethenylcyclohexene; 4-Ethenyl-1-cyclohexene; NCI-C54999; 1,2,3,4-Tetrahydrostyrene; 1-Vinylcyclohex-3-ENE; 1-Vinylcyclohexene-3; 4-Vinyl-1-cyclohexene; 4-Vinylcyclohexene; 4-Vinylcyclohexene-1

CAS Registry Number: 100-40-3

RTECS® Number: GW6650000

UN/NA & ERG Number: UN1993/128

EC Number: 202-848-9

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1994; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; inadequate study: rat.

California Proposition 65 Chemical: Cancer 2/27/87; Developmental/Reproductive toxin (female) 8/7/09.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: 4-Vinyl-1-cyclohexene, a cyclic alkene, is a flammable liquid. Molecular weight = 108.20; Specific gravity (H_2O:1) = 0.83 at 25°C; Boiling point = 130.3°C; Freezing/Melting point = −109°C; Flash point = 16−21°C; Autoignition temperature = 269°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 2. Hydrolyzes in water.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector. 4-Vinyl-1-cyclohexene is used as an intermediate for the production of vinylcyclohexene dioxide, which is used as a reactive diluent in epoxy resins. Previous uses of 4-vinyl-1-cyclohexene include comonomer in the polymerization of other monomers and for halogenation to polyhalogenated derivatives which are used as flame retardants.

Incompatibilities: Hydrolyzes in water. Reacts with oxidizers, amines, alcohols.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: None.

ACGIH TLV®[1]: 0.1 ppm/0.44 mg/m^3 TWA; confirmed animal carcinogen with unknown relevance to humans.
AIHA WEEL: 1 ppm/4.4 mg/m^3 TWA.
Protective Action Criteria (PAC)
TEEL-0: 0.1 ppm
PAC-1: 0.3 ppm
PAC-2: 3500 ppm
PAC-3: 3500 ppm
DFG MAK: [skin] Carcinogen Category: 2.
Poland: MAC (TWA) 10 mg/m^3, 1999; the Netherlands: MAC-TGG 0.4 mg/m^3, 2003.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.93$.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vapors cause irritation and smarting of the eyes and respiratory system if present in high concentrations. The effect is temporary.

Long Term Exposure: Workers exposed to 4-vinyl-1-cyclohexene experienced keratitis (inflammation of the cornea), rhinitis, headache, hypotonia, leucopenia (decrease in the number of white blood cells), neutrophilia, lymphocytosis, and impairment of pigment and carbohydrate metabolism. A confirmed carcinogen.

Points of Attack: Blood, eyes.

Medical Surveillance: Complete eye examination. Complete blood count and hematocrit.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 min. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Store in an explosion-proof refrigerator. Protect from exposure to oxidizers, alcohols, amines, air, and light. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Flammable liquids, n.o.s. require a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be ineffective due to the low flash point. Water spray may be used however. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

US Environmental Protection Agency. (September 19, 1985). *Chemical Hazard Information Profile: 4-Vinyl-1-Cyclohexene*. Washington, DC

Vinyl cyclohexene dioxide V:0190

Molecular Formula: $C_8H_{12}O_2$

Synonyms: 1,2-Epoxy-4-(epoxyethyl)cyclohexane; 3-(Epoxyethyl)-7-oxabicyclo(4.1.0) heptane, vinyl cyclohexene diepoxide; NCI-C60139; 3-Oxiranyl-7-oxabicyclo(4.1.0) heptene; Ucet textile finish 11-74 (obs.); Unox epoxide 206; 4-Vinyl-1,2-cyclohexene diepoxide; 4-Vinyl-1-cyclohexene diepoxide; 4-Vinylcyclohexene diepoxide; Vinyl cyclohexene diepoxide; 1-Vinyl-3-cyclohexene dioxide; 4-Vinyl-1-cyclohexene dioxide; 4-Vinylcyclohexene dioxide

CAS Registry Number: 106-87-6; (*alt.*) 25550-49-6

RTECS® Number: RN8640000

UN/NA & ERG Number: UN2810/153

EC Number: 203-437-7 [*Annex I Index No.:* 603-066-00-4]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1994; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

California Proposition 65 Chemical: Cancer 7/1/90; Developmental/Reproductive toxin 8/1/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: T; Risk phrases: R23/24/25; R40; Safety phrases: S1/2; S36/37; S45; S63 (see Appendix 4).

WGK (German Aquatic Hazard Class): No value assigned.

Description: Vinyl cyclohexene dioxide is a colorless liquid. Molecular weight = 140.20; Specific gravity (H_2O:1) = 1.10 at 25°C; Boiling point = 227.2°C; Freezing/Melting point = −109°C; Vapor pressure = 0.1 mmHg at 25°C; Flash point = 110°C; Autoignition temperature = 392°C. Hazard Identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 3, Flammability 1, Reactivity 0. Highly soluble in water; reacts slowly.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Primary Irritant. This material is used as a monomer in the production of epoxy resins for coatings and adhesives, as a chemical intermediate, and as a reactive diluent.

Incompatibilities: Reacts with alcohols, amines and other active hydrogen compounds, water. Slowly hydrolyzes in water.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH REL: 10 ppm/60 mg/m^3 TWA [skin]; Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 10 ppm/57 mg/m^3 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)

TEEL-0: 0.1 ppm

PAC-1: 0.35 ppm

PAC-2: 2.5 ppm

PAC-3: 75 ppm

DFG MAK: [skin], Carcinogen Category: 2.

Australia: TWA 10 ppm (60 mg/m^3), [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (57 mg/m^3), [skin], carcinogen, 1993; Denmark: TWA 10 ppm (60 mg/m^3), 1999; Finland: TWA 10 ppm (60 mg/m^3), STEL 20 ppm (120 mg/m^3), carcinogen, 1999; Norway: TWA 10 ppm (60 mg/m^3), 1999; the Netherlands: MAC-TGG 60 mg/m^3, 2003; United Kingdom: LTEL 10 ppm (60 mg/m^3), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for vinyl cyclohexene dioxide in ambient air[60] ranging from zero (North Dakota) to 6.0 μg/m^3 (Virginia) to 150.0 μg/m^3 (Pennsylvania) to 600.0 μg/m^3 (Connecticut) to 1429 μg/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.32.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vinyl cyclohexene dioxide can affect you when breathed in and by passing through your skin. Irritates the eyes, skin and severely irritates the nose, throat, and lungs, causing coughing and wheezing. Prolonged contact can cause severe burns and blisters.

Long Term Exposure: Vinyl cyclohexene dioxide may cause a skin allergy to develop. If this happens, very small future exposure can cause itching and a rash. It can cause lung irritation; bronchitis may develop. A potential occupational carcinogen and a mutagen; handle with extreme caution. It may also damage the testes (male reproductive system). In animals: irritation of the eyes, skin, respiratory system; testicular atrophy; leukopenia (reduced blood leukocytes), necrosis thymus; skin sensitization.

Points of Attack: Eyes, skin, respiratory system, blood, thymus, lungs, reproductive system. Cancer site in animals: skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: White blood cell count. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately.

Skin Contact: Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of water. Seek medical attention.

Breathing: Remove the person from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat or flames, water, alcohols, amines. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic, liquids, organic, n.o.s. require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Concentrated waste containing no peroxides: discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides: perforation of a container of the waste from a safe distance followed by open burning.

References

National Institute for Occupational Safety and Health. (October 1977). *Information Profiles on Potential Occupational Hazards: Vinyl Cyclohexene Dioxide*, Report PB-276,678. Rockville, MD, pp. 54−57

New Jersey Department of Health and Senior Services. (August 2005). *Hazardous Substances Fact Sheet: Vinyl Cyclohexene Dioxide*. Trenton, NJ

Vinyl ether V:0200

Molecular Formula: C_4H_6O
Common Formula: $(CH_2{=}CH)_2O$
Synonyms: Divinyl ether; Divinyl oxide; Ethene, ethoxy-; Ethenyloxyethene; Ether, vinyl ethyl; Ethyl vinyl ether; Etoxyethene; EVE; 1,1-Oxybisethene; Vinamar; Vinesthene; Vinesthesin; Vinethen; Vinethene; Vinether; Vinidyl; Vinil etil eter (Spanish); Vinydan; Vinyl ethyl ether
CAS Registry Number: 109-93-3; 109-92-2
RTECS$^{®}$ Number: XZ6700000
UN/NA & ERG Number: UN1167(stabilized)/128
EC Number: 203-720-5
Regulatory Authority and Advisory Bodies
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 1—Slightly water polluting (*CAS: 109-92-2*).
Description: Vinyl ether is a volatile liquid. Molecular weight = 70.10; Boiling point = 28°C; Freezing/Melting point = −101°C; Flash point ≤ −30°C; Autoignition temperature = 360°C. Explosive limits: LEL = 1.7%; UEL = 27%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. Insoluble in water.
Potential Exposure: It is used as an inhalation anesthetic; in formulation of copolymers with vinyl chloride.
Incompatibilities: Forms peroxides when exposed to air or oxygen; may polymerize explosively with evolution of acetylene gas. Store away from oxidizers, heat, and sunlight. Reacts with concentrated nitric acid. May accumulate static electricity.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
109-92-2
TEEL-0: 15 ppm
PAC-1: 50 ppm
PAC-2: 350 ppm
PAC-3: 1500 ppm
Permissible Concentration in Water: No criteria set.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: A moderate health hazard. Irritates the eyes, skin, and respiratory tract. Affects the central nervous system, causing anesthesia, narcosis, and loss of consciousness.
Long Term Exposure: Prolonged exposure may cause liver damage.
Points of Attack: Central nervous system, liver.
Medical Surveillance: Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear skin protection. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Follow regulations in OSHA 29CFR1910.134 or European Standard EN149. Use a NIOSH/MSHA- or European Standard EN149-approved respirator; or use an approved supplied-air respirator with a full-face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a

full face-piece operated in pressure-demand or other positive-pressure mode.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage room or cabinet. Protect against static electricity and lightning. For large-quantity storage rooms, protect with automatic sprinklers, total flooding carbon dioxide, or dry chemical systems.

Shipping: Divinyl ether, inhibited, requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Allow to evaporate or incinerate. Beware of explosive peroxides in old containers.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 78−79 (1981). New York: Van Nostrand Reinhold Co.

Vinyl fluoride V:0210

Molecular Formula: C_2H_3F

Common Formula: $CHF{=}CH_2$

Synonyms: Ethene, fluoro-; Ethylene fluoro-; Fluorethylene; Fluoroethene; Fluoruro de vinilo (Spanish); Monofluroethylene; Vinyl fluoride monomer

CAS Registry Number: 75-02-5

RTECS® Number: YZ7351000

UN/NA & ERG Number: UN1860 (stabilized)/116

EC Number: 200-832-6

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Thresshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP: 11th Report on Carcinogens, 2004: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A, 1995.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

California Proposition 65 Chemical: Cancer 5/1/97.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Vinyl fluoride is a colorless gas. Molecular weight = 46.05; Boiling point = −72.2°C; Freezing/Melting point = −160.6°C; Relative vapor density (air = 1) = 1.60; Vapor pressure = 25.2 atm; Flash point = flammable gas; Autoignition temperature = 385°C. Explosive limits: LEL = 2.6%; UEL = 21.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: Compound Description: Tumorigen; Mutagen. Vinyl fluoride's primary use is as a chemical and polymer intermediate; used to make polyvinyl fluoride (Tedlar®) film. Polyvinyl fluoride film is characterized by superior resistance to weather, high strength, and a high dielectric constant. It is used as a film laminate for building materials and in packaging electrical equipment. Polyvinyl fluoride film poses a hazard, so it is not recommended for food packaging. Polyvinyl fluoride evolves toxic fumes upon heating.

Incompatibilities: May polymerize. Inhibited with 0.2% terpenes to prevent polymerization. Violent reaction with oxidizers. May accumulate static electrical charges.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.82 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 1 ppm TWA; 5 ppm Ceiling Concentration/15 min, CFR 1910.1017.
ACGIH TLV®[1]: 1 ppm, Suspected Human Carcinogen.
NIOSH IDLH: Not determined. Suspected occupational carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 1 ppm
PAC-1: 7.5 ppm
PAC-2: 50 ppm
PAC-3: 75,000 ppm
The state of South Carolina has set a guideline of 19.0 μg/m^3 for vinyl fluoride in ambient air.[60]

Following are OELs for hydrogen fluoride which is produced as a decomposition product in the heat of fire.

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA.
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration.
ACGIH TLV®[1]: 3 ppm/2.5 mg[F]/m^3 TWA; BEI: 3 mg [F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.
NIOSH IDLH: 30 ppm.

Determination in Air: There is no method listed by NIOSH. However, the following method is listed for gaseous fluorides: NIOSH Analytical Method 7902.[18]

Permissible Concentration in Water: The EPA has set a standard of 4 mg/L for fluoride[61] and the state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: A CNS depressant, causing headache, dizziness, confusion, a lack of coordination, nausea, vomiting, narcosis, unconsciousness. In industrial use, inhalation of dusts of decomposed fluorocarbon polymers may cause polymer fume fever characterized by headache, aching joints, general feeling of discomfort, cough, shivering, chills, fever, rapid heartbeat, and chest discomfort. Animal data indicate that concentrations at and above 30% (300,000 ppm) vinyl fluoride may cause symptoms of intoxication. Contact with the liquid may cause frostbite.

Long Term Exposure: May be a human carcinogen. Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite, diarrhea, or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Central nervous system, skeleton, kidneys.

Medical Surveillance: Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof or splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a well-ventilated area away from sources of ignition. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Vinyl fluoride, inhibited, requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (January 30, 1978). *Chemical Hazard Information Profile: Vinyl Fluoride*. Washington, DC

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Vinyl Fluoride*. Albany, NY: Bureau of Toxic Substance Assessment

Vinylidene chloride V:0220

Molecular Formula: $C_2H_2Cl_2$

Synonyms: Clorure de vinylidene (French); Cloruro de vinildeno (Spanish); 1,1-DCE; 1,1-Dichloroethene; 1,1-Dichloroethylene; Ethene, 1,1-dichloro-; Ethylene, 1,1-dichloro-; NCI-C54262; Sconatex; *asym*-Dichloroethylene; VDC; Vinylidene chloride(II); Vinylidene dichloride; Vinylidine chloride(II)

CAS Registry Number: 75-35-4

RTECS® Number: KV9275000

UN/NA & ERG Number: UN1303 (stabilized)/130

EC Number: 200-864-0 [*Annex I Index No.:* 602-025-00-8]

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal, Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA (*inhalation*) Suggestive evidence of carcinogenic potential; (*oral*): Available data are inadequate for an assessment of human carcinogenic potential; Possible Human Carcinogen; NCI: Carcinogenesis

Studies (gavage); no evidence: mouse, rat; NIOSH: Potential occupational carcinogen.

US EPA Gene-Tox Program, Positive: Histidine reversion—Ames test; Positive/limited: Carcinogenicity—mouse/rat; Negative: Rodent dominant lethal.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92); Toxic Pollutant (Section 401.15).

US EPA Hazardous Waste Number (RCRA No.): U078; D029.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA Toxicity Characteristic (Section 261.24), Maximum. Concentration of Contaminants, regulatory level, 0.7 mg/L.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.025; Nonwastewater (mg/kg), 6.0.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5).

Safe Drinking Water Act: MCL, 0.007 mg/L; MCLG, 0.007 mg/L; Regulated chemical (47 FR 9352).

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: F+, Xn; Risk phrases: R12; R20; R40; Safety phrases: S2; S7; S16; S29; S36/36; S46 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Vinylidene chloride is a volatile liquid or gas with a mild, sweet odor resembling that of chloroform. The odor threshold in air is 500 ppm. Molecular weight = 96.94; Specific gravity (H_2O:1) = 1.21 at 25°C; Boiling point = 31.7°C at 760 mm; Freezing/Melting point = −122.8°C; Vapor pressure = 500 mmHg at 25°C; Flash point = −18.9°C (cc); Autoignition temperature = 570°C. Explosive limits: LEL = 6.5%; UEL = 15.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. Practically insoluble in water; solubility = 0.04%.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Reproductive Effector; Human Data. Vinylidene chloride is used in the manufacture of 1,1,1-trichloroethane (methyl chloroform). However, the manufacture of polyvinylidene copolymers is the major use of VDC. The extruded films of the copolymers are used in packaging and have excellent resistance to water vapor and most gases. The chief copolymer is Saran® (polyvinylidene chloride/vinyl chloride), a transparent film used for food packaging. The films shrink when exposed to higher than normal temperatures. This characteristic is advantageous in the heat shrinking of overwraps on packaged goods and in the sealing of the wraps. Applications of VDC latexes include mixing in cement to produce high-strength mortars and concretes, and as binders for paints and nonwoven fabrics providing both water resistance and nonflammability. VDC polymer lacquers are also used in coating films and paper. VDC is also used to produce fibers. Monofilaments, made by extruding the copolymer, are used in the textile industry as furniture and automobile upholstery, drapery fabric, outdoor furniture, venetian-blind tape, and filter cloths.

Incompatibilities: Readily forms explosive peroxides; violent polymerization from heat or on contact with oxidizers, chlorosulfonic acid; nitric acid; or oleum; or under the influence of oxygen, sunlight, alkali metals; aluminum, copper. Explosive on heating or on contact with flames. Inhibitors, such as the monomethyl ether of hydroquinone, are added to prevent polymerization.

Permissible Exposure Limits in Air

OSHA PEL: None.

NIOSH PEL: None.

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV®[1]: 5 ppm/20 mg/m^3 TWA Not classifiable as a human carcinogen.

Protective Action Criteria (PAC)

TEEL-0: 5 ppm

PAC-1: 75 ppm

PAC-2: 500 ppm

PAC-3: 1000 ppm

DFG MAK: 2 ppm/8.0 mg/m^3; Peak Limitation Category II (2); Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 5 ppm (20 mg/m^3), STEL 20 ppm, 1993; Austria: MAK 2 ppm (8 mg/m^3), Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (20 mg/m^3), STEL 20 ppm (79 mg/m^3), 1993; Denmark: TWA 2 ppm (8 mg/m^3), 1999; Finland: TWA 10 ppm (40 mg/m^3), STEL 20 ppm (80 mg/m^3), carcinogen, 1999; France: VME 5 ppm (20 mg/m^3), 1999; the Netherlands: MAC-TGG 20 mg/m^3, 2003; Poland: MAC (TWA) 50 mg/m^3; MAC (STEL) 80 mg/m^3, 1999; Russia: STEL 50 mg/m^3, 1993; Sweden: NGV 5 ppm (20 mg/m^3), KTV 10 ppm (40 mg/m^3), 1999; Switzerland: MAK-W 2 ppm (8 mg/m^3), KZG-W 4 ppm (16 mg/m^3), 1999; United Kingdom: TWA 10 ppm (40 mg/m^3), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for Vinylidene chloride in ambient air[60] ranging from 0.2 μg/m^3 (Massachusetts) to 0.238 μg/m^3

(Kansas) to 3.5 μg/m^3 (Virginia) to 24.0 μg/m^3 (Pennsylvania) to 66.7 μg/m^3 (New York) to 120.0 μg/m^3 (North Carolina) to 200.0 μg/m^3 (Indiana) to 400.0 μg/m^3 (Connecticut) to 476.0 μg/m^3 (Nevada) to 200.0−10,000 μg/m^3 (North Dakota).

Determination in Air: NIOSH Analytical Method (IV) #1015, Vinylidene chloride, OSHA Analytical Method 19.

Permissible Concentration in Water: *To protect freshwater aquatic life:* 11,600 μg/L on an acute toxicity basis for dichloroethylenes as a class. *To protect saltwater aquatic life:* 224,000 μg/L on an acute basis for dichloroethylenes as a class; 1700 μg/L as a 24-h average, never to exceed 3900 μg/L. *To protect human health:* preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.33 μg/L.[6] Russia set a MAC of 0.6 μg/L in water bodies used for domestic purposes and WHO has set a limit of 0.3 μg/L for drinking water.

Determination in Water: Inert gas purge followed by gas chromatography with halide-specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 1.32$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Vinylidene chloride can affect you when breathed and by passing through skin. Exposure can irritate the eyes, nose, and throat. Contact can irritate and burn the eyes and skin. High levels may affect the CNS, causing dizziness, headache, nausea, dyspnea (breathing difficulty), a "drunken" feeling, unconsciousness. Swallowing the liquid may cause chemical pneumonitis.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis with drying and cracking. Repeated exposure may damage the liver, kidneys, and lungs. A potential occupational carcinogen. Handle with extreme caution. It may damage the developing fetus and cause reproductive damage in males.

Points of Attack: Eyes, skin, respiratory system, central nervous system, liver, kidneys. Cancer site in animals: liver and kidney; skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not present. Vinylidene chloride must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates, and strong acids, such as hydrochloric, sulfuric, and nitric, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where vinylidene chloride is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of vinylidene chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinylidene chloride. Wherever vinylidene chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Vinylidene chloride, inhibited, requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group I.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases, including phosgene, hydrogen chloride, and chlorine, are produced in fire. Do not extinguish fire unless flow can be stopped. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.[22]

References

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US Environmental Protection Agency. (April 30, 1980). *1,1-Dichloroethylene: Health and Environmental Effects Profile No. 71*. Washington, DC: Office of Solid Waste

US Environmental Protection Agency. (April 30, 1980). *Dichloroethylenes: Health and Environmental Effects Profile No. 73*. Washington, DC: Office of Solid Waste

Sax, N. I. (Ed.). (1982). *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 92−94

US Public Health Service. (December 1988). *Toxicological Profile for 1,1-Dichloroethene*. Atlanta, GA: Agency for Toxic Substances and Disease Registry

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Vinylidene Chloride*. Trenton, NJ

Vinylidene fluoride V:0230

Molecular Formula: $C_2H_2F_2$

Common Formula: $CH_2{=}CF_2$

Synonyms: 1,1-Difluoroethylene; Ethene, 1,1-difluoro-; Fluoruro de vinilideno (Spanish); Genetron®; Halocarbon 1132A; NCI-C60208; R1132A; Refrigerant gas, R 1132a; VDF; Vinylidene difluoride

CAS Registry Number: 75-38-7

RTECS® Number: KW0560000

UN/NA & ERG Number: UN1959/116

EC Number: 200-867-7

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal, Inadequate Data; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Vinylidene fluoride is a colorless gas with a faint ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 64.04; Boiling point = −85.6°C; Freezing/Melting point = −143.9°C; Vapor pressure = 35.2 atm; Flash point (flammable gas) ≤ −65°C; Autoignition temperature = 640°C. Explosive limits: LEL = 5.5%; UEL = 21.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Slightly soluble in water.

Potential Exposure: Compound Description: Tumorigen; Mutagen. Vinylidene fluoride is used in the formulation of many polymers and copolymers, such as chlorotrifluoroethylene-vinylidene fluoride (Kel F®), perfluoropropylene-vinylidene fluoride (Viton™, Fluorel®); polyvinylidene fluoride; and hexafluoropropylene-*tetra*-fluoroethylene-vinylidene fluoride; elastomeric copolymers. It is also used as a chemical intermediate in organic synthesis. NIOSH has estimated that 32,000 workers are exposed annually.

Incompatibilities: Contact with oxidizers can cause fire and explosions. Reacts with aluminum chloride. Capable of forming unstable peroxides, which can cause explosive polymerization. May accumulate static electricity, and cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.62 mg/m^3 at 25°C & 1 atm.
OSHA PEL: None.
NIOSH REL: 1 ppm TWA; 5 ppm Ceiling Concentration [15 min], use 29CFR1910.1017.
ACGIH TLV®[1]: 500 ppm/1310 mg/m^3 TWA, Not classifiable as a human carcinogen.
NIOSH IDLH: Not determined. Suspected occupational carcinogen.
Protective Action Criteria (PAC)
TEEL-0: 500 ppm
PAC-1: 500 ppm
PAC-2: 1250 ppm
PAC-3: 25,000 ppm
DFG MAK: Carcinogen Category 3B.
Austria: Suspected: carcinogen, 1999; Finland: carcinogen, 1993.

Determination in Air: NIOSH Analytical Method #3800.[18]

Permissible Concentration in Water: The EPA has set a standard of 4 mg/L for fluoride[61] and the state of Maine has set 2.4 mg/L as a guideline for drinking water. Arizona[61] has set 1.8 mg/L as a standard for drinking water.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short Term Exposure: Vinylidene fluoride is considered toxic by inhalation. The lowest lethal concentration is 128,000 ppm for a 4-h exposure. Vinylidene fluoride has been reported to be nontoxic to rats at 800,000 ppm. Irritating to skin and pulmonary tract. May affect the CNS, causing dizziness, disorientation, headache, a lack of coordination, narcosis, dizziness, nausea, vomiting. Contact with the liquid can cause frostbite.

Long Term Exposure: Repeated high exposures may affect kidneys. Repeated high exposures may cause deposits of fluorides in the bones (fluorosis), which may cause pain, disability, and mottling of the teeth.

Points of Attack: Eyes, respiratory system, central nervous system, skeleton, kidneys, skin.

Medical Surveillance: Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton™ and butyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator). *Up to 25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting face-piece and organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece); *Up to 200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. May form peroxides in storage. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store gas cylinders in a cool, dry place and use the safety precautions necessary with all compressed gases. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: 1,1-Difluoroethylene [or] Refrigerant gas, R 1132a requires a shipping label of "FLAMMABLE GAS." It falls in Hazard Class 2.1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Poisonous gases are produced in fire, including hydrogen fluoride, fluorine, and fluorides. Extinguish with CO_2 or dry chemical to allow access to valves to shut off supply if necessary. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

US Environmental Protection Agency. (January 30, 1978). *Chemical Hazard Information Profile: Vinylidene Fluoride*. Washington, DC

Vinyl toluene V:0240

Molecular Formula: C_9H_{10}

Common Formula: $CH_3C_6H_4CH{=}CH_2$

Synonyms: Ethenylmethylbenzene; *m*-Methyl styrene; *p*-Methyl styrene; 3- and 4-Methyl styrene; Methyl styrene; NCI-C56406; Tolyethylene; *m*-Vinyl toluene; *p*-Vinyl toluene; *p*-Vinyltoluene; Vinyl toluene, inhibited; Vinyl toluene, mixed isomers

a-isomer: see *a*-Methylstyrene

m-isomer: 1-Ethenyl-3-methylbenzene; Benzene, 1-ethenyl-3-methyl-; *m*-Methylstyrene; 3-Methylstyrene; 1-Methyl-3-vinylbenzene; *m*-Vinyltoluene; 3-Vinyltoluene

CAS Registry Number: 25013-15-4; *(alt.)* 1321-45-5; 100-80-1 (*m*-isomer)
RTECS® Number: WL5075000
UN/NA & ERG Number: UN2618 (stabilized)/130
EC Number: 246-562-2
Regulatory Authority and Advisory Bodies
Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat; IARC: Animal Lack Carcinogenicity; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994; NTP: Carcinogenesis studies (α-isomer); on test (prechronic studies), October 2000.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Vinyl toluene is a colorless liquid with a strong, disagreeable odor. It consists of mixed *meta*- and *para*-isomers. The odor threshold is 50 ppm. Molecular weight = 118.19; Specific gravity (H_2O:1) = 0.89 at 25°C; Boiling point = 170.6°C; Melting point = −76.7°C; Flash point = 53°C; Autoignition temperature = 538°C; also listed at 489−515°C. Explosive limits: LEL = 0.8%; UEL = 11.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2. Practically insoluble in water; solubility = 0.009%.

Potential Exposure: Compound Description (mixed isomers): Tumorigen, Mutagen; Reproductive Effector; Human Data; Primary Irritant; (*m*-isomer) Tumorigen, Mutagen. Vinyl toluene is used in copolymers and as specialty monomer for paint, varnish, and polyester preparations; as a solvent and an organic intermediate.

Incompatibilities: Violent reaction with oxidizers; catalysts for vinyl polymerization, such as peroxides, strong acids, iron or aluminum salts. Usually inhibited with *tert*-butylcatechol to prevent polymerization.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.83 mg/m^3 at 25°C & 1 atm.
Methyl styrene, all isomers
OSHA PEL: 100 ppm/480 mg/m^3 TWA.
NIOSH REL: 100 ppm/480 mg/m^3 TWA.
ACGIH TLV®[1]: 50 ppm/242 mg/m^3 TWA; 100 ppm/483 mg/m^3 STEL, Not classifiable as a human carcinogen.
No TEEL available.
DFG MAK: 100 ppm/490 mg/m^3 TWA; Peak Limitation Category I(2).
NIOSH IDLH: 400 ppm.
Australia: TWA 50 ppm (240 mg/m^3), STEL 100 ppm, 1993; Austria: MAK 100 ppm (480 mg/m^3), 1999; Belgium: TWA 50 ppm (242 mg/m^3), STEL 100 ppm (483 mg/m^3), 1993; Denmark: TWA 25 ppm (120 mg/m^3), [skin], 1999; Finland: TWA 50 ppm (240 mg/m^3), STEL 100 ppm (480 mg/m^3), 1999; France: VME 50 ppm (240 mg/m^3), 1999; the Netherlands: MAC-TGG 50 mg/m^3, [skin], 2003; the Philippines: TWA 100 ppm (480 mg/m^3), 1993; Poland: MAC (TWA) 100 mg/m^3; MAC (STEL) 300 mg/m^3, 1999; Russia: STEL 50 mg/m^3, 1993; Sweden: NGV 10 ppm (50 mg/m^3), KTV 75 ppm (150 mg/m^3), [skin], 1999; Switzerland: MAK-W 50 ppm (240 mg/m^3) KZG-W 100 ppm (480 mg/m^3), 1999; Turkey: TWA 100 ppm (480 mg/m^3), 1993; United Kingdom: TWA 100 ppm (491 mg/m^3), STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 100 ppm. Several states have set guidelines or standards for vinyl toluene in ambient air[60] ranging from 40 μg/m^3 (Virginia) to 2400.0 to 4850.0 μg/m^3 (North Dakota) to 5714 μg/m^3 (Nevada) to 9600.0 μg/m^3 (Connecticut).
m-isomer
Denmark: TWA 25 ppm (120 mg/m^3), [skin], 1999; France: VME 50 ppm (240 mg/m^3), 1999; Switzerland: MAK-W 50 ppm (240 mg/m^3), KZG-W 100 ppm (480 mg/m^3), 1999; United Kingdom: TWA 100 ppm (491 mg/m^3), STEL 150 ppm, 2000.

Determination in Air: Use NIOSH Analytical Method (IV) #1501, aromatic hydrocarbons, OSHA Analytical Method 7.

Determination in water: Octanol−water coefficient: Log K_{ow} = 3.58.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Vinyl toluene can affect you when breathed in. Exposure can irritate the eyes, nose, and upper respiratory system. A CNS depressant; very high levels can cause you to become dizzy, lightheaded, and drowsy. In animals: narcosis.

Long Term Exposure: Repeated exposure may affect the liver, kidneys, and nervous system. There is limited evidence that vinyl toluene may damage the developing fetus.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Liver and kidney function tests. Evaluation of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits,

gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *400 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl toluene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong acids, and aluminum chloride, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls into Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

New Jersey Department of Health and Senior Services. (November 2000). *Hazardous Substances Fact Sheet: Vinyl Toluene*. Trenton, NJ

Vomiting agents

Vomiting agents are not designed to kill or cause serious injury. They have been formulated to cause nausea and vomiting, causing their victims to become helpless. The major chemical warfare agent in this category and its code name are listed below along with its record number for quick access.

Adamsite, agent DM see A:0435.

VX (Agent VX, WMD) V:0250

Molecular Formula: $C_{11}H_{26}NO_2PS$

Synonyms: *S*-(2-Diisopropylaminoethyl) *O*-ethyl methylphosphonothiolate; *EA-1701; O*-Ethyl *S*-(2-[bis(1-methylethyl)amino] ethyl) methylphosphonothioate; Ethyl *S*-diiosopropylaminoethylmethyl thiophosphonate; *O*-Ethyl *S*-diisopropylaminoethyl methylphosphonothioate; Ethyl *S*-dimethylaminoethyl methyl phosphonothiolate; Methylphosphonothioic acid, *S*-(2-[bis(methylethyl)amino]ethyl) *O*-ethyl ester; Methylphosphonothioic acid, *S*-[2-bis(1-methylethyl)amino]ethyl) *O*-ethyl ester; Phosphonothioic acid, methyl-, *S*-[2-[bis(1-methylethyl)aminoethyl] *O*-ethyl] ester; Phosphonothioic acid, methyl-, S-[2-[bis(1-methylethyl)amino]ethyl] O-ethyl; ester; TX-60; VX (military designation)

CAS Registry Number: 50782-69-9

RTECS® Number: TB1090000

UN/NA & ERG Number: UN2810/123

EC Number: None assigned

Regulatory Authority and Advisory Bodies

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Carcinogenicity: VX is not listed by the International Agency for Research on Cancer (IARC); American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg).

Reportable Quantity (RQ): 100 lb (45.4 kg).

US DOT 49CFR172.101, Inhalation Hazardous Chemical.

Note: Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: VX, a sulfinated organophosphorus compound, is a nerve agent, and the most toxic of all known chemical warfare agents. VX can cause death in minutes. As little as one drop of VX on the skin can be fatal. VX is a colorless, to straw to amber-colored, odorless liquid. Looks like motor oil. Molecular weight = 267.37; Boiling point = 298°C (decomposition); Freezing/Melting point = −51°C; Volatility = 8.9−10.5 mg/m^3 at 25°C Vapor density (air = 1): 9.2; Vapor pressure = 0.0007 mmHg at 25°C; Vapor density (air = 1) = 9.2; Flash point = 159°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly to moderately soluble in water below 9.4°C; 30 g/L at 25°C. See "Medical Surveillance" below for odor detection.

Potential Exposure: VX is a quick-acting, military chemical nerve agent. VX is the most potent of all chemical warfare agents. It attacks the nervous system, causing the muscles to convulse uncontrollably. The nerve agent works similarly to pesticide and was originally developed in the early 1950s. Highly persistent, it can be dangerous for weeks and remains a liquid for more than 24 h. It poses little vapor hazard. The least volatile of the nerve agents, VX, is very slow to evaporate; about as slowly as motor oil. VX is highly efficient at skin penetration, more than any other of the "G" agents. It is used in the M-23 land mine. VX was never used in combat by the United States and all stockpiles of approximately 4400 tons of the Agent were destroyed in 2008 by the US Army Chemical Materials Agency (CMA).

Persistence of Chemical Agent: Agent VX: Summer: 2 days to a week; Winter: 2 days to weeks.

Incompatibilities: Contact with metals may evolve flammable hydrogen gas. Relatively stable at room temperature. Unstabilized VX of 95% purity decomposed at a rate of 5% a month at 71°C. At pH 12, the toxic by-product has a half-life of about 14 days and in 90 days there is about a 64-fold reduction.

Permissible Exposure Limits in Air

Conversion factor: 0.09145 ppm = 1 mg/m^3.

Protective Action Criteria (PAC) VX*

TEEL-0: 0.000005 ppm

PAC-1: 0.000016 ppm

PAC-2: **0.000016** ppm

PAC-3: **0.00027** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

STEL: 0.00001 mg/m^3.

WPL (worker population limit): 0.000001 mg/m^3.

The suggested permissible airborne exposure concentration of VX for an 8-h workday or a 40-h workweek is an 8-h time-weighted average (TWA) of 0.00001 mg/m^3 (9×10^{-7} ppm). This value is based on the TWA of VX as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX.*

GPL (general population limit): 0.0000006 mg/m^3.

Determination in Air: Available monitoring equipment for agent VX is the M8/M9 detector paper, (ACADA), detector ticket; M256/M256A1 kits; bubbler. Depot Area Air Monitoring System (DAMMS); automated Continuous Air Monitoring System (ACMS); Real-Time Monitor (RTM); Demilitarization Chemical Agent Concentrator (DCAC); M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED); and the Miniature Chemical Agent Monitor (MINICAM).

Determination in Water: Octanol−water coefficient: Log K_{ow} (estimated) = 2.06. VX is hydrolyzed only slowly, and the hydrolysis products include EA2192, which is nearly as toxic as VX and is hydrolyzed over 1000 times more slowly. Oxidation using common bleach Na(OCl) and superchlorinated bleach ($Ca(OCl)_2$)-calcium hypochlorite (HTH) will decontaminate.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Summary: Exposure can result in loss of consciousness, convulsions, paralysis, and respiratory failure resulting in death.

Short Term Exposure: VX. Acts as a cholinesterase inhibitor. Lowest toxic oral dose (TD_{LO}) to humans is 4 mg/kg; lowest lethal skin dose to humans (LD_{LO}) is 86 mg/kg. Death occurs within 15 min after fatal dose is absorbed. *Also reported:* VX is a lethal anticholinergic agent with the median dose in humans being: LC_{50} (skin) = 0.135 mg/kg; ID LC_{50} (Skin)—0.07−0.71 mg/kg; LCt_{50} (inhalation) = 30 mg-min/m^3; LCt_{50} (inhalation)—30 mg-min/m^3; LCt_{50} (inhalation)—24 mg-min/m^3.

One to several minutes after overexposure to airborne VX the following acute symptoms appear: *Local effects* (lasting 1−15 days, increases with dose). *Eyes:* Miosis (constriction of pupils); redness, pressure sensation on eyes. *Inhalation:* Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting. *Systemic effects* (increases with dose): *Inhalation*—excessive secretion causing coughing/breathing difficulty, salivation and sweating, vomiting, diarrhea, stomach cramps, involuntary urination/defecation, generalized muscle twitching/muscle cramps, CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming, and nightmares. With more severe exposure, headache, tremor, drowsiness, concentration difficulty, memory impairment, confusion, unsteadiness on standing or walking, and progression to death may also occur.

After exposure to liquid VX, the following acute symptoms appear: Local efffects: Eyes: Miosis, redness, pressure sensation on eyes. *Ingestion:* salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn. *Skin:* Sweating, muscle twitching. *Systemic effects:* Similar to generalized effects from exposure to airborne material.

Long Term Exposure: Chronic overexposure to VX causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Although *cer*-organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for VX.[US Army]

Medical Surveillance: A chemical agent monitor (CAM) can detect VX at 0.1 mg/m^3. The US military also has the following detectors for VX and other chemical agents: *M256A1 Chemical Agent Detector Kit*; *M8A1 Automatic Chemical Agent Alarm.*

First Aid: Immediate decontamination of the smallest drop is essential. For decontamination, the *M291 Skin Decontamination Kit* should be used.

Inhalation: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, lack of coordination, etc.), immediately administer, in rapid succession; all three Nerve Agent Antidote Kit(s), *Mark 1* injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5- to 20-min intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *immediately*.

Eye contact: Immediately flush eyes with water for 10−15 min, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken immediately to the medical treatment facility for observation.

Skin contact: Don respirator with protective mask and remove contaminated clothing. Immediately wash contaminated skin with a solution of 5% household bleach. Rinse well with water to remove excess bleach followed by copious soap and water wash. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are present. Seek medical attention *immediately.*

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. Immediately administer nerve agent antidote kit, Mark I. Seek medical attention *immediately*.

Medical observation recommended.

***Medical treatment*:** Electrocardiogram (ECG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5−10 mg in adults and 0.2−0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6−12 h to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination*:* This is very important. The rapid physical removal of a chemical agent is essential. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Nerve gases stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Do not wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 min. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate upwind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 min. Remember that the water you use to decontaminate the victims is dangerous. Be sure you have decontaminated the victims as much as you can before they are released from the area, so they do not spread the nerve gas. Rinse the eyes, mucous membranes, or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

*The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach (NaOCl or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

Note: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: For emergency situations, wear a "moon suit" consisting of a positive pressure, pressure-demand, full-face-piece self-contained breathing apparatus (SCBA) or pressure-demand supplied-air respirator SCBA with escape cylinder in combination with a fully encapsulating, chemical-resistant suit capable of maintaining a positive air pressure within the suit. *Protective gloves*: butyl glove M3 and M4; Norton chemical protective glove set. *Eye protection*: Chemical goggles. For splash hazards use goggles and face shield.

Other protective equipment: Full protective clothing will consist of M9 mask and hood; M3 butyl rubber suit; M2A1 butyl boots; M3 and M4 gloves; unimpregnated underwear; or demilitarization protective ensemble (DPE). For laboratory operations, wear lab coats and have a protective mask readily available. In addition, daily clean smock, foot covers, and head covers will be required when handling contaminated lab animals.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Less than 0.00001 mg/m*^{3}*:* M9, M17, or M40 series mask shall be available for escape as necessary. 0.00001 *mg/m*^{3} to 0.02 *mg/m*^{3}*:* M9 or M40 series mask with Level A or Level B ensemble. *Greater than 0.02 mg/m*^{3}*:* or DPE or TAPES used with prior approval from AMC Field Safety Activity. *Note:* When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed 1 h. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit conc. to <0.00001 mg/m^3 (averaged over 8 h/day, indefinitely).

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lf/m) + 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent VX. Emergency back-up power necessary: Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face. *Other:* Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. *Precautions to be taken in handling and storing:* in handling, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities shall be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday. *Other precautions:* agent must be double-contained in liquid and vapor-tight containers when in storage or when outside of the ventilation hood.

Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Toxic, liquids, organic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group III. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling: See also above. Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. See Medical Surveillance section for decontamination kit. If kit is not available when needed, decontaminants include bleach slurry and hot soapy water.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 min after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the US EPA Environmental Response Team at (908) 548-8730 (24-h response line).

VX, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

Fire Extinguishing: When heated, vapors may form explosive mixtures with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Use moon suit/respirator protection. Poisonous gases, including oxides of nitrogen and sulfur, are produced in fire. *Extinguishing media*: Water mist, fog, foam, CO_2—Avoid using extinguishing methods that will cause splashing or spreading of the VX. *Special firefighting procedures:* All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving VX should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing nerve agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face-piece, NIOSH-approved self contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/incident (CAI) operations officer. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Do not breathe fumes. Skin contact with V-agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with VX or VX vapors can be fatal. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Recommended field procedures (for quantities greater than 50 g): *NOTE:* These procedures can only be used with the approval of a qualified expert or safety officer. An alcoholic calcium hypochlorite (HTH) mixture is prepared by adding 100 mL of denatured ethanol to 900 mL slurry of 10% calcium hypochlorite (HTH) in water. This mixture should be made just prior to use since the HTH can react with the ethanol. Fourteen grams of alcoholic calcium hypochlorite (HTH) solution is used for each gram of VX. Agitate the contamination mixture as the VX is added. Continue the agitation for a minimum of 1 h. This reaction is reasonably exothermic and evolves substantial off gassing. The evolved reaction gases should be routed through a decontaminate-filled scrubber prior to release through filtration systems. After completion of 1 h minimum agitation, 10% sodium hydroxide is added in a quantity equal to that necessary to assure that a pH of 12.5 is maintained for a period not less than 24 h. Hold the material at a pH between 10 and 12 for a period not less than 90 days to ensure that a hazardous intermediate material is not formed. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If the alcoholic calcium hypochlorite (HTH) mixture is not available, then the following decontaminates may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], Supertropical Bleach Slurry (STB), and sodium hypochlorite. Open pit burning or burying of VX or items containing or contaminated with VX in any quantity is prohibited. The detoxified VX (using procedures above) can be thermally destroyed by incineration in an EPA-approved incinerator in accordance with appropriate provisions of federal, state, and local RCRA regulations.

Note: Several states define decontaminated surety material as a RCRA Hazardous Waste.

Recommended laboratory procedures (for quantities less than 50 g): If the active chlorine of the calcium hypochlorite (HTH) is at least 55%, then 80 g of a 10% slurry is required for each gram of VX. Proportionally more HTH is required if the chlorine activity of the HTH is lower than 55%. The mixture is agitated as the VX is added and the agitation is maintained for a minimum of 1 h. If phasing of the VX/decon solution continues after 5 min, an amount of denatured ethanol equal to a 10 wt. % of the total agent/decon shall be added to assist miscibility.

Note: Ethanol should be minimized to prevent the formation of a hazardous waste. Upon completion of the 1-h agitation, the decon mixture shall be adjusted to a pH between 10 and 11. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

References

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W

Warfarin W:0100

Molecular Formula: $C_{19}H_{16}O_4$
Synonyms: 3-(α-Acetonylbenzyl)-4-hydroxycoumarin; Arab Rat Deth; Atrombine-K; 2H-1-Benzopyran-2-one,4-hydroxy-3-(3-oxo-1- phenylbutyl)-; Brumin; Compound 42; CO-RAX; Coumadin; Coumafene; Coumarin, 3-(α-acetonylbenzyl)-4-hydroxy-; D-CON; Dethmore; Eastern states duocide; Grovex sewer bait; 4-Hydroxy-3-(3-oxo-1-phenylbutyl)coumarin; Killgerm sewarin P; Kilmol; Kumander; Kypfarin; Liqua-tox; Mouse PAK; (Phenyl-1acetyl-2-ethyl)-3-hydroxy-4 coumarine (French); 3-(1′-Phenyl-2′-acetylethyl)-4-hydroxycoumarin; 3-(α-Phenyl-β-acetylethyl)-4-hydroxycoumarin; Plusbait; Prothromadin; Rat-*A*-Way; Rat-B-Gon; Rat-Gard; Rat & mice bait; Rat-o-cide; Ratron; Rats-no-more; Rax; RCR Squirrel killer; Rentokil; Rentokil biotrol; Rodentex; RO-Deth; Rodex blox; Rough & ready mouse mix; Sakarat; Sewarin; Solfarin; Sorexa plus; Sorex Cr1; Spray-trol branch roden-trol; Toxic chemical category code, N874; Twin light rat away; Vampirinip; Warfarine (French); Warf compound; Zoocoumarin
sodium: 3-(α-Acetonylbenzyl)-4-hydroxy-coumarin sodium salt; Athrombin; Coumadin sodium; 4-Hydroxy-3-(3-oxo-1-phenylbutyl)-2H-1-benzopyran-2-one sodium salt; Marevan (sodium salt); Panwarfin; Prothrombin; Ratsul soluble; Sodium coumadin; Sodium warfarin; Tintorane; Varfine; Waran; Warcoumin; Warfilone
CAS Registry Number: 81-81-2; 129-06-6 (sodium)
RTECS® Number: GN4550000; GN4725000 (sodium)
UN/NA & ERG Number: UN3027 (coumarin derivative pesticide, solid, poisonous)
EC Number: 201-377-6 [*Annex I Index No.:* 607-056-00-0]; 204-929-4 (sodium)
Regulatory Authority and Advisory Bodies
US EPA, FIFRA 1998 Status of Pesticides: RED completed.
Very Toxic Substance (World Bank).[15]
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
US EPA Hazardous Waste Number (RCRA No.): P001; U248.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (Warfarin and salts).
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).
California Proposition 65 Chemical: Developmental/ Reproductive toxin 7/1/87.
Warfarin sodium:
Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).
Reportable Quantity (RQ): 100 lb (45.4 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
European/International Regulations (*81-81-2*): Hazard Symbol: T; Risk phrases: R61; R48/25; Safety phrases: S3; S45 (see Appendix 4).
WGK (German Aquatic Hazard Class): No value assigned.
Description: Warfarin is a colorless, odorless crystalline solid. Molecular weight = 308.35. Combustible. Although warfarin is usually available commercially as the sodium salt, the following physical properties refer to the pure substance: Freezing/Melting point = 161°C (decomposes below BP); Vapor pressure = 0.09 mmHg at 25°C. Hazard Identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 4, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.002%.
Potential Exposure: Compound Description: Agricultural Chemical; Reproductive Effector; Human Data; Natural Product. Warfarin is used as an oral anticoagulant and as a rodenticide or rat poison.
Incompatibilities: Strong oxidizers, strong acids, strong bases. Dust mixtures with air may cause explosion.
Permissible Exposure Limits in Air
Warfarin 81-81-2
OSHA PEL: 0.1 mg/m^3 TWA.
NIOSH REL: 0.1 mg/m^3 TWA.
ACGIH TLV®[1]: 0.1 mg/m^3 TWA.
NIOSH IDLH: 100 mg/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.1 mg/m^3
PAC-1: 0.3 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 100 mg/m^3
Protective Action Criteria (PAC) (sodium)
TEEL-0: 1.5 mg/m^3
PAC-1: 5 mg/m^3
PAC-2: 9 mg/m^3
PAC-3: 9 mg/m^3
DFG MAK 0.5 mg/m^3, inhalable fraction TWA; Peak Limitation Category II(2).
Compound Description: Agricultural Chemical; Reproductive Effector; Human Data; Natural Product.
Australia: TWA 0.1 mg/m^3, 1993; Austria: MAK 0.1 mg/m^3, 1999; Belgium: TWA 0.1 mg/m^3, 1993; Denmark: TWA 0.1 mg/m^3, 1999; Finland: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 1999; France: VME 0.1 mg/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg/m^3, 2003; Norway: TWA 0.1 mg/m^3, 1999; the Philippines: TWA

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00022-9

0.1 mg/m^3, 1993; Russia: STEL 0.001 mg/m^3, 1993; Switzerland: MAK-W 0.1 mg/m^3, KZG-W 0.5 mg/m^3, 1999; Thailand: TWA 0.1 mg/m^3, 1993; Turkey: TWA 0.1 mg/m^3, 1993; United Kingdom: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 0.1 mg/m^3.

Several states have set guidelines or standards for warfarin in ambient air[60] ranging from 0.016 μg/m^3 (Virginia) to 1.0−3.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5002.

Determination in water: Octanol−water coefficient: Log $K_{ow} = 2.51$.

Routes of Entry: Skin absorption, ingestion, inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Warfarin is classified as very toxic, and may cause hemorrhage at even low levels. Probable oral lethal dose in humans is 50−500 mg/kg, between 1 teaspoon and 1 oz for a 150-lb person. Material is an anticoagulant. Toxic effects other than hemorrhage are rarely seen in humans. Other symptoms of warfarin exposure begin a few days or weeks after ingestion. They include epistaxis (nose bleed); bleeding gums; pallor, and sometimes hematomas around joints and on buttocks; blood in urine and feces; hematoma arms, legs; bleeding lips; mucous membrane hemorrhage; petechial rash; abnormal/abnormalities hematologic indices. Later, paralysis due to cerebral hemorrhage and finally, hemorrhagic shock and death may occur. Warfarin sodium is an anticoagulant. Hemorrhage is the most common sign and may be manifested by hemorrhagic skin rashes and lip, nose, and upper airway bleeding. Upper airway pain, difficulty in speaking and swallowing, and dyspnea (shortness of breath) may occur. Back pain may be noted.

Long Term Exposure: Anemia can result from severe or repeated bleeding. Repeated exposure may affect the liver and kidneys. Material is believed to be teratogenic in humans. There is limited evidence that warfarin may decrease fertility in females. Animal tests indicates that warfarin may cause malformations in human babies.

Points of Attack: Blood, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: blood plasma: prothrombin time; complete blood count; urine (chemical/metabolite): whole blood (chemical/metabolite); urinalysis (routine): red blood cells/count. Persons taking "blood thinning" medications are at increased risk.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *Up to 0.5 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *Up to 1 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 100 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this

chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Coumarin derivative pesticides, solid, toxic, require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Do not touch spilled material. Eating and smoking should not be permitted in areas where it is handled, processed, or stored. *Small spills:* sweep onto paper or other suitable material. Place in an appropriate container and burn in a safe place. *Large quantities:* may be destroyed by dissolving in a flammable solvent (e.g., alcohol) and atomizing in a combustion chamber.

Fire Extinguishing: Warfarin is combustible; however, no flash point can be found. Extinguish fire using agent suitable for type of surrounding fire. Use alcohol foam, carbon dioxide, or dry chemical. Wear full protective clothing and self-contained breathing apparatus when engaged in firefighting. Poisonous gases are produced in fire, including oxides of sodium (warfarin sodium). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Warfarin*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Warfarin Sodium*. Washington, DC: Chemical Emergency Preparedness Program

X

Xylenes X:0100

Molecular Formula: C_8H_{10}
Common Formula: $C_6H_4(CH_3)_2$
Synonyms: *m-isomer:* Benzene, *m*-dimethyl-; Benzene, 1,3-dimethyl-; *m*-Dimethylbenzene; 1,3-Dimethylbenzene; *m*-Methyltoluene; *m*-Xileno (Spanish); *m*-Xylene; 1,3-Xylene; Xylene, *m*-; *m*-Xylol
o-isomer: Benzene-*o*-dimethyl; Benzene-1,2-dimethyl-; *o*-Dimethylbenzene; 1,2-Dimethylbenzene; *o*-Methyltoluene; 1,2-Methyltoluene; *o*-Xileno (Spanish); *o*-Xylene; 1,2-Xylene; Xylene, *o*-; *o*-Xylol
p-isomer: Benzene-*p*-dimethyl; Benzene-1,4-dimethyl; Chromar; *p*-Dimethylbenzene; 1,4-Dimethylbenzene; *p*-Methyltoluene; 4-Methyltoluene; Scintillar; *p*-Xileno (Spanish); *p*-Xylene; 1,4-Xylene; Xylene, *p*-; *p*-Xylol
CAS Registry Number: 108-38-3 (*m*-isomer); 95-47-6 (*o*-isomer); 106-42-3 (*p*-isomer); 1330-20-7 (mixed isomers)
RTECS® Number: ZE2100000 (mixed isomers); ZE2275000 (*m*-isomer); ZE2450000 (*o*-isomer); ZE2625000 (*p*-isomer)
UN/NA & ERG Number: UN1307 (all isomers)/130
EC Number: 203-576-3 [*Annex I Index No.:* 601-022-00-9] (*m*-isomer); 202-422-2 [*Annex I Index No.:* 601-022-00-9] (*o*-isomer); 203-396-5 [*Annex I Index No.:* 601-022-00-9] (*p*-isomer); 215-535-7 [*Annex I Index No.:* 601-022-00-9] (mixed isomers)

Regulatory Authority and Advisory Bodies

Carcinogenicity (*m-, o-, and p-isomers*): IARC: Animal, Inadequate Evidence; Human, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
All isomers and mixtures:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 100 lb (45.4 kg); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): U239.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 30.
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested methods (PQL μg/L): total dust 8020 (5); 8240 (5).
Safe Drinking Water Act: Xylenes, total dust, MCL, 10 mg/L; MCLG, 10 mg/L; Regulated chemical (47 FR 9352).
Reportable Quantity (RQ): 1000 lb (454.0 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% (*o*- and *m*-isomers); 0.1% (*p*-isomer).
European/International Regulations (*all isomers*): Hazard Symbol: Xn; Risk phrases: R10; R20/21; R38; Safety phrases: S2; S25 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Water polluting (*all isomers*).

Description: Xylene exists in three isomeric forms, *ortho*-, *meta*-, and *para*-xylene. Commercial xylene is a mixture of these three isomers and may also contain ethylbenzene as well as small amounts of toluene, trimethylbenzene, phenol, thiophene, pyridine, and other nonaromatic hydrocarbons. *m*-Xylene is predominant in commercial xylene. The physical properties of the three isomers are as follows:

Isomer	Melting Point (°C)	Boiling Point (°C)	Flash Point (°C)	Lower Expl. (%)	Upper Expl. (%)	Auto-Temp. (°C)
ortho-	−25	144	32	0.9	6.7	463
meta-	−48	139	27	1.1	7.0	527
para-	13	138	27	1.1	7.0	528

Odor threshold = 0.081−40 ppm. The range of odor threshold values is quite broad and caution is advised in relying on odor alone as a warning of potentially hazardous exposures. NFPA 704 M Hazard Identification (all isomers): Health 2, Flammability 3, Reactivity 0. All isomers are practically insoluble in water.

Potential Exposure: Compound Description (*m*-isomer): Tumorigen; Reproductive Effector; Human Data; Primary Irritant; (*o*-isomer) Tumorigen; Reproductive Effector; Human Data; (*p*-isomer) Tumorigen; Reproductive Effector. Xylene is used as a solvent; as a constituent of paint, lacquers, varnishes, inks, dyes, adhesives, cements, cleaning fluids, and aviation fuels; and as a chemical feed-stock for xylidines, benzoic acid, phthalic anhydride, isophthalic, and terephthalic acids, as well as their esters (which are specifically used in the manufacture of plastic materials and synthetic textile fabrics). Xylene is also used in the manufacture of quartz crystal oscillators, hydrogen peroxide, perfumes, insect repellants, epoxy resins, pharmaceuticals, and in the leather industry. *m*-Xylene is used as an intermediate in the preparation of isophthalic acid; *o*-xylene is used in the manufacture of phthalic anhydride and in pharmaceutical and insecticide synthesis. *p*-Xylene is used in pharmaceutical and insecticide systhesis and in the production of polyester.

Incompatibilities: Strong oxidizers, strong acids. Electrostatic charges can be generated from agitation or flow.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.34 mg/m^3 *(all isomers)* at 25°C & 1 atm.
OSHA PEL: 100 ppm/435 mg/m^3 TWA.
NIOSH REL: 100 ppm/435 mg/m^3 TWA; 150 ppm/655 mg/m^3 STEL.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00023-0

ACGIH TLV®[1]: 100 ppm/434 mg/m^3 TWA; 150 ppm/651 mg/m^3 STEL, not classifiable as a human carcinogen; BEI: (technical grade) 1.5 g[methylhippuric acids]/g creatinine in urine, end-of-shift.

NIOSH IDLH: 900 ppm.

Protective Action Criteria (PAC)*

All isomers and mixed isomers

TEEL-0: 100 ppm

PAC-1: **130** ppm

PAC-2: **920** ppm

PAC-3: **2500** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are in **bold face**.

DFG MAK: 100 ppm/440 mg/m^3 TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D; BAT: 1.5 mg[xylene]/L in blood, end-of-shift; 2000 mg[methylhippuric (toluric)acid]/L in urine, end-of-shift.

European OEL: 50 ppm TWA; 100 ppm STEL [skin] (2000) Austria: MAK 100 ppm (440 mg/m^3), 1999; Denmark: TWA 35 ppm (150 mg/m^3), [skin], 1999; France: VME 100 ppm (435 mg/m^3), VLE 150 ppm (650 mg/m^3), 1999; Japan; 100 ppm (430 mg/m^3), 1999; Norway: TWA 25 ppm (108 mg/m^3), 1999; Switzerland: MAK-W 100 ppm (435 mg/m^3), KZG-W 200 ppm (870 mg/m^3), 1999; United Kingdom: TWA 100 ppm (441 mg/m^3), STEL 150 ppm, [skin], 2000. Russia[43] set a MAC value of 0.2 mg/m^3 (200 μg/m^3) for ambient air in residential areas both on a momentary and a daily average basis. Several states have set guidelines or standards for xylenes in ambient air[60] ranging from zero (Colorado) to 0.059 mg/m^3 (Massachusetts) to 0.073 mg/m^3 (Virginia) to 0.700 mg/m^3 (Rhode Island) to 1.45 mg/m^3 (New York) to 8.68 mg/m^3 (Connecticut) to 8.70 mg/m^3 (South Dakota) to 10.357 mg/m^3 (Nevada) to 2.6−65.5 mg/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1501, Hydrocarbons, aromatic, #3800, OSHA Analytical Method 1002.

Permissible Concentration in Water: Russia[43] set a MAC of 0.05 mg/L (50 μg/L) in water both for household and fishery purposes. The EPA has proposed a limit of 10 μg/L (10 ppm)[62] and has determined a lifetime health advisory of 400 μg/L.[48] Several states have set guidelines and standards for xylenes in drinking water[61] ranging from 44.0 μg/L (New Jersey) to 50.0 μg/L (New York) to 440.0 μg/L (Arizona, Kansas, Minnesota) to 620.0 μg/L (Massachusetts, Maine, New Mexico, Vermont, and Wisconsin).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.20$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Exposure to vapor can be irritating to the nose and throat. Inhalation of vapor at concentrations *above 200 ppm* or 3−5 min can lead to xylene intoxication. Symptoms include headache, dizziness, nausea, and vomiting. If exposure continues, central nervous system depression characterized by shallow breathing and weak pulse can occur. Levels of 230 ppm for 15 min may cause lightheadedness without loss of equilibrium. Reversible liver and kidney damage in humans has followed exposure to sudden high concentrations of vapor. Such high levels may also give rise to lung congestion. Exposure to extremely high concentrations (10,000 ppm or more) of xylene vapors can lead to a strong narcotic effect with symptoms of slurred speech, stupor fatigue, confusion, unconsciousness, coma, and possible death. *Skin:* Contact with vapor or liquid can cause defatting which may lead to irritation, drying, and cracking. *Eyes:* Vapor and liquid may be irritating to the eye and eyelids at levels of 100 ppm for 15 min. *Ingestion:* Swallowing liquid xylene will bring about an immediate burning sensation in the mouth and throat. Irritation of the stomach and intestine can give rise to sharp stomach pains. Symptoms are the same as inhalation, except that lung congestion will not usually develop.

Long Term Exposure: Inhalation of xylene vapor and skin contact with liquid are the two most probable routes of long-term exposure. Symptoms of inhalation are dizziness, headache, and nausea. Long-term exposure has been associated with liver and kidney damage, intestinal tract disturbances, and central nervous system depression. Prolonged contact with skin can lead to irritation, dryness, and cracking. Repeated exposure can cause poor memory, difficulty in concentration, and other brain effects. It can also cause damage to the eye surface.

Points of Attack: Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys.

Medical Surveillance: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; Complete blood count; Complete blood count; hematopoietic depression, expired air, urine (chemical/metabolite); urine (chemical/metabolite): end-of-shift; urine (chemical/metabolite): end-of-work-week; urine (chemical/metabolite): Last 4 h of 8-h exposure; urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following is recommended before beginning work and at regular times after that: examination of the eyes by slit lamp. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Urine concentration of *m-methylhippuric acid* (at the end-of-shift) as an index of overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. If victim is *conscious*, administer water or milk. Do not induce vomiting.

Note to physician: May require supportive measures for pulmonary edema.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton™, polyvinyl alcohol, and Teflon™ are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *900 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)] or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)] or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical you should be trained on its proper handling and storage. Xylenes must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where xylenes are used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of xylenes. Protect storage containers from physical damage.

Shipping: This compound requires a shipping label of "FLAMMABLE LIQUID." It falls in Hazard Class 3 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Poisonous gases are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

National Institute for Occupational Safety and Health. (1975). *Criteria for a Recommended Standard: Occupational Exposure to Xylene*, NIOSH Document No. 75-168

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 79−81 (1981) (*meta*-); 3, No. 3, 88−92 (1983); 4 No. 5, 75−88 (*para*-); and 4, No. 5, 63−75 (1984) (*ortho*-)

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Xylenes*. Version 3. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (August 2006). *Hazardous Substances Fact Sheet: Xylenes*. Trenton, NJ

m-Xylene-α,α′-diamine X:0110

Molecular Formula: $C_8H_{12}N_2$
Common Formula: $H_2NCH_2C_6H_4CH_2NH_2$
Synonyms: 1,3-Benzenedimethanamine; 1,3-Bis(aminomethyl)benzene; Methylamine, *m*-phenylenebis-; MXDA; *m*-Phenylenebis(methylamine); *m*-Xylylenediamine
CAS Registry Number: 1477-55-0
RTECS® Number: PF8970000
UN/NA & ERG Number: Not regulated.
EC Number: 216-032-5
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): 2—Hazard to waters.
Description: *m*-Xylene-α,α′-diamine is a colorless liquid. Molecular weight = 136.22; Specific gravity (H_2O:1) = 1.032 at 25°C; Boiling point = 247.2°C; Freezing/Melting point = 15°C; Vapor pressure = 0.03 mmHg at 25°C; Flash point = 117°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.
Potential Exposure: Compound Description: Primary Irritant. *m*-Xylene-α,α′-diamine is a source of *m*-xylene diisocyanate and used as an intermediate in the manufacture of epoxy and polyamide resins.
Incompatibilities: Oxidizers, strong acids.
Permissible Exposure Limits in Air
OSHA PEL: None.
NIOSH REL: 0.1 mg/m^3 Ceiling Concentration [skin].
ACGIH TLV®[1]: 0.1 mg/m^3 Ceiling Concentration [skin].
No TEEL available.
DFG MAK: [skin] Danger of skin sensitization.
Australia: TWA 1 mg/m^3, 1993; Belgium: STEL 0.1 mg/m^3, 1993; Denmark: TWA 0.02 ppm (0.1 mg/m^3), [skin], 1999; Finland: TWA 0.1 mg/m^3, [skin], 1999; France: VLE 0.1 mg/m^3, 1999; Norway: TWA 0.1 mg/m^3, 1999; Switzerland: MAK-W 0.1 mg/m^3, [skin], 1999; the Netherlands: MAC-0.1 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 0.1 mg/m^3 [skin].
Several states have set guidelines or standards for MXDA in ambient air[60] ranging from 0.008 μg/m^3 (Virginia) to 1.0 μg/m^3 (North Dakota) to 2.0 μg/m^3 (Nevada) to 33.0 μg/m^3 (New York).
Determination in Air: Use OSHA Analytical Method 105
Permissible Concentration in Water: No criteria set.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: *m*-Xylene-α,α′-diamine can affect you when breathed in and by passing through your skin. Contact can severely irritate and burn the skin and eyes. Exposure can irritate the nose and throat. High levels may cause respiratory depression, tiredness, and unconsciousness. The LC_{50} (rat) = 700 ppm/1 h.
Long Term Exposure: *m*-Xylene-α,α′-diamine may cause skin and lung allergies. Once this happens, even very small future exposures may cause a skin rash to develop and/or may cause an asthma-like reaction with wheezing, coughing, and shortness of breath. May cause liver and kidney damage. In animals: liver, kidney, lung damage.
Points of Attack: Eyes, skin, respiratory system, liver, kidneys.
Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function tests. These may be normal if person is not having an attack at the time of test. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposures over *0.1 mg/m^3*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a

full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—White: Corrosive or Contact Hazard; Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloride, sulfuric, and nitric). Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *m*-Xylene-α,α'-diamine may burn but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Poisonous gases, including oxides of nitrogen, are produced in fire. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (December 2006). *Hazardous Substances Fact Sheet: m-Xylene-2,2′-Diamine*. Trenton, NJ

3,5-Xylenol X:0120

Molecular Formula: $C_8H_{10}O$

Common Formula: $C_6H_3(CH_3)_2OH$

Synonyms: AI3-01553; 3,5-Dimethylphenol; 3,5-DMP; 1-Hydroxy-3,5-dimethylbenzene; Phenol, dimethyl-; *sym, m*-Xylenol; 1,3,5-Xylenol

CAS Registry Number: 108-68-9; 1300-71-6 (mixed isomers)

RTECS$^{®}$ Number: ZE6475000

UN/NA & ERG Number: UN2261/153

EC Number: 203-606-5 [*Annex I Index No.:* 604-037-00-9]; 215-089-3 [*Annex I Index No.:* 604-006-00-X] (mixed isomers)

Regulatory Authority and Advisory Bodies

Mixed isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

Reportable Quantity (RQ): 1000 lb (454 kg).

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as xylenols.

WHMIS Classifications, E, D2B.

European/International Regulations (*xylenols*): Hazard Symbol: T, N; Risk phrases: R24/25; R34; R51/53; Safety phrases: S1/2; S26; S36/3739; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Water polluting (*CAS: 108-68-9*).

Description: 3,5-Xylenol is a crystalline solid. Molecular weight = 122.17; Boiling point = 220°C (sublimes); Freezing/Melting point = 64°C; Flash point = 109°C. Soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: Compound Description: Tumorigen; Reproductive Effector; Primary Irritant. 3,5-Xylenol is used as an antioxidant, solvent, plasticizer, wetting agent; and in pharmaceuticals. Xylenols are also used in pesticides, fuel and lubricant additives; as a rubber chemical; in dyestuff manufacture. There are actually six xylenol isomers.

Incompatibilities: A weak organic acid. Keep away from oxidizers.

Permissible Exposure Limits in Air

No standards or TEEL available.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.35$.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Xylenol can affect you when breathed in and by passing through your skin. Can severely irritate the eyes, skin, and respiratory tract. Contact can severely burn the eyes and skin. LD_{50} = (oral-rat) 608 mg/kg.

Long Term Exposure: Repeated exposure may lead to vomiting, headaches, dizziness, and fainting. Chronic poisoning can cause digestive disturbances, nervous disorders, and skin eruptions. Closely related compounds can cause liver and kidney damage, and even collapse and death. Highly irritating substances can affect the lungs although it is not known if xylenols cause lung damage.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Urinary phenol test. Liver and kidney function tests. Lung function tests.

First Aid: Get medical attention at once following exposure to this compound.

Inhalation: Remove patient immediately to fresh air; irritation of nose or throat may be somewhat relieved by spraying or gargling with water until all odor is gone; 100% oxygen inhalation is indicated for cyanosis or respiratory distress; keep patient warm but not hot.

Eyes: Flood with running water for 15 min; if physician is not immediately available, continue irrigation for another 15 min; 2−3 drops of 0.5% pontocaine or equivalent may be instilled after first 15 min; do not use oils or oily ointments unless ordered by physician.

Skin: Wash affected areas with large quantities of water or soapy water until all odor is gone; then wash with alcohol or 20% glycerin solution and more water; keep patient warm but not hot; cover chemical burns continuously with compresses wet with saturated solution of sodium thiosulfate; apply no salves or ointments for 24 h after injury.

Ingestion: Give large quantities of liquid (saltwater, weak sodium bicarbonate solution, milk, or gruel) followed by demulcent, such as raw egg white or corn starch paste; if profuse vomiting does not follow immediately, give a mild emetic (such as 1 tablespoon of mustard in glass of water) or tickle back of throat. Repeat procedure until vomitus is free of the odor. Some demulcent should be left in stomach after vomiting. Keep patient comfortably warm.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to xylenols, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chemical oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where xylenols is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Xylenols require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910. 120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 81−82 (1981) and 4, No. 1, 102−106 (1984)

New Jersey Department of Health and Senior Services. (February 2001). *Hazardous Substances Fact Sheet: Xylenol*. Trenton, NJ

Xylidines X:0130

Molecular Formula: $C_8H_{11}N$

Common Formula: $(CH_3)_2C_6H_3NH_2$

Synonyms: *mixed isomers:* Aminodimethylbenzene; Aminoxylene; Dimethylaminobenzene; Dimethylaniline; Xylidine isomers

2,6-isomer: 1-Amino-2,6-dimethylbenzene; 2-Amino-1,3-dimethylbenzene; 2-Amino-*m*-xylene; 2-Amino-1,3-xylene; Benzenamine, 2,6-dimethyl-; 2,6-Dimethylaniline; 2,6-Dimethylbenzenamine; 2,6-Dimethylphenylamine; 2,6-Xilidina (Spanish); *o*-Xylidine; 2,6-Xylidine; 2,6-Xylylamine

Note: Dimethylaniline is also used as a synonym for *N,N*-Dimethylaniline

CAS Registry Number: 1300-73-8 (mixed isomers); 87-62-7 (2,6-); 87-59-2 (2,3-); 95-68-1 (2,4-); 95-78-3 (2,5-); 95-64-7 (3,4-); 108-69-0 (3,5-)

RTECS® Number: ZE8575000 (mixed isomers); ZE9275000 (2,6-)

UN/NA & ERG Number: UN1711/153

EC Number: 215-091-4 (mixed isomers); 201-758-7 [*Annex I Index No.:* 612-161-00-X] (2,6-); 201-755-0 (2,3-); 202-440-0 (2,4-); 202-451-0 (2,5-); 202-437-4 (3,4-); 203-607-0 (3,5-)

EC Number: [*Annex I Index No.:* 612-027-00-0]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

2,6-isomer:*

Carcinogenicity: NCI: Carcinogenesis Studies (feed); clear evidence: rat; IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1993.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

California Proposition 65 Chemical: Cancer 1/1/91 (2,6-).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, xylidine (mixed isomers).

*The 2,6-isomer is the only xylidine specifically regulated by the US EPA.

European/International Regulations (*87-62-7*): Hazard Symbol: T, N; Risk phrases: R23/24/25; R33; R51/53; Safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Highly water polluting (*mixed isomers, dimethylaniline, and 3,5-isomer*). 2 for the (2,6-, 2,3-, 2,4-, 2,5-, and 3,4-isomers).

Description: There are six xylidine isomers. Xylidine, mixed isomers (principally made up of 2,4-, 2,5-, and 2,6-isomers), is a pale yellow to brown liquid with a weak, aromatic amine odor. The odor threshold is 0.056 ppm. Molecular weight = 121.20; Specific gravity (H_2O:1) = 0.98 at 25°C; Boiling point (mixed isomers) = 213−226°C; Freezing/Melting point = −36°C; Vapor pressure = <1 mmHg at 25°C; Flash point (2,6-isomer) = 91°C; (mixed isomers) 96.7°C. Explosive limits (2,6-isomer): LEL = 1.0%; UEL—unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Compound Description (2,6-isomer): Tumorigen, Mutagen, Natural Product. Xylidines are used in dyestuff manufacture; as intermediates in the manufacture of pesticides, antioxidants, pharmaceuticals, and other organic compounds.

Incompatibilities: Strong oxidizers. Contact with hypochlorite salts and bleaches form explosive chloroamines.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.96 mg/m^3 at 25°C & 1 atm.

OSHA PEL: 5 ppm/25 mg/m^3 TWA [skin].

NIOSH REL: 2 ppm/10 mg/m^3 TWA [skin].

ACGIH TLV®[1]: 0.5 ppm/2.5 mg/m^3, inhalable fraction and vapor [skin], confirmed animal carcinogen with unknown relevance to humans; BEI$_M$ issued for methemoglobin inducers.

NIOSH IDLH: 50 ppm.

DFG MAK: *(2,3-, 2,5-, 3,4-, 3,5-isomers):* [skin]; Carcinogen Category 3A; *(2,4- & 2,6-isomers):* [skin]; Carcinogen Category 2.

2,3-isomer

Protective Action Criteria (PAC)

TEEL-0: 0.5 ppm

PAC-1: 10 ppm

PAC-2: 10 ppm

PAC-3: 50 ppm

2,6-isomer

Protective Action Criteria (PAC)

TEEL-0: 0.5 ppm

PAC-1: 10 ppm

PAC-2: 25 ppm

PAC-3: 50 ppm

Denmark: TWA 0.5 ppm (2.5 mg/m^3), [skin], 1999; France: VME 2 ppm (10 mg/m^3), [skin], 1999; Poland: MAC (TWA) 10 mg/m^3, 1999; Switzerland: MAK-W 2 ppm (10 mg/m^3), [skin], 1999; United Kingdom: TWA 2 ppm (10 mg/m^3), STEL 10 ppm, [skin], 2000.

Mixed isomers

ACGIH TLV®[1]: 0.5 ppm, inhalable fraction and vapor [skin], confirmed animal carcinogen with unknown relevance to humans; BEI issued (1999).

Protective Action Criteria (PAC)
TEEL-0: 0.5 ppm
PAC-1: 10 ppm
PAC-2: 10 ppm
PAC-3: 50 ppm
DFG MAK: [skin] Carcinogen Category 3A.

Arab Republic of Egypt: TWA 5 ppm (25 mg/m^3), [skin], 1993; Australia: TWA 2 ppm (10 mg/m^3), [skin], 1993; Austria: MAK 5 ppm (25 mg/m^3), [skin], 1999; Belgium: TWA 2 ppm (9.9 mg/m^3), [skin], 1993; Denmark: TWA 0.5 ppm (2.5 mg/m^3), [skin], 1999; Finland: TWA 5 ppm (25 mg/m^3), STEL 10 ppm (50 mg/m^3), [skin], 1999; France: VME 2 ppm (10 mg/m^3), [skin], 1999; the Netherlands: MAC-TGG 2.5 mg/m^3, 2003; Norway: TWA 1 ppm (5 mg/m^3), 1999; the Philippines: TWA 100 ppm (435 mg/m^3), [skin], 1993; Poland: MAC (TWA) 10 mg/m^3, 1999; Russia: STEL 3 mg/m^3, [skin], 1993; Switzerland: MAK-W 2 ppm (10 mg/m^3), [skin], 1999; Turkey: TWA 5 ppm (25 mg/m^3), [skin], 1993; United Kingdom: TWA 2 ppm (10 mg/m^3), STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic has set a TWA of 5.0 mg/m^3. Several states have set guidelines or standards for xylidine in ambient air[60] ranging from 1.6 μg/m^3 (Virginia) to 33.3 μg/m^3 (New York) to 50.0 μg/m^3 (South Carolina) to 100.0 μg/m^3 (Connecticut, Florida, and North Dakota) to 238.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2002, amines, aromatic.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient concentration of 345 μg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = (estimated) <2.0 (mixed isomers).

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Xylidine can affect you when breathed in and by passing through your skin. The effects of exposure may be delayed in case of skin absorption. Irritates the eyes, skin, and respiratory tract. Exposure can cause the formation of methemoglobin causing interference with the ability of the blood to carry oxygen, causing headaches, dizziness, nausea, vomiting, and cyanosis (a bluish color to the skin and lips). Higher levels can cause trouble breathing, collapse, and even death. High or repeated exposure may damage the liver.

Long Term Exposure: May cause anemia. Affects the kidneys, liver, and blood. 2,6-Xylidine has been shown to cause cancer in animals.

Points of Attack: Respiratory system, blood, liver, kidneys, cardiovascular system. Cancer site in animals: nose.

Medical Surveillance: US DHHS PHS CDC NIOSH, and US DOL OSHA list the following tests: whole blood (chemical/metabolite), methemoglobin; complete blood count. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobin in urine. If symptoms of serious cyanosis develop, *methylene blue* may be given as an antidote (by a trained medical person only), over 5 min. Repeat in 1 h if not improving. 100% oxygen can be given only by a trained person.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or CcrFOv (APF = 50) [any chemical cartridge respirator with a full face-piece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or PaprOv (APF = 25) [any powered, air-purifying respirator with an organic vapor cartridge(s)] or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Xylidine must be stored to avoid contact with strong oxidizers (such as bromine, chlorine, or fluorine) since violent reactions occur. Contact with hypochlorite bleaches may form explosive chloroamines. Store in tightly closed containers in a cool, dry, well-ventilated area away from heat sources. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Xylidines, solid require a shipping label of "POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 6.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Poisonous gases, including nitrogen oxides, are produced in fire. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. Storage containers and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.

References

New Jersey Department of Health and Senior Services. (October 1986). *Hazardous Substances Fact Sheet: Xylidine*. Trenton, NJ

New Jersey Department of Health and Senior Services. (May 2006). *Hazardous Substances Fact Sheet: 2,6-Xylidine*. Trenton, NJ

Y

Yttrium & compounds Y:0100

Molecular Formula: Y
Synonyms: Yttria; Yttrium-89; Yttrium, elemental
other yttrium compounds: Yttrium chloride 10361-92-9; Yttrium chloride, hexahydrate 10025-94-2; Yttrium nitrate 10361-93-0; Yttrium oxide 1314-36-9
CAS Registry Number: 7440-65-5
RTECS®Number: ZG2980000; ZG3150000 (chloride); ZG3675000 (nitrate); ZG3850000 (oxide)
UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170
EC Number: 231-174-8; 233-801-0 (chloride); 233-802-6 (nitrate); 215-233-5 (oxide)
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%, elemental and compounds.
European/International Regulations: not listed in Annex 1.
WGK (German Aquatic Hazard Class): No value assigned (metal); 1 Slightly water polluting (oxide)
Description: Yttrium is a silvery-white to dark-gray, or black solid. Odorless. An element in Group III-B of the Periodic Table. It is very similar to the rare earth metals. Molecular weight = 88.91; Specific gravity (H_2O:1) = 4.47 @ 25°C; Boiling point = 2927°C; Freezing/Melting point = 1509°C. Soluble in hot water.
Potential Exposure: Yttrium is used in iron and other alloys, in incandescent gas mantles, and as a deoxidizer for metals. Yttrium metal has a low cross section for neutron capture and is very stable at high temperatures. Further, it is very inert toward liquid uranium and many liquid uranium alloys. Thus, it may well have applications in nuclear power generation. The metal is usually prepared by reduction of the halide with an active metal, such as calcium. To identify and analyze this element, x-ray fluorescence spectroscopy is commonly employed.
Incompatibilities: Flammable in the form of dust in air. Reacts with oxidizers, halogens. Yttrium nitrate: combustible materials.
Permissible Exposure Limits in Air
Note: applies to yttrium and compounds.
OSHA PEL: 1 mg[Y]/m^3 TWA
NIOSH REL: 1 mg[Y]/m^3 TWA
ACGIH TLV®[1]: 1 mg[Y]/m^3 TWA
Protective Action Criteria (PAC)
NIOSH IDLH: 500 mg[Y]/m^3
metal
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 5 mg/m^3
PAC-3: 500 mg/m^3
chloride, hexahydrate
TEEL-0: 3.41 mg/m^3
PAC-1: 10.2 mg/m^3
PAC-2: 500 mg/m^3
PAC-3: 500 mg/m^3
oxide
TEEL-0: 1.18 mg/m^3
PAC-1: 3.54 mg/m^3
PAC-2: 150 mg/m^3
PAC-3: 500 mg/m^3
trioxide
TEEL-0: 1.27 mg/m^3
PAC-1: 3.81 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 500 mg/m^3
Australia: TWA 1 mg/m^3, 1993; Austria: MAK 1 mg/m^3, 1999; Belgium: TWA 1 mg/m^3, 1993; Denmark: TWA 1 mg/m^3, 1999; Finland: TWA 1 mg/m^3, 1999; France: VME 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; the Philippines: TWA 5 ppm (25 mg/m^3), 1993; Poland: MAC (TWA) 1 mg/m^3, 1999; Switzerland: MAK-W 1 mg/m^3, 1999; United Kingdom: TWA 1 mg/m^3, STEL 3 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: TWA 1 mg[Y]/m^3. Several states have set guidelines or standards for yttrium in ambient air[60] ranging from 0.16 μg/m^3 (Virginia); to 10.0 μg/m^3 (North Dakota); to 20.0 μg/m^3 (Connecticut); to 24.0 μg/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (IV) #7300, #7301, #7303, #9102, OSHA Analytical Method ID-121.
Permissible Concentration in Water: No criteria set.
Routes of Entry: Inhalation of dusts, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short Term Exposure: Eye irritation in humans.
Long Term Exposure: In animals: pulmonary irritation; eye injury; possible liver damage.
Points of Attack: Eyes, respiratory system; liver
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00024-2

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 mg/m^3:* Qm (APF = 25) (any quarter-mask respirator). *Up to 10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 mg/m^3:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 50 mg/m^3:* 100F (APF = 50) (any air purifying, full face-piece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece); or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red (*powder*): Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from storage containers to process containers.

Shipping: Flammable powder requires a shipping label of "FLAMMABLE SOLID." It falls in Hazard Class 4.1 and Packing Group III.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid in bulk form. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery is indicated wherever possible. Specifically, processes are available for yttrium oxysulfide recovery from color television tube manufacture.

Reference

New Jersey Department of Health and Senior Services. (October 2002). *Hazardous Substances Fact Sheet:* Yttrium, Trenton, NJ

Z

Zinc & compounds Z:0100

Molecular Formula: Zn
Synonyms: Asareo L15; Blue powder; C.I. 77945; C.I. Pigment black 16; C.I. Pigment metal 6; Emanay zinc dust; Jasad; Merrillite (powder); Pasco; Zinc dust; Zinc powder
CAS Registry Number: 7440-66-6
RTECS® Number: ZG8600000
UN/NA & ERG Number: UN1436 (powder or dust)/138; UN1383 (pyrophoric powder)/135
EC Number: 231-175-3 [*Annex I Index No.*: 030-001-00-1]
Regulatory Authority and Advisory Bodies
Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential; Available data are inadequate for an assessment of human carcinogenic potential.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
Metal:
US EPA, FIFRA 1998 Status of Pesticides: RED completed.
US EPA Gene-Tox Program, Inconclusive: *In vivo* cytogenetics—human lymphocyte.
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 2.61; Nonwastewater (mg/L), 5.3 TCLP. *Note:* these constituents are not "underlying hazardous constituents" in characteristic wastes, according to the definition at Section 268.2(i).
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L), total dust 6010 (20); 7950 (50).
Safe Drinking Water Act: SMCL, 5 mg/L; Priority List (55 FR 1470).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Fume or dust:
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/92).
Reportable Quantity (RQ): 1000 lb (454 kg).
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration zinc metal not listed.
European/International Regulations (dust, pyrophoric): Hazard Symbol: F; Risk phrases: R15; R17; Safety phrases: S2; S7/8; S43 (see Appendix 4).
WGK (German Aquatic Hazard Class): 2—Water polluting (*zinc, grain size < = 1 mm*); Nonwater polluting agent (*metal*).
Description: Zinc is a soft silver-colored metal; the dust is odorless and gray. Molecular weight = 65.37; Boiling point = 908°C; Freezing/Melting point = 420°C; Autoignition temperature = 460°C. Ignition temperature of dust cloud = 600°C; Minimum explosive concentration = 0.48 oz/ft^3.[USBM] Relative explosion hazard of dust: Moderate. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0; (*powder*) Health 1, Flammability 3, Reactivity 2. The metal is insoluble in water. The dust reacts with water.
Potential Exposure: Compound Description: Tumorigen, Mutagen, Human Data; Primary Irritant. Zinc is used most commonly as a protective coating of other metals. In addition, it is used in alloys, such as bronze and brass, for electrical apparatus in many common goods; and in organic chemical extractions and reductions. Zinc chloride is a primary ingredient in smoke bombs used by military for screening purposes, crowd dispersal, and occasionally in firefighting exercises by both military and civilian communities. In pharmaceuticals, salts of zinc are used as solubilizing agents in many drugs, including insulin.
Incompatibilities: Dust may self-ignite in air. A strong reducing agent. Violent reaction with oxidizers, chromic anhydride, manganese chloride, chlorates, chlorine, and magnesium. Reacts with water and reacts violently with acids, alkali hydroxides, and bases forming highly flammable hydrogen gas. Reacts violently with sulfur, halogenated hydrocarbons, and many other substances, causing fire and explosion hazard.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 240 mg/m^3
PAC-3: 500 mg/m^3
Zinc nitrate (7779-88-6)
TEEL-0: 1 mg/m^3
PAC-1: 3 mg/m^3
PAC-2: 20 mg/m^3
PAC-3: 100 mg/m^3
DFG MAK (*zinc & zinc inorganic compounds*): 0.1 mg/m^3, respirable fraction; Peak Limitation Category I(4); 2 mg/m^3, inhalable fraction (excluding zinc chloride) TWA; Peak Limitation Category II(2).
Arab Republic of Egypt: 0.1 mg/m^3 TWA, 1993.
Several states have set a standard for zinc metal in ambient air[60] ranging from 0.03 μg/m^3 (New York) to 6.55−39.29 μg/m^3 (Montana).
Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements, #7030 Zinc and compounds (as Zn), #8005, Elements in blood or tissue, #8310 Metals in urine, OSHA Analytical Methods ID-121; ID-125G.
Permissible Concentration in Water: There are a number of standards for *zinc* in water set around the world[35]: EC: 100−500 μg/L, for drinking water; Germany: 2000 μg/L,

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: 10.1016/B978-1-4377-7869-4.00025-4

for drinking water; Mexico: 10,000 μg/L, for estuaries; Mexico: 10 μg/L, for coastal waters; Russia: 5000 μg/L, for drinking water; Russia: 1000 μg/L, for surface water; Russia: 10 μg/L, in water for fishery purposes; WHO: 5000 μg/L, in water for esthetic quality. The US EPA[6] has set 5 mg/L (5000 μg/L) for the prevention of adverse effects due to the organoleptic properties of zinc. The state of Kansas has also set a drinking water limit of 5 mg/L.[61]

Determination in Water: There are a number of standards for *zinc* in water set around the world[35]: EC: 100−500 μg/L, for drinking water; Germany: 2000 μg/L, for drinking water; Mexico: 10,000 μg/L, for estuaries; Mexico: 10 μg/L, for coastal waters; Russia: 5000 μg/L, for drinking water; Russia: 1000 μg/L, for surface water; Russia: 10 μg/L, in water for fishery purposes; WHO: 5000 μg/L, in water for esthetic quality. The US EPA recommends there be no more than 5 ppm of drinking water because of taste. The state of Kansas has set a drinking water limit of 5 mg/L.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Zinc can affect you when breathed in. Zinc dust particles can irritate the eyes. Exposure to solid zinc is not known to cause acute or chronic health effects, but heated zinc may give off zinc oxide fumes that can cause health effects. Metal fragments can scratch the eyes. When zinc is refined, cadmium is released. *Cadmium* is a cancer causing agent. Inhalation of the dust or fume may cause metal fume fever.

Long Term Exposure: Repeated contact with the dust or fume may cause dermatitis. Ingestion of high levels of zinc can cause anemia, pancreas damage, and lower levels of high-density lipoprotein cholesterol (HDL, the good form of cholesterol). It is not known if high levels of zinc affect human reproduction or cause birth defects. Rats that were fed large amounts of zinc became infertile or had small babies. Zinc is an essential element in our diet. Not enough zinc can cause a loss of appetite, a decrease in the sense of taste and smell, slow wound healing, and skin sores, or a damaged immune system. The recommended dietary allowance (RDA) for zinc is 15 mg/day for men; 12 mg/day for women; 10 mg/day for children; 5 mg/day for infants. Harmful health effects generally begin at levels from 10 to 15 times the RDA (in the 100−250 mg/day range).

Points of Attack: Skin, blood, pancreas.

Medical Surveillance: Zinc can be measured in the blood or feces.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning do not use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc or cadmium.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact with the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to zinc dusts, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Yellow Stripe (*powder is a strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow-coded materials. Prior to working with this chemical you should be trained on its proper handling and storage. Zinc must be stored to avoid contact with chromic anhydride, manganese chloride, chlorates, chlorine, and magnesium since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, acids, and alkali hydroxides because flammable hydrogen gas is produced. Sources of ignition, such as smoking and open flames, are prohibited where zinc is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Zinc powder or zinc dust requires a shipping label of "DANGEROUS WHEN WET, SPONTANEOUSLY COMBUSTIBLE." They fall in DOT Hazard Class 4.3.

Pyrophoric metals, n.o.s., or Pyrophoric alloys, n.o.s. require a label of "SPONTANEOUSLY COMBUSTIBLE." They fall in DOT Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is

complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zinc is a combustible solid. Use dry chemical, sand, or foam extinguishers. Poisonous gases are produced in fire, including zinc oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Zinc powder should be reclaimed. Unsalvageable waste may be buried in an approved landfill. Leachate should be monitored for zinc content.[22]

References

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 82–85

US Public Health Service. (December 1988). *Toxicological Profile for Zinc*, Atlanta, GA: Agency for Toxic Substances and Disease Registry

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Zinc*. Albany, NY: Bureau of Toxic Substance Assessment

ATSDR. (September 1995). *Toxicological Fact Sheet: Zinc*. Atlanta, GA: US Department of Health and Human Services, Public Health Service

Note: In the interest of compactness and utility of this work, a few zinc compounds have been selected for inclusion. Data are available on other zinc compounds as follows:

Compounds: Sax, N. I. (Ed.). *Dangerous Properties of Industrial Material Report*

Zinc Acetate(I), No. 7, 88–90 (1981)
Zinc Borate(IV), No. 2, 93–96 (1984)
Zinc Carbonate(IV), No. 2, 98–100 (1984)
Zinc Cyanide(IV), No. 2, 100–102 (1984)
Zinc Dithionite (Zinc Hydrosulfite) 4, No. 1, 108–110 (1984)
Zinc Fluoride(III), No. 6, 83–85 (1983)
Zinc Nitrate(VIII), No. 5, 101–110 (1988)
Zinc Sulfate(V), No. 5, 106–113 (1985)

US Environmental Protection Agency. Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (October 2005). *Hazardous Substances Fact Sheet: Zinc*. Trenton, NJ

Compounds: New Jersey Fact Sheet

Zinc Acetate (September 2002)
Zinc Borate (September 2002)
Zinc Carbonate (September 2002)
Zinc Chlorate (September 2002)
Zinc Cyanide (December 2000)
Zinc Dithionite (December 2000)
Zinc Fluoride (December 2000)
Zinc Nitrate (November 2000)
Zinc Permanganate (November 2000)
Zinc Peroxide (November 2000)
Zinc Potassium Chromate (September 1998)
Zinc Sulfate (September 1998)

Zinc bromide Z:0110

Molecular Formula: Br_2Zn
Common Formula: $ZnBr_2$
Synonyms: Anhydrous zinc bromide; Bromuro de zinc (Spanish); Zinc bromide, anhydrous; Zinc dibromide
CAS Registry Number: 7699-45-8
RTECS® Number: ZH1150000
EC Number: 231-718-4

Regulatory Authority and Advisory Bodies

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

European/International Regulations: not listed in Annex 1.

WGK (German Aquatic Hazard Class): No value assigned.

Description: Zinc bromide is an odorless white crystalline solid. Boiling point = 650°C; Freezing/Melting point = 394°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Zinc bromide is used in photography, rayon manufacturing, and medicine.

Incompatibilities: Alkali metals. Violent reaction with metallic sodium or potassium. Store above 32°F/0°C.

Permissible Exposure Limits in Air
Protective Action Criteria (PAC)
TEEL-0: 2 mg/m^3
PAC-1: 6 mg/m^3
PAC-2: 40 mg/m^3
PAC-3: 200 mg/m^3
Neither ACGIH nor OSHA have set standards but the state of New York has set a guideline for ambient air of 3.0 μg/m^3.[60]

DFG MAK (*zinc & zinc inorganic compounds*): 0.1 mg/m^3, respirable fraction; Peak Limitation Category I(4); 2 mg/m^3, inhalable fraction (excluding zinc chloride) TWA; Peak Limitation Category II(2).

Permissible Concentration in Water: There are a number of standards for *zinc* in water set around the world[35]: EC: 100−500 μg/L, for drinking water; Germany: 2000 μg/L, for drinking water; Mexico: 10,000 μg/L, for estuaries; Mexico: 10 μg/L, for coastal waters; Russia: 5000 μg/L, for drinking water; Russia: 1000 μg/L, for surface water; Russia: 10 μg/L, in water for fishery purposes; WHO: 5000 μg/L, in water for esthetic quality. The US EPA[6] has set 5 mg/L (5000 μg/L), for the prevention of adverse effects due to the organoleptic properties of zinc. The state of Kansas has also set a drinking water limit of 5 mg/L.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Dust levels of 80 mg/m^3 may cause irritation of the mouth, nose, and throat resulting in coughing, wheezing, and difficult breathing. *Skin:* Can cause irritation and burns. *Eyes:* Can cause irritation and burns. *Ingestion:* Dust or solution may cause irritation to the mouth, throat, and digestive tract. Large doses can cause violent vomiting, severe stomach pain, diarrhea, shock, and collapse. Scars may form in the throat and stomach. Long lasting kidney irritation may occur. Less than 1 oz may cause death. Repeated exposure can lead to bromine poisoning, with symptoms of personality changes (such as depression), poor appetite, and confusion.

Long Term Exposure: Can cause headache, personality changes, poor appetite, lethargy, and confusion. Skin rash can occur with repeated exposure. Can irritate the lungs; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood test for bromide.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Administer prompt and complete gastric lavage and demulcents. Observe for gastric perforations and late complications, such as pyloric stenosis. For eye exposure, rinsing with 0.05 molar neutral sodium edetate may help prevent or reverse corneal opacification.

Note to physician: For severe poisoning, *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to zinc bromide, use a NIOSH/MSHA- or European Standard EN149-approved full-face-piece respirator with a high-efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures*, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Green: General storage may be used. Prior to working with this chemical you should be trained on its proper handling and storage. Zinc bromide must be stored to avoid contact with metallic sodium or potassium since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Zinc bromide itself does not burn. Poisonous gases are produced in fire, including hydrogen bromide and zinc. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position.

References

Sax, N. I. (Ed.). (1984). *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 96−98

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Zinc Bromide*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (October 1998). *Hazardous Substances Fact Sheet: Zinc Bromide*. Trenton, NJ

Zinc chloride Z:0120

Molecular Formula: Cl_2Zn

Common Formula: $ZnCl_2$

Synonyms: Butter of zinc; Chlorure de zinc (French); Cloruro de zinc (Spanish); Tinning glux; Zinc butter; Zinc chloride, anhydrous; Zinc chloride fume; Zinc (chlorure de) (French); Zinc dichloride; Zinc muriate solution; Zinkchlorid (German)

CAS Registry Number: 7646-85-7

RTECS® Number: ZH1400000

UN/NA & ERG Number: UN2331 (anhydrous)/154; UN1840 (solution)/154

EC Number: 231-592-0 [*Annex I Index No.*: 030-003-00-2]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA (*fume*): Inadequate Information to assess carcinogenic potential; US EPA Gene-Tox Program, Positive: Cell transform.—SA7/SHE; Host-mediated assay; Positive: Histidine reversion—Ames test; Negative: *In vitro* cytogenetics—human lymphocyte; Negative: *B. subtilis* rec assay; Sperm morphology—mouse.

FDA—over-the-counter drug.

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

Reportable Quantity (RQ): 1000 lb (454 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: C, N; Risk phrases: R22; R34; R50/53; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Zinc chloride is a white hexagonal, deliquescent crystals or colorless solution. The fume is a white particulate dispersed in air. Molecular weight = 136.27; Specific gravity (H_2O:1) = 2.91 at 25°C; Boiling point = 732°C; Freezing/Melting point = 290°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility = 435% at 21°C.

Potential Exposure: Compound Description: Agricultural Chemical; Tumorigen, Mutagen; Reproductive Effector; Human Data. Zinc chloride is used in iron galvanizing; as a wood preservative; for dry battery cells; as a soldering flux; in textile finishing; in vulcanized fiber; reclaiming rubber; in oil and gas well operations; oil refining; manufacturing of parchment paper; in dyes; activated carbon; in chemical synthesis; in adhesives; dentists’ cement; deodorants, disinfecting, and embalming solutions; and taxidermy. It is also produced by military screening smoke.

Incompatibilities: Aqueous solutions are strongly acidic. Incompatible with bases and potassium. Corrosive to metals.

Permissible Exposure Limits in Air

Fume

OSHA PEL: 1 mg/m^3 TWA.

NIOSH REL: 1 mg/m^3 TWA; 2 mg/m^3 STEL.

ACGIH TLV®[1]: 1 mg/m^3 TWA; 2 mg/m^3 STEL.

NIOSH IDLH: 50 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 1 mg/m^3

PAC-1: 2 mg/m^3

PAC-2: 50 mg/m^3

PAC-3: 50 mg/m^3

DFG MAK (*fume*): 0.1 mg/m^3, respirable fraction; Peak Limitation Category I(1); 2 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(4).

Arab Republic of Egypt: TWA 1 mg/m^3 (fume), 1993; Australia: TWA 1 mg/m^3, STEL 2 mg/m^3 (fume), 1993; Belgium: TWA 1 mg/m^3, STEL 2 mg/m^3 (fume), 1993; Denmark: TWA 0.5 mg[Zn]/m^3, 1999; Finland: TWA 1 mg/m^3 (fume), 1999; France: VME 1 mg/m^3 (fume), 1999; Norway: TWA 1 mg/m^3, 1999; the Netherlands: MAC-TGG 1 mg/m^3, 2003; Poland: TWA 1 mg/m^3, STEL 2 mg/m^3, 1999; Sweden: NGV 1 mg/m^3 (resp. dust), 1999; Switzerland: MAK-W 1 mg/m^3 (fume), 1999; Thailand: TWA 1 mg/m^3

(fume), 1993; Turkey: TWA 1 mg/m^3 (fume), 1993; United Kingdom: TWA 1 mg/m^3, STEL 2 mg/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 2 mg/m^3. Several states have set guidelines or standards for zinc chloride in ambient air[60] ranging from 0.16 μg/m^3 (Virginia) to 3.3 μg/m^3 (New York) to 10.0 μg/m^3 (Florida, North Dakota, South Dakota) to 20.0 μg/m^3 (Connecticut) to 24.0 μg/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #ID-121, #ID-125G.

Permissible Concentration in Water: There are a number of standards for *zinc* in water set around the world[35]: EC: 100−500 μg/L, for drinking water; Germany: 2000 μg/L, for drinking water; Mexico: 10,000 μg/L, for estuaries; Mexico: 10 μg/L, for coastal waters; Russia: 5000 μg/L, for drinking water; Russia: 1000 μg/L, for surface water; Russia: 10 μg/L, in water for fishery purposes; WHO: 5000 μg/L, in water for esthetic quality. The US EPA[6] has set 5 mg/L (5000 μg/L) for the prevention of adverse effects due to the organoleptic properties of zinc. The state of Kansas has also set a drinking water limit of 5 mg/L.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: *Inhalation:* Corrosive to the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Symptoms of exposure can include cough, copious sputum, dyspnea (breathing difficulty), chest pain, bronchopneumonia, pulmonary fibrosis, cor pulmonale, fever, cyanosis, tachypnea. No effects were reported from 30 min exposure to 0.07−0.04 mg/m^3. Exposure to dust or fumes above 80 mg/m^3 for 2 min may cause nose and throat irritation, cough, chest pain, cyanosis (bluish skin), fever, nausea and vomiting, shortness of breath, difficult breathing, and pneumonia. Breathing difficulties may not appear for several hours. Fume concentrations over 52 mg/m^3 may produce symptoms listed above. Fatal accidental exposures have occurred. *Skin:* Corrosive. Dust or solution can cause irritation and chemical burns particularly on areas where skin is broken. *Eyes:* Corrosive. Dust can cause burning irritation. Concentrated solutions are very dangerous to the eyes, causing extreme pain, redness, and swelling. Eye damage may result. *Ingestion:* Dust or solution may be irritating and corrosive to the mouth, throat, and digestive tract. Other symptoms may include stomach pain, nausea, vomiting, bloody diarrhea, swelling of the throat, blood in the urine, and shock. Less than 1 oz has killed an adult although recovery has been reported after ingestion of 4 oz.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. There is limited evidence that zinc chloride is a teratogen in animals. Repeated exposure can lead to delayed permanent lung damage. Prolonged contact can cause skin burns and ulcers.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, whole blood (chemical/metabolite), biologic tissue/biopsy, chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s), sputum cytology, urine (chemical/metabolite), white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis. Ingestion—gastric lavage with 5% sodium bicarbonates; Dimercaprol has been suggested for treatment. *Eyes:* rinsing with 0.05 molar neutral sodium edetate may prevent or reverse corneal opacification.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and use a face shield when working with powders or dust unless full face-piece respiratory protection is worn. Wear splash-proof chemical goggles and use a face shield when working with liquid unless full-face-piece respiratory protection is worn. Where the fume is present, wear gas-proof goggles and use face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *25 mg/m^3:* Sa:Cf

(APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or PaprTHie (APF = 50)* (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color Code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium.

Shipping: Zinc chloride, anhydrous or solution, requires a shipping label of "CORROSIVE." It falls in Hazard Class 8 and Packing Group III.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Wash spill area with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is noncombustible. Use agent suitable for surrounding fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dump in water; add soda ash and stir, then neutralize and flush to sewer with water. Alternatively, zinc chloride may be recovered from spent catalysts and used in acrylic fiber spinning solutions.

References

Sax, N. I. (Ed.). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 90−92 (1981) and 5, No. 3, 77−82 (1985)

New York State Department of Health. (April 1986). *Chemical Fact Sheet: Zinc Chloride*. Albany, NY: Bureau of Toxic Substance Assessment

New Jersey Department of Health and Senior Services. (December 2000). *Hazardous Substances Fact Sheet: Zinc Chloride*. Trenton, NJ

Zinc chromate Z:0130

Molecular Formula: CrO_4Zn

Common Formula: $ZnCrO_4$

Synonyms: Basic zinc chromate; Basic zinc chromate X-2259; Buttercup yellow; Chromic acid, zinc salt; Chromium zinc oxide; C.I. 77955; C.I. Pigment yellow 36; Citron yellow; C.P. zinc yellow X-883; Primrose yellow; Pure zinc chrome; Pure zinc yellow; Zinc chromate C; Zinc chromate (VI) hydroxide; Zinc chromate O; Zinc chromate T; Zinc chromate Z; Zinc chrome; Zinc chrome (anti-corrosion); Zinc chrome yellow; Zinc chromium oxide; Zinc hydroxychromate; Zinc tetraoxychromate; Zinc tetraoxychromate 76A; Zinc tetraoxychromate 780B; Zinc tetroxychromate; Zinc yellow; Zinc yellow 1; Zinc yellow 1425; Zinc yellow 386N; Zinc yellow 40-9015; Zinc yellow AZ-16; Zinc yellow AZ-18; Zinc yellow KSH

CAS Registry Number: 13530-65-9; *(alt.)* 1308-13-0; *(alt.)* 1328-67-2; *(alt.)* 14675-41-3; 11103-86-9; 37300-23-5; 12018-19-8; 14018-95-2; 37224-57-0 (zinc potassium chromate)

RTECS® Number: GB3290000

UN/NA & ERG Number: UN3288 (toxic solid, inorganic, n.o.s.)/151

EC Number: 236-878-9 [*Annex I Index No.*: 024-007-00-3]

Regulatory Authority and Advisory Bodies

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP: 11th Report on Carcinogens, 2004: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Cannot be Determined; Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

US EPA Gene-Tox Program, Positive: Carcinogenicity—mouse/rat; Cell transform.—SA7/SHE; NIOSH: Potential occupational carcinogen.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

Chromium compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

California Proposition 65 Chemical: (*hexavalent chromium*) Cancer 2/27/87; Developmental/Reproductive toxin (male, female) 12/19/08.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%.

European/International Regulations: Hazard Symbol: E, T + , N; Risk phrases: R45; R46; R60; R61; R2; R8; R21; R25; R26; R34; R42/43; R48/23; R50/53; Safety phrases: S53; S45; S60; S61.

European/International Regulations (*zinc chromates including zinc potassium chromate*): Hazard Symbol: T, N; Risk phrases: R45; R22; R43; R50/53; Safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Zinc chromate is a yellow crystalline powder. Molecular weight = 181.37; Freezing/Melting point = 316°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Compound Description: Tumorigen, Mutagen; Human Data. Zinc chromate is used as an anticorrosion pigment in primers and as a coloring agent; as a pigment in surface coatings and linoleum; to impart corrosion-resistance to epoxy laminates.

Incompatibilities: An oxidizer; reacts with reducing agents, combustibles, organic materials.

Permissible Exposure Limits in Air

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 (*13530-65-9 only*) TWA; 0.1 mg[CrO^3]/m^3 (*11103-86-9 and 37300-23-5*) Ceiling Concentration. See 29CFR1910.1026.

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV®[1]: 0.015 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued.

NIOSH IDLH: 15 mg[Cr(VI)]/m^3.

Protective Action Criteria (PAC)

TEEL-0: 0.0174 mg/m^3

PAC-1: 0.4 mg/m^3

PAC-2: 2.5 mg/m^3

PAC-3: 52.3 mg/m^3

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; Pregnancy Risk Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Australia: TWA 0.01 mg/m^3, carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.01 mg/m^3, carcinogen, 1993; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; France: VME 0.05 mg[Cr]/m^3, 1999; Japan; 0.05 mg[Cr]/m^3, 1999; Norway: TWA 0.02 mg[CrO$_3$]/m^3, 1999; Poland: TWA 0.1 mg/m^3, STEL 0.3 mg/m^3, 1999; Sweden: TWA 0.02 mg[Cr]/m^3, carcinogen, 1999; Switzerland: MAK-W 0.01 mg[Cr]/m^3, carcinogen, 1999; United Kingdom: TWA 0.5 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Confirmed Human Carcinogen. Several states have set guidelines or standards for zinc chromate in ambient air[60] ranging from 0.008 μg/m^3 (Virginia) to 0.5 μg/m^3 (Connecticut) to 1.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600,#7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: Since zinc chromate may consist of compounds with various ZnO/Cr$_2$O$_3$ rations, it is best simply to refer to the EPA water quality criteria cited in the sections of the volume dealing with "Chromium" and with "Zinc Chloride." There are a number of standards for *zinc* in water set around the world[35]: The US EPA[6] has set 5 mg/L (5000 μg/L) for the prevention of adverse effects due to the organoleptic properties of zinc. The state of Kansas has also set a drinking water limit of 5 mg/L.[61] EC: 100−500 μg/L (drinking water); Germany: 2000 μg/L (drinking water); Mexico: 10,000 μg/L (estuaries); 10 μg/L (coastal waters); Russia: 5000 μg/L (drinking water); 1000 μg/L (surface water); 10 μg/L (for fishery purposes); WHO: 5000 μg/L (for esthetic quality). *As a hexavalent chromium compound:* For the protection of freshwater aquatic life: *Hexavalent chromium:* 0.29 μg/L as a 24-h average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: *Hexavalent chromium:* 18 μg/L as a 24-h average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L according to EPA.[6] US EPA[49] has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L.[62] Germany, Canada, EEC, and WHO[35] have set a limit of 0.05 mg/L in drinking water. The states of Maine and Minnesota have set a guideline of 50 μg/L for chromium in drinking water[61] for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide), or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μm filtration followed by the above-cited methods.[49]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Zinc chromate can affect you when breathed in and may enter the body through the skin. Zinc chromate is a carcinogen; handle with extreme caution. Zinc chromate can irritate the skin, causing a rash or skin ulcers. It can also trigger a skin allergy.

Long Term Exposure: Repeated exposure can cause a hole in the nasal septum (bone dividing the inner nose). Nose bleeds and sores are earlier signs. Zinc chromate is a human carcinogen. Repeated exposure may cause skin allergy with rash and itching.

Points of Attack: Skin. Cancer site in humans: Lung and throat.

Medical Surveillance: NIOSH lists the following tests for chromates: Blood gas analysis, complete blood count, chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before beginning employment and at regular times after that, the following is recommended: Urine test for *chromates.* This test is most accurate shortly after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Prevent skin contact. (As chromic acid and chromates) **8 h** (more than 8 h of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; **4 h** (At least 4 but <8 h of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton™ gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129 [Chromium(VI)].

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from reducing agents. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solid, inorganic, n.o.s. requires a shipping label of "POISONOUS/TOXIC MATERIALS." They fall in Hazard Class 6.1.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Use agent suitable for surrounding fire. Poisonous gases are produced in fire, including zinc and chromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Chromium*, NIOSH Document No. 76-129. Rockville, MD

Sax, N. I. (Ed.). (1981). *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 92−94

New Jersey Department of Health and Senior Services. (August 2002). *Hazardous Substances Fact Sheet: Zinc Chromate*. Trenton, NJ

Zinc oxide Z:0140

Molecular Formula: OZn

Common Formula: ZnO

Synonyms: Akro-zinc bar 85; Akro zinc bar 90; Amalox; Azo-33; Azo-55; Azo-66; Azo-77; Azodox-55; Calamine; Chinese white; C.I. 77947; C.I. Pigment white 4; Emanay zinc oxide; Emar; Felling zinc oxide; Flowers of zinc; Green seal-8; HC (military designation); Hubbuck's white; Kadox-25; K-zinc; Ozide; Ozlo; Pasco; Permanent white; Philosopher's wool; Protox type 166; Protox type 167; Protox type 168; Protox type 169; Protox type 267; Protox type 268; Red-seal-9; Snow white; White flower of zinc; White seal-7; Zincite; Zincoid; Zinc oxide fume; Zinc peroxide; Zinc white

CAS Registry Number: 1314-13-2; *(alt.)* 8051-03-4; *(alt.)* 78590-82-6

RTECS® Number: ZH4810000

UN/NA & ERG Number: UN3077/171

EC Number: 215-222-5 [*Annex I Index No.:* 030-013-00-7]

Regulatory Authority and Advisory Bodies

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; Inadequate Information to assess carcinogenic potential; Available data are inadequate for an assessment of human carcinogenic potential.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

FDA—over-the-counter drug.

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol: N; Risk phrases: R50/53; Safety phrases: S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 2—Hazard to waters.

Description: Zinc oxide is an amorphous, white or yellowish-white powder. Odorless. Molecular weight = 81.37; Specific gravity (H_2O:1) = 5.61 at 25°C; Freezing/Melting point = 1975°C. Hazard Identification (based on NFPA-704 M Rating System) (*powder*): Health 2, Flammability 2, Reactivity 0. Practically insoluble in water; zinc oxide undergoes slow decomposition; solubility = 0.0004% at 18°C.

Potential Exposure: Compound Description: Mutagen; Reproductive Effector; Human Data; Primary Irritant. Zinc oxide is primarily used as a white pigment in rubber formulations and as a vulcanizing aid. It is also used as an anti-inflammatory agent; in photocopying; paints, chemicals, ceramics, lacquers, and varnishes; as a filler for plastic; in cosmetics, pharmaceuticals, and calamine lotion. Exposure may occur in the manufacture and use of zinc oxide and products, or through its formation as a fume when zinc or its alloys are heated. HC may have been used as a Choking/Pulmonary Agent.

Incompatibilities: Incompatible with linseed oil, magnesium. Contact with chlorinated rubber (at 215°C) may cause a violent reaction. Slowly decomposed by water.

Permissible Exposure Limits in Air

OSHA PEL: 15 mg/m^3 TWA (*total dust*); 5 mg/m^3 TWA (*respirable fraction and fume*).

NIOSH REL: (*dust only*): 5 mg/m^3 TWA; 15 mg/m^3 Ceiling Concentration; (*fume*) 5 mg/m^3 TWA; 10 mg/m^3 Ceiling Concentration.

ACGIH TLV®[1]: 2 mg/m^3, respirable fraction TWA; 10 mg/m^3, respirable fraction STEL.

NIOSH IDLH: 500 mg/m^3.

Protective Action Criteria (PAC)

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 15 mg/m^3

PAC-3: 500 mg/m^3

DFG *MAK* (*zinc oxide and fume*): 0.1 mg/m^3, respirable fraction TWA; Peak Limitation Category I(4); 2 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(2).

Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Australia: TWA 10 mg/m^3, 1993; Australia: TWA 5 mg/m^3, STEL 10 mg/m^3 (fume), 1993; Belgium: TWA 10 mg/m^3, 1993; TWA 5 mg/m^3, STEL 10 mg/m^3 (fume), 1993; Denmark: TWA 4 mg[Zn]/m^3, 1999; Finland: TWA 5 mg/m^3 (fume), 1999; the Netherlands: MAC-TGG 5 mg/m^3, 2003; France: VME (fume) 5 mg/m^3, 1999; Hungary: TWA 5 mg/m^3, 1993; Japan; 5 mg/m^3 (fume), 1999; Norway: TWA 5 mg/m^3, 1999; the Philippines: TWA 1 mg/m^3, 1993; Poland: MAC (TWA) fume 5 mg/m^3; MAC (STEL) fume 10 mg/m^3, 1999; Sweden: NGV 5 mg/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, 1999; Thailand: TWA 5 mg/m^3 (fume), 1993; Turkey: TWA 5 mg/m^3, 1993; United Kingdom: TWA 5 mg/m^3, STEL 10 mg/m^3, fume, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 mg/m^3. Russia[43] set a MAC of 0.05 mg/m^3 in ambient air in residential areas on a daily average basis. Several states have set guidelines or standards for zinc oxide fume in ambient air[60] ranging from 0.8 μg/m^3 (Virginia) to 16.7 μg/m^3 (New York) to 50.0 μg/m^3 (Florida) to 50.0–100.0 μg/m^3 (North Dakota) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7303, Elements by ICP, #7502, Zinc and compounds, OSHA Analytical Method #ID-121, #ID1-43.

Permissible Concentration in Water: There are a number of standards for *zinc* in water set around the world.[35] The US EPA[6] has set 5 mg/L (5000 μg/L) for the prevention of adverse effects due to the organoleptic properties of zinc. EC: 100–500 μg/L (drinking water); Germany: 2000 μg/L (drinking water); Mexico: 10,000 μg/L (estuaries); 10 μg/L (coastal waters); Russia: 5000 μg/L (drinking water); 1000 μg/L (surface water); 10 μg/L (for fishery purposes); WHO: 5000 μg/L (for esthetic quality). The state of Kansas has also set a drinking water limit of 5 mg/L.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: *Note:* Symptoms of metallic or sweet taste and/or throat irritation or dryness may indicate overexposure. *Inhalation:* Irritates the respiratory tract. Exposure to fumes over 52 mg/m^3 can cause "metal fume fever." Onset of symptoms may be delayed 4–12 h. Symptoms include irritation of the nose, mouth, and throat; chills, muscle ache, nausea, fever, dry throat, cough, weakness, lassitude (weakness, exhaustion), metallic taste, headache, blurred vision, low back pain, vomiting, fatigue, malaise (vague feeling of discomfort), tightness in chest, dyspnea (breathing difficulty), rales, decreased pulmonary function, stomach pain, chills, fever, pains in the muscles and joints, thirst, bronchitis or pneumonia, and bluish tint to the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Skin: Dust may cause irritation which can result in rash. *Eyes:* No information available. *Ingestion:* May cause abdominal discomfort, watery diarrhea, and cramps.

Long Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged inhalation exposure may cause asthma. There is limited evidence that zinc oxide may damage the developing fetus. Repeated overexposure may cause ulcer symptoms and affect the liver.

Points of Attack: Respiratory system, liver, skin.

Medical Surveillance: There are no special tests for this chemical. However, if overexposure is suspected or if illness occurs medical attention is recommended. Lung function tests. Liver function tests. GI series. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. If metal fume fever develops, it may last less than 36 h.

Note to physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). *Up to 125 mg/m^3:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust, mist, and fume filter). *Up to 250 mg/m^3:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). *Up to 500 mg/m^3:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with a high-efficiency particulate filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from chlorinated rubber, magnesium, and linseed oil.

Shipping: The name of this material is not on the DOT list of materials[19] for label and packaging standards. However, based on regulations, it may be classified[52] as an Environmentally hazardous substances, solid, n.o.s. This chemical requires a shipping label of "CLASS 9." It falls in Hazard Class 9 and Packing Group III.[20, 21]

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not burn. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire, including oxides of zinc. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

National Institute for Occupational Safety and Health. (1976). *Criteria for a Recommended Standard: Occupational Exposure to Zinc Oxide*, NIOSH Document No. 76-104

US Environmental Protection Agency. (July 1987). *Summary Review of Health Effects Associated with Zinc and Zinc Oxide*, Report EPA/600/8-87/022F. Research Triangle Park, NC

New York State Department of Health. (March 1986). *Chemical Fact Sheet: Zinc Oxide*. Albany, NY: Bureau of Toxic Substance Assessment

US Environmental Protection Agency. Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (January 2007). *Hazardous Substances Fact Sheet: Zinc Oxide*. Trenton, NJ

Zinc phosphide Z:0150

Molecular Formula: P_2Zn_3

Common Formula: Zn_3P_2

Synonyms: Blue-ox; Fosfuro de zinc (Spanish); Kilrat; Mous-con; Phosphure de zinc (French); Phosvin; Ratol; Zinc (phosphure de) (French); Zinc-tox; Zinkphosphid (German); ZP

CAS Registry Number: 1314-84-7; (*alt.*) 39342-49-9

RTECS® Number: ZH4900000

UN/NA & ERG Number: UN1714/139

EC Number: 215-244-5 [*Annex I Index No.:* 015-006-00-9]

Regulatory Authority and Advisory Bodies

US EPA, FIFRA 1998 Status of Pesticides: RED completed.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/92).

US EPA Hazardous Waste Number (RCRA No.): P122.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR355, Extremely Hazardous Substances: TPQ = 500 lb (227 kg). This material is a reactive solid. The TPQ does not default to 10,000 lb for nonpowder, nonmolten, nonsolution form.

Reportable Quantity (RQ): 100 lb (45.4 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations: Hazard Symbol: T+, F, N; Risk phrases: R15/29; R28; R32; R50/53; Safety phrases: S1/2; S28; S30; S36/37; S43; S45; S60; S61 (see Appendix 4).

WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Zinc phosphide is a gray crystalline solid. Molecular weight = 258.05; Boiling point = 1100°C; Freezing/Melting point = 420°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Insoluble in water; slowly decomposes.

Potential Exposure: Compound Description: Agricultural Chemical; Mutagen; Reproductive Effector; Human Data. It is used as an acute single-feeding rodenticide.

Incompatibilities: Heat and contact with water causes decomposition, producing toxic and flammable fumes of phosphorus, zinc oxides, and toxic and flammable phosphine gas. Reacts violently with concentrated sulfuric acid, nitric acid, and other oxidizers. Reacts with hydrochloric acid or sulfuric acid with the evolution of spontaneously flammable phosphine gas. Incompatible with carbon dioxide, halogenated agents.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)*

TEEL-0: 0.05 ppm

PAC-1: 0.15 ppm

PAC-2: **1** ppm

PAC-3: **1.8** ppm

*AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guidelines) are in **bold face**.

Russia: TWA 0.1 mg/m^3, 1993.

Determination in Air: Use #7502, Zinc and compounds, OSHA Analytical Method #ID-121, #ID1-43.

Permissible Concentration in Water: There are a number of standards for zinc in water set around the world[35]: The EC: 100−500 μg/L (drinking water); Germany: 2000 μg/L (drinking water); Mexico: 10,000 μg/L (estuaries); 10 μg/L (coastal waters; Russia: 5000 μg/L (drinking water); 1000 μg/L (surface water); 10 μg/L (for fishery purposes); WHO: 5000 μg/L (for esthetic quality). US EPA[6] has set 5 mg/L (5000 μg/L) for the prevention of adverse effects due to the organoleptic properties of zinc. The state of Kansas has also set a drinking water limit of 5 mg/L.[61]

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short Term Exposure: Irritates the respiratory tract. Contact with the eyes can cause severe irritation, burns, and permanent damage. Skin contact causes irritation. This chemical is a CNS depressant. Inhalation of zinc phosphide dust is followed in several hours by vomiting, diarrhea, cyanosis (bluing of skin), rapid pulse, fever, and shock. The breath smells of phosphine. The compound is very caustic and may cause closing of the esophagus. Inhalation of phosphine (formed when zinc phosphide is exposed to flame, water, or acids) can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Zinc phosphide is very caustic when ingested and forms phosphine. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70-kg (150−lb) person. Most patients die after about 30 h from peripheral vascular collapse secondary to the compound's direct effects. Extensive liver damage and kidney damage can also occur. Ingestion of 4−5 g has produced death in human adults, but also doses of 25−50 g have been survived. The lowest oral lethal dose reported for women is 80 mg/kg. Symptoms of oral ingestion include nausea, abdominal pain, vomiting, tightness in chest, excitement, agitation and chills, faintness, weakness, dyspnea, fall in blood pressure, change in pulse rate, diarrhea, intense thirst, convulsions, paralysis, and coma. Early labored breathing, shock, halted urinary output, metabolic acidosis, muscle cramps, and convulsions are grave prognostic signs.

Long Term Exposure: The substance may cause effects on the liver, kidneys, heart, and nervous system. Repeated exposures to low exposures cause chronic poisoning, anemia, bronchitis, and gastrointestinal, visual, speech, and motor disturbances.

Points of Attack: Lungs, liver, kidneys, heart, blood, nervous system.

Medical Surveillance: Liver and kidney function tests. EKG. Lung function tests. Consider chest X-ray following acute overexposure. Complete blood count (CBC).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled get medical attention for phosphine, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention for phosphine poisoning. Give one tablespoonful of mustard in a glass of warm water; repeat until vomit fluid is clear; avoid use of all oils. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray.

Note to physician: For severe poisoning *do not* use BAL [British Anti-Lewisite, dimercaprol, dithiopropanol

($C_3H_8OS_2$)] as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to zinc dusts, use a NIOSH/MSHA- or European Standard EN149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure, use a NIOSH/MSHA- or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full face-piece operated in a pressure-demand or other positive-pressure mode.

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical you should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and oxidizers.

Shipping: Zinc phosphide requires a shipping label of "DANGEROUS WHEN WET, POISONOUS/TOXIC MATERIALS." It falls in Hazard Class 4.3 and Packing Group I.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water*. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Keep material dry. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. For a land spill, dig a pit, pond, lagoon, or holding area to contain liquid or solid material. For water spill, neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. Use mechanical dredges or lifts to remove immobilized wastes of pollutants and precipitates. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Clean up only under supervision of an expert. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. UN1714, zinc phosphide is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water*. Dangerous from 0.5 to 10 km (0.3−6.0 miles) downwind.

Fire Extinguishing: *Do not use water* or foam. For small fires, use dry chemical, soda ash, or lime. For large fires, withdraw from area and let burn. *Do not use water* or any agent with an acid reaction (i.e., carbon dioxide or halogenated agents) as phosphine will be liberated. Poisonous gases, including phosphine, zinc oxide, and phosphorus, are produced in fire. Wear boots, protective gloves, and goggles. Wear self-contained breathing apparatus when fighting fires involving this material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Move container from fire area if you can do so without risk.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

US Environmental Protection Agency. (November 30, 1987). *Chemical Hazard Information Profile: Zinc Phosphide*. Washington, DC: Chemical Emergency Preparedness Program

US Environmental Protection Agency. Special Review and Reregistration Division Office of Pesticide Programs. (1998). *Agency Status of Pesticides in Registration, Reregistration, and Special Review* (Rainbow Report). Washington, DC

New Jersey Department of Health and Senior Services. (May 2000). *Hazardous Substances Fact Sheet: Zinc Phosphide*. Trenton, NJ

Zirconium & compounds Z:0160

Molecular Formula: Zr

Common Formula: Zr

Synonyms: Zirconium metal

other zirconium compounds: Zirconium boride (12045-64-6); Zirconium carbide (12070-14-3); Zirconium chloride (10026-11-6); Zirconium fluoride (7783-64-4); Zirconium hydride (7704-99-6); Zirconium hydroxide (14475-63-9);

Zirconium nitrate (13746-89-9); Zirconium nitride (25658-42-8); Zirconium oxide (1314-23-4); Zirconium phosphide (12037-80-8); (Zirconium oxychloride) 7699-43-6; Zirconyl chloride (10026-11-6)

CAS Registry Number: 7440-67-7 (metal)

RTECS® Number: ZH7070000 (elemental)

UN/NA & ERG Number: UN1358 [Zirconium powder, wetted with not <25% water (a visible excess of water must be present); (a) mechanically produced, particle size <53 μm; (b) chemically produced, particle size <840 μm]/170; UN1932 (metal scrap)/135; UN2008 (metal powder, dry)/135; UN2858 [dry, coiled wire, finished metal sheets, strip (thinner than 254 μm but not thinner than 18 μm)]/170; UN2009[dry, finished sheets, strip or coiled wire]/135

EC Number: 231-176-9 [*Annex I Index No.:* 040-001-00-3]

Regulatory Authority and Advisory Bodies

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

The FDA controls zirconium-containing drugs and/or cosmetic products.

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: Hazard Symbol (*powder, pyrophoric*): F; Risk phrases: R15; R17; Safety phrases: S2; S7/8; S43; (*powder stabilized*) Risk phrases: R17; Safety phrases: S2; S7/8; S43 (see Appendix 4).

WGK (German Aquatic Hazard Class): Nonwater polluting agent (*metal*); 1-Slightly water polluting (*acetate, dichloride, dioxide, propionate*).

Description: Zirconium is a grayish-white, lustrous metal in the form of platelets, flakes, or a bluish-black, amorphous powder. Molecular weight = 91.22 (elemental); Specific gravity (H_2O:1) = 6.51 at 25°C; Boiling point = 3577°C; Freezing/Melting point = 1857°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1. Insoluble in water. The powdered metal is a fire and explosive hazard: it may ignite *spontaneously* and can continue burning under water.

Zirconium is never found in the free state; the most common sources are the ores zircon and baddeleyite. It is generally produced by reduction of the chloride or iodide. The metal is very reactive, and the process is carried out under an atmosphere of inert gas.

Potential Exposure: Zirconium metal is used as a "getter" in vacuum tubes, a deoxidizer in metallurgy, a substitute for platinum; it is used in priming of explosive mixtures; flashlight powders; lamp filaments; flash bulbs; and construction of rayon spinnerets. Zirconium or its alloys (with nickel, cobalt, niobium, tantalum) are used as lining materials for pumps and pipes, for chemical processes, and for reaction vessels. Pure zirconium is a structural material for atomic reactor; and alloyed, particularly with aluminum, it is a cladding material for fuel rods in water-moderated nuclear reactors. A zirconium–columbium alloy is an excellent superconductor.

Zircon ($ZrSiO_4$) is utilized as a foundry sand, an abrasive, a refractory in combination with zirconia, a coating for casting molds, a catalyst in alkyl and alkenyl hydrocarbon manufacture, a stabilizer in silicone rubbers, and as a gem stone; in ceramics, it is used as an opacifier for glazes and enamels and in fritted glass filters. Both zircon and zirconia (zirconium oxide, ZrO_2) bricks are used as linings for glass furnaces. Zirconia itself is used in die extrusion of metals and in spout linings for pouring metals, as a substitute for lime in oxyhydrogen flam, as a pigment; and an abrasive; it is used, too, in incandescent lights, as well as in the manufacture of enamels, white glass, and refractory crucibles. Other zirconium compounds are used in metal cutting tools, thermocouple jackets, waterproofing textiles, ceramics, and in treating dermatitis and poison ivy.

Incompatibilities: Violent reactions with oxidizers, air, alkali hydroxides, alkali metal compounds (such as chromates, dichromates, molybdates, salts, sulfates, and tungstates), borax, carbon tetrachloride, lead, lead oxide, phosphorus, potassium compounds. Incompatible with boron, carbon, nitrogen, halogens, lead, platinum, potassium nitrate. Powder may ignite *spontaneously* and can continue burning under water. Explodes if mixed with hydrated borax when heated. Fine powder may be stored completely immersed in water.

Permissible Exposure Limits in Air

OSHA PEL (compounds): 5 mg[Zr]/m^3 TWA.

NIOSH REL: 5 mg[Zr]/m^3 TWA; 10 mg/m^3 STEL [The REL applies to all zirconium compounds (as Zr) except Zirconium tetrachloride].

ACGIH TLV®[1] (*elemental & zirconium compounds*): 5 mg[Zr]/m^3 TWA; 10 mg/m^3 STEL; not classifiable as a human carcinogen.

NIOSH IDLH: 50 mg[Zr]/m^3.

Protective Action Criteria (PAC)

Metal

TEEL-0: 5 mg/m^3

PAC-1: 10 mg/m^3

PAC-2: 10 mg/m^3

PAC-3: 25 mg/m^3

1314-23-4 (zirconium oxide)

TEEL-0: 6.75 mg/m^3

PAC-1: 13.5 mg/m^3

PAC-2: 13.5 mg/m^3

PAC-3: 33.8 mg/m^3

DFG MAK: (*elemental and insoluble compounds*): 1 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(1) danger of sensitization of the airways and skin; Pregnancy Risk Group; (*soluble compounds*): danger of sensitization of the airways and skin.

Arab Republic of Egypt: TWA 5 mg/m^3, 1993; Austria: MAK 5 mg/m^3, 1999; Denmark: TWA 5 mg[Zr]/m^3, 1999; Finland: TWA 5 mg/m^3, 1999; Hungary: STEL 5 mg/m^3, 1993; Poland: MAC (TWA) 5 mg/m^3; MAC (STEL) 10 mg/m^3, 1999; Russia: STEL 6 mg/m^3, 1993; the Netherlands: MAC-TGG 5 mg/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: STEL 10 mg/m^3. Several states have set guidelines or standards for zirconium compounds in ambient air[60] ranging from 0.8 μg/m^3 (Virginia) to 50.0−100.0 μg/m^3 (North Dakota) to 100.0 μg/m^3 (Connecticut) to 119.0 μg/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements by ICP, #8005, Elements in blood or tissue. See also OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation of dust or fume, eye and/or skin contact.

Harmful Effects and Symptoms

Short Term Exposure: Zirconium can affect you when breathed in. The dust can irritate the lungs, causing coughing and/or shortness of breath.

Long Term Exposure: Contact can cause an allergic skin reaction to develop with small nodules (granulomas). May cause change in chest X-ray; lung granulomas. In animals: irritation of skin, mucous membrane; X-ray evidence of retention in lungs.

Points of Attack: Skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. If breathing problems occur, lung function tests and a chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Skin protection is not generally necessary, but it is probably advisable especially where there is a history of zircon granuloma from deodorants. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *25 mg/m^3*: Qm (APF = 25) (any quarter-mask respirator). *50 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust, mist, and fume filter); 100F (APF = 50) (any air-purifying, full face-piece respirator with an N100, R100, or P100 filter) or Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Red Stripe (*powder*): Flammability Hazard: Store separately from all other flammable materials. Zirconium must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable materials. Sources of ignition, such as smoking and open flames, are prohibited where zirconium is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of zirconium should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of zirconium. Wherever zirconium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Dry zirconium powder requires a shipping label of "SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 4.2 and Packing Group II.

Spill Handling: Evacuate persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep zirconium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zirconium is a flammable powder. Fire may restart after it has been extinguished. Containers may explode in fire. Use dry chemicals appropriate for extinguishing metal fires, salt, dry sand. *Do not use water*. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

References

New Jersey Department of Health and Senior Services. (October, 1998). *Hazardous Substances Fact Sheet: Zirconium*. Trenton, NJ

General Guide to Chemical Resistant Gloves

Material	Generally suitable for
Butyl rubber	Aldehydes Carboxylic acids Glycols and ethers Hydroxyl compounds and alcohol peroxides
Latex	Limit use (see note below) Acetone Alcohols Alkalies and caustics Ammonium fluoride Dimethyl sulfoxide (DMSO) Phenol
Natural rubber	Plating solutions Alcohols Alkalies and caustics Cellosolve Degreasing solvents Mineral acids Oils
Neoprene	Plating solutions
Nitrile rubber	Alcohols Ammonium fluoride Freons Hexane Hydrofluoric and hydrochloric acid Perchloric acid Perchloroethylene Phosphoric acid Potassium and sodium hydroxide Water-soluble materials, dilute acids and bases
Vinyl	General prevention of contamination Medical examination Nuisance materials

Important Note: Latex gloves present a risk of irritation, allergic reaction, or sensitization which, for susceptible individuals, can be significant. The latex protein can leach out of the gloves into the user's skin, or into the glove powdering, if powdered gloves are used. This can lead to allergic skin reaction or a potentially more serious reaction if latex protein-contaminated powder is released into the environment and breathed in. The use of any sort of latex gloves should be considered carefully, and they should only be used when no other glove is appropriate. You are strongly advised not to use powdered latex gloves. *Users at University of Oxford should be aware that University Safety Policy statement S3/02 prohibits the use of powdered latex gloves for any purpose and advises that, if use of latex is essential, only latex gloves with low levels of extractable latex protein may be used.*
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Appendix 1: Oxidizing Materials

Notes: Best efforts have been made to ensure the information below is as accurate as possible. This list is not (and cannot be) comprehensive. Therefore, the absence of an oxidizing material from this list *does not* mean that it is not an oxidizer. The Publisher or Author cannot accept any responsibility for the use or misuse of this information. Generally, solid oxidizers include the following materials: bromates, chlorates, chlorites, chromates, dichromates, hypochlorites, iodates, nitrates, nitrites, perchlorates, permanganates, peroxides, persulfates, picrates, and chemical oxygen generators (such as potassium superoxide). Also, many fertilizers are oxidizing materials.

Oxidizing Materials by Name and CAS

Aluminum nitrate	13473-90-0
Ammonium chloride	7446-70-0
Ammonium chromate	7788-98-9
Ammonium dichromate	7789-09-5
Ammonium nitrate	6484-52-2
Ammonium nitrate−phosphate mixture	57608-40-9
Ammonium nitrate−sulfate mixture	6484-52-2
Ammonium perchlorate	7790-98-9
Ammonium permanganate	13446-10-1
Ammonium persulfate	7727-54-0
Ammonium picrate (wet)	131-74-8
Amyl nitrate	463-04-7
Barium bromate	13967-90-3
Barium chlorate	13477-00-4
Barium hypochlorite	13477-10-6
Barium nitrate	10022-31-8
Barium perchlorate trihydrate	10294-39-0
Barium permanganate	7787-36-2
Barium peroxide	1304-29-6
Benzoyl peroxide	94-36-0
Beryllium nitrate	13597-99-4
Bromine	7726-95-6
Bromine chloride	13863-41-7
Bromine pentafluoride	7789-30-2
Bromine trifluoride	7787-71-5
t-Butyl peroxybenzoate	614-45-9
Cadmium nitrate	10325-94-7
Cadmium nitrate tetrahydrate	10022-68-1
Calcium chlorate	10137-74-3
Calcium chlorite	14674-72-7
Calcium hypochlorite*	7778-54-3
Calcium nitrate	10124-37-5
Calcium perchlorate	13477-36-6
Calcium permanganate	10118-76-0
Calcium peroxide	1305-79-9
Cesium nitrate	7789-18-6
Chloric acid solution	7790-93-4
Chlorine	7787-50-5
Chlorine oxide	10049-04-4
Chlorine trifluoride	7790-91-2
Chromic acid*	7738-94-5
Chromic anhydride	11115-74-5
Chromium nitrate	7789-02-8
Chromium oxychloride	14977-61-8
Chromium trioxide, anhydrous	1333-82-0
Cobalt nitrate	10141-05-6
Cobalt(II) perchlorate, hexahydrate	13478-33-6
Cumene hydroperoxide	80-15-9
Cupric nitrate (copper nitrate)	3251-23-8
Cyclohexanone peroxide	12262-58-7
Diacetone alcohol peroxide	N/A
Dimethylhexane dihydroperoxide	3025-88-5
Di-*t*-butyl peroxide	110-05-4
Dichloroisocyanuric acid	2782-57-2
Ferric nitrate	10421-48-4
Gallium(III) nitrate	13494-90-1
Guanidine nitrate	506-93-4
Hydrogen peroxide (27.5−52% by weight)*	7722-84-1
Indium nitrate	13770-61-1
Iodine pentafluoride	7783-66-6
Iron(II) nitrate hexahydrate (1:2:6)	13520-68-8
Isopropyl nitrate	1712-64-7
Isopropyl peroxydicarbonate	105-64-6
Lanthanum nitrate	10099-59-9
Lead dioxide	1309-60-0
Lead nitrate	10099-74-8
Lead perchlorate	13637-76-8
Lithium bichromate	N/A
Lithium chromate	14307-35-8
Lithium hypochlorite	13840-33-0
Lithium nitrate	7790-69-4
Lithium peroxide	12031-80-0
Magnesium bromate	7789-36-8
Magnesium chlorate	7791-19-7
Magnesium nitrate	10377-60-3
Magnesium perchlorate	10034-81-8
Magnesium peroxide	14452-57-4
Manganese dioxide	1313-13-9
Manganese nitrate	10377-66-9
Mercuric nitrate	10045-94-0
Mercurous nitrate	10415-75-5
Nickel nitrate	14216-75-2
Nickel nitrite	17861-62-0
Nickel perchlorate	13637-71-3
Nickel(II) nitrate	13138-45-9
Nitrogen dioxide	10102-44-0
Nitrogen trifluoride	7783-54-2
Nitrosylsulfuric acid	7782-78-7

Oxalic acid	6153-56-6
Ozone	10028-15-6
Palladium dinitrate	10102-05-3
Peracetic acid	79-21-0
Perchloric acid	7601-90-3
Perchloryl fluoride	7616-94-6
Potassium bromate*	7758-01-2
Potassium chlorate	1811-04-9
Potassium chromate(VI)	7789-00-6
Potassium dichloroisocyanurate	2244-21-5
Potassium dichromate	7778-50-9
Potassium nitrate	7757-79-1
Potassium nitrite	7758-09-0
Potassium perchlorate	7778-74-7
Potassium permanganate	7722-64-7
Potassium peroxide	17014-71-0
Potassium persulfate	7727-21-1
Potassium superoxide	12030-88-5
n-Propyl nitrate	627-13-4
Pyrosulfuryl chloride	7791-27-7
Silver nitrate	7761-88-8
Sodium dichloro-*s*-triazinetrione	2893-78-9
Sodium bromate	7789-38-0
Sodium chlorate	7775-09-9
Sodium chlorite (>40%)*	7758-19-2
Sodium chromate	7775-11-3
Sodium dichlorocyanurate*	2893-78-9
Sodium dichromate	7789-12-0
Sodium hypochlorite	7681-52-9
Sodium nitrate	7631-99-4
Sodium nitrite	7632-00-0
Sodium percarbonate	15630-89-4
Sodium perchlorate	7601-89-0
Sodium permanganate*	10101-50-5
Sodium peroxide*	1313-60-6
Sodium persulfate	7775-27-1
Sodium superoxide	12034-12-7
Strontium chlorate	7791-10-8
Strontium nitrate	10042-76-9
Strontium perchlorate	13450-97-0
Strontium peroxide	1314-18-7
Tetranitromethane	509-14-8
Thorium(IV) nitrate	13823-29-5
Trichloroisocyanuric acid*	87-90-1
Uranyl nitrate	10102-06-4
Urea peroxide	124-43-6
Vanadium pentoxide	1314-62-1
Ytterbium nitrate	13768-67-7
Yttrium(III) nitrate hexahydrate	13494-98-9
Zinc ammonium nitrite	63885-01-8
Zinc bichromate	N/A
Zinc bromate	13517-27-6
Zinc chromate	13530-65-9
Zinc chlorate	10361-95-2
Zinc nitrate	7779-88-6
Zinc permanganate	23414-72-4
Zinc peroxide	1314-22-3
Zirconium nitrate	13746-89-9

Oxidizing Materials by CAS and Name

N/A	Diacetone alcohol peroxide
N/A	Lithium bichromate
N/A	Zinc bichromate
79-21-0	Peracetic acid
80-15-9	Cumene hydroperoxide
87-90-1	*Trichloroisocyanuric acid
94-36-0	Benzoyl peroxide
105-64-6	Isopropyl peroxydicarbonate
110-05-4	Di-*t*-butyl peroxide
124-43-6	Urea peroxide
131-74-8	Ammonium picrate (wet)
463-04-7	Amyl nitrate
506-93-4	Guanidine nitrate
509-14-8	Tetranitromethane
614-45-9	*t*-Butyl peroxybenzoate
627-13-4	*n*-Propyl nitrate
1304-29-6	Barium peroxide
1305-79-9	Calcium peroxide
1309-60-0	Lead dioxide
1313-13-9	Manganese dioxide
1313-60-6	*Sodium peroxide
1314-18-7	Strontium peroxide
1314-22-3	Zinc peroxide
1314-62-1	Vanadium pentoxide
1333-82-0	Chromium trioxide, anhydrous
1712-64-7	Isopropyl nitrate
1811-04-9	Potassium chlorate
2244-21-5	Potassium dichloroisocyanurate
2244-21-5	*Potassium dichloroisocyanurate
2782-57-2	Dichloroisocyanuric acid
2893-78-9	Sodium dichlorocyanurate
2893-78-9	Sodium dichloro-*s*-triazinetrione
3025-88-5	Dimethylhexane dihydroperoxide
3251-23-8	Cupric nitrate (copper nitrate)
3597-99-4	Beryllium nitrate
6153-56-6	Oxalic acid
6484-52-2	Ammonium nitrate
6484-52-2	Ammonium nitrate−sulfate mixture
7446-70-0	Ammonium chloride
7601-89-0	Sodium perchlorate
7601-90-3	Perchloric acid
7616-94-6	Perchloryl fluoride
7631-99-4	Sodium nitrate
7632-00-0	Sodium nitrite
7681-52-9	Sodium hypochlorite
7722-64-7	Potassium permanganate
7722-84-1	*Hydrogen peroxide (27.5−52% by weight)
7726-95-6	Bromine
7727-21-1	Potassium persulfate
7727-54-0	Ammonium persulfate

7738-94-5	*Chromic acid
7757-79-1	Potassium nitrate
7758-01-2	*Potassium bromate
7758-09-0	Potassium nitrite
7758-19-2	*Sodium chlorite
7761-88-8	Silver nitrate
7775-11-3	Sodium chromate
7775-09-9	Sodium chlorate
7775-27-1	Sodium persulfate
7778-50-9	Potassium dichromate
7778-54-3	*Calcium hypochlorite
7778-74-7	Potassium perchlorate
7779-88-6	Zinc nitrate
7782-78-7	Nitrosyl sulfuric acid
7783-54-2	Nitrogen trifluoride
7783-66-6	Iodine pentafluoride
7787-36-2	Barium permanganate
7787-50-5	Chlorine
7787-71-5	Bromine trifluoride
7788-98-9	Ammonium chromate
7789-00-6	Potassium chromate(VI)
7789-02-8	Chromium nitrate
7789-09-5	Ammonium dichromate
7789-12-0	Sodium dichromate
7789-18-6	Cesium nitrate
7789-30-2	Bromine pentafluoride
7789-36-8	Magnesium bromate
7789-38-0	Sodium bromate
7790-69-4	Lithium nitrate
7790-91-2	Chlorine trifluoride
7790-93-4	Chloric acid solution
7790-98-9	Ammonium perchlorate
7791-10-8	Strontium chlorate
7791-19-7	Magnesium chlorate
7791-27-7	Pyrosulfuryl chloride
10022-31-8	Barium nitrate
10022-68-1	Cadmium nitrate tetrahydrate
10028-15-6	Ozone
10034-81-8	Magnesium perchlorate
10042-76-9	Strontium nitrate
10045-94-0	Mercuric nitrate
10049-04-4	Chlorine oxide
10099-59-9	Lanthanum nitrate
10099-74-8	Lead nitrate
10101-50-5	*Sodium permanganate
10102-05-3	Palladium dinitrate
10102-06-4	Uranyl nitrate
10102-44-0	Nitrogen dioxide
10118-76-0	Calcium permanganate
10124-37-5	Calcium nitrate
10137-74-3	Calcium chlorate
10141-05-6	Cobalt nitrate
10294-39-0	Barium perchlorate trihydrate
10325-94-7	Cadmium nitrate
10361-95-2	Zinc chlorate
10377-60-3	Magnesium nitrate
10377-66-9	Manganese nitrate
10415-75-5	Mercurous nitrate
10421-48-4	Ferric nitrate
11115-74-5	Chromic anhydride
12030-88-5	Potassium superoxide
12031-80-0	Lithium peroxide
12034-12-7	Sodium superoxide
12262-58-7	Cyclohexanone peroxide
13138-45-9	Nickel(II) nitrate
13446-10-1	Ammonium permanganate
13450-97-0	Strontium perchlorate
13473-90-0	Aluminum nitrate
13477-00-4	Barium chlorate
13477-10-6	Barium hypochlorite
13477-36-6	Calcium perchlorate
13478-33-6	Cobalt(II) perchlorate, hexahydrate
13494-90-1	Gallium(III) nitrate
13494-98-9	Yttrium(III) nitrate hexahydrate
13517-27-6	Zinc bromate
13520-68-8	Iron(II) nitrate hexahydrate (1:2:6)
13530-65-9	Zinc chromate
13637-71-3	Nickel perchlorate
13637-76-8	Lead perchlorate
13746-89-9	Zirconium nitrate
13768-67-7	Ytterbium nitrate
13770-61-1	Indium nitrate
13823-29-5	Thorium(IV) nitrate
13840-33-0	Lithium hypochlorite
13863-41-7	Bromine chloride
13967-90-3	Barium bromate
14216-75-2	Nickel nitrate
14307-35-8	Lithium chromate
14452-57-4	Magnesium peroxide
14674-72-7	Calcium chlorite
14977-61-8	Chromium oxychloride
15630-89-4	Sodium percarbonate
17014-71-0	Potassium peroxide
17861-62-0	Nickel nitrite
23414-72-4	Zinc permanganate
57608-40-9	Ammonium nitrate−phosphate mixture
63885-01-8	Zinc ammonium nitrite

Note: The asterisk (*) denotes some of those materials with potential for spontaneous ignition.

Appendix 2: Carcinogens

Carcinogen Index by Name and CAS

A-α-C (2-Amino-9H-pyrido [2,3-b]indole)	26148-68-5
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acetochlor	34256-82-1
2-Acetylaminofluorene	53-96-3
Acifluorfen sodium	62476-59-9
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Actinomycin D	50-76-0
AF-2 [2-(2-furyl)-3-(5-nitro-2-furyl)] acrylamide	3688-53-7
Aflatoxins	various CAS
Alachlor	15972-60-8
Alcoholic beverages, when associated with alcohol abuse	no CAS
Aldrin	309-00-2
Allyl chloride (*delisted 1999*)	107-05-1
2-Aminoanthraquinone	117-79-3
p-Aminoazobenzene	60-09-3
o-Aminoazotoluene	97-56-3
4-Aminobiphenyl (4-amin *o*-diphenyl)	92-67-1
1-Amino-2,4-dibromo-anthraquinone	81-49-2
3-Amino-9-ethylcarbazole hydrochloride	6109-97-3
2-Aminofluorene	153-78-6
1-Amino-2-methylanthraquinone	82-28-0
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	712-68-5
4-Amino-2-nitrophenol	119-34-6
Amitrole	61-82-5
Amsacrine	51264-14-3
Analgesic mixtures containing phenacetin	various CAS
Aniline	62-53-3
Aniline hydrochloride	142-04-1
o-Anisidine	90-04-0
o-Anisidine hydrochloride	134-29-2
Antimony oxide (Antimony trioxide)	1309-64-4
Anthraquinone	84-65-1
Aramite	140-57-8
Areca nut	no CAS
Aristolochic acids	various CAS
Arsenic (inorganic arsenic compounds)	7440-38-2
*List of arsenic compounds, inorganic**	
Arsanilic acid [arsonic acid, (4-aminophenyl)-]	98-50-0
Arsenic pentoxide [arsenic oxide (As_2O_5)]	1303-28-2
Arsenic sulfide [arsenic sulfide (As_2S_3)]	1303-33-9
Arsenic trioxide [arsenic oxide (As_2O_3)]	1327-53-3
Arsine	7784-42-1
Calcium arsenate [arsenic acid (H_3AsO_4), calcium salt (2:3)]	7778-44-1
Dimethylarsinic acid (arsinic acid, dimethyl-)	75-60-5
Lead arsenate [arsenic acid (H_3AsO_4), lead(2+) salt (1:1)]	7784-40-9
Methanearsonic acid, disodium salt (arsonic acid, methyl-, disodium salt)	144-21-8
Methanearsonic acid, monosodium salt (arsonic acid, methyl-, monosodium salt)	2163-80-6
Potassium arsenate [arsenic acid (H_3AsO_4), monopotassium salt]	7784-41-0
Potassium arsenite (arsenenous acid, potassium salt)	13464-35-2
Sodium arsenate, sodium salt	7631-89-2
Sodium arsenite	7784-46-5
Sodium cacodylate (arsinic acid, dimethyl-, sodium salt)	124-65-2
Asbestos	1332-21-4
Asbestos, amosite	12172-73-5
Asbestos, actinolite	77536-66-4
Asbestos, anthophylite	77536-67-5
Asbestos, anthophyllite	17068-78-9
Asbestos, chrysotile	12001-29-5
Asbestos, crocidolite	12001-28-4
Asbestos, tremolite	77536-68-6
Auramine	492-80-8
Azacitidine	320-67-2
Azaserine	115-02-6
Azathioprine	446-86-6
Azobenzene	103-33-3
Benthiavalicarb-isopropyl	177406-68-7
Benz[a]anthracene	56-55-3
Benzene	71-43-2
Benzidine [and its salts]	92-87-5
Benzidine-based dyes	various CAS
Benzo[b]fluoranthene	205-99-2
Benzo[j]fluoranthene	205-82-3
Benzo[k]fluoranthene	207-08-9
Benzofuran	271-89-6
Benzo[a]pyrene	50-32-8
Benzotrichloride	98-07-7
Benzyl chloride	100-44-7
Benzyl violet 4B	1694-09-3
Beryllium (and beryllium compounds)	7440-41-7
*List of beryllium compounds**	
Beryllium chloride	7787-47-5
Beryllium fluoride	7787-49-7
Beryllium nitrate	13597-99-4
Beryllium sulfate	13510-49-1
Betel quid with tobacco	no CAS
Betel quid without tobacco	no CAS
2,2-Bis(bromomethyl)-1,3-propanediol	3296-90-0
Bis(2-chloroethyl)ether	111-44-4

N,*N*-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)	494-03-1
Bischloroethyl nitrosourea (BCNU) (Carmustine)	154-93-8
Bis(chloromethyl)ether	542-88-1
Bis(2-chloro-1-methylethyl)ether, technical grade	no CAS
Bitumens, extracts of steam-refined and air refined	no CAS
Bracken fern	no CAS
Bromate	15541-45-4
Bromochloroacetic acid	5589-96-8
Bromodichloromethane	75-27-4
Bromoethane	74-96-4
Bromoform	75-25-2
1,3-Butadiene	106-99-0
1,4-Butanediol dimethanesulfonate (Busulfan)	55-98-1
Butylated hydroxyanisole	25013-16-5
β-Butyrolactone	3068-88-0
Cacodylic acid	75-60-5
Cadmium (and cadmium compounds)	7440-43-9
*List of cadmium compounds**	
Cadmium acetate	543-90-8
Cadmium bromide	7789-42-6
Cadmium chloride	10108-64-2
Cadmium cyanide	542-83-6
Cadmium fluoroborate	14486-19-2
Cadmium nitrate	10325-94-7
Cadmium nitrate tetrahydrate	10022-68-1
Cadmium oxide	1306-19-0
Cadmium oxide fume	1306-19-0
Cadmium stearate	2223-93-0
Cadmium succinate	141-00-4
Cadmium sulfate	10124-36-4
Caffeic acid	331-39-5
Captafol	2425-06-1
Captan	133-06-2
Carbaryl	63-25-2
Carbazole	86-74-8
Carbon black (airborne, unbound particles of respirable size)	1333-86-4
Carbon tetrachloride	56-23-5
Carbon-black extracts	no CAS
N-Carboxymethyl-*N*-nitrosourea	60391-92-6
Catechol	120-80-9
Ceramic fibers (airborne particles of respirable size)	no CAS
Certain combined chemotherapy for lymphomas	no CAS
Chlorambucil	305-03-3
Chloramphenicol	56-75-7
Chlordane	57-74-9
Chlordecone (Kepone)	143-50-0
Chlordimeform	6164-98-3
Chlorendic acid	115-28-6
Chlorinated paraffins (Average Chain length, C12; approximately 60% chlorine by weight)	108171-26-2
p-Chloroaniline	106-47-8
p-Chloroaniline hydrochloride	20265-96-7
Chlorodibromomethane (*delisted 1999*)	124-48-1
Chloroethane (Ethyl chloride)	75-00-3
1-(2-Chloroethyl)-3-cyclohexylnitrosourea (CCNU) (Lomustine)	13010-47-4
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)	13909-09-6
Chloroform	67-66-3
Chloromethyl methyl ether (technical grade)	107-30-2
3-Chloro-2-methylpropene	563-47-3
1-Chloro-4-nitrobenzene	100-00-5
4-Chloro-*o*-phenylenediamine	95-83-0
Chloroprene	126-99-8
Chlorothalonil	1897-45-6
p-Chloro-*o*-toluidine	95-69-2
p-Chloro-*o*-toluidine, strong acid salts of	various CAS
5-Chloro-*o*-toluidine and its strong acid salts	various CAS
Chlorotrianisene	569-57-3
Chlorozotocin	54749-90-5
Chromium (hexavalent compounds)	various CAS
Chrysene	218-01-9
C.I. Acid Red 114	6459-94-5
C.I. Basic Red 9 monohydrochloride	569-61-9
C.I. Direct Blue 15	2429-74-5
C.I. Direct Blue 218	28407-37-6
C.I. Solvent Yellow 14	842-07-9
Ciclosporin (Cyclosporin A; Cyclosporine)	59865-13-3; 79217-60-0
Cidofovir	113852-37-2
Cinnamyl anthranilate	87-29-6
Cisplatin	15663-27-1
Citrus Red No. 2	6358-53-8
Clofibrate	637-07-0
Cobalt metal powder	7440-48-4
Cobalt[II] oxide	1307-96-6
Cobalt sulfate	10124-43-3
Cobalt sulfate heptahydrate	10026-24-1
Coke oven emissions	no CAS
Conjugated estrogens	no CAS
Creosotes	various CAS
p-Cresidine	120-71-8
Cumene	98-82-8
Cupferron	135-20-6
Cycasin	14901-08-7
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2
Cytembena	21739-91-3
D&C Orange No. 17	3468-63-1
D&C Red No. 8	2092-56-0
D&C Red No. 9	5160-02-1
D&C Red No. 19	81-88-9
Dacarbazine	4342-03-4
Daminozide	1596-84-5

Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)	117-10-2
Daunomycin	20830-81-3
DDD (Dichlorodiphenyl-dichloroethane)	72-54-8
DDE (Dichlorodiphenyldichloroethylene)	72-55-9
DDT (Dichlorodiphenyltrichloroethane)	50-29-3
DDVP (Dichlorvos)	62-73-7
N,*N*′-Diacetylbenzidine	613-35-4
2,4-Diaminoanisole	615-05-4
2,4-Diaminoanisole sulfate	39156-41-7
4,4′-Diaminodiphenyl ether(4,4′-Oxydianiline)	101-80-4
2,4-Diaminotoluene	95-80-7
Diaminotoluene (mixed)	no CAS
Diazoaminobenzene	136-35-6
Dibenz[a,h]acridine	226-36-8
Dibenz[a,j]acridine	224-42-0
Dibenz[a,h]anthracene	53-70-3
7H-Dibenzo[c,g]carbazole	194-59-2
Dibenzo[a,e]pyrene	192-65-4
Dibenzo[a,h]pyrene	189-64-0
Dibenzo[a,i]pyrene	189-55-9
Dibenzo[a,l]pyrene	191-30-0
Dibromoacetic acid	631-64-1
1,2-Dibromo-3-chloropropane (DBCP) (male)	96-12-8
2,3-Dibromo-1-propanol	96-13-9
Dichloroacetic acid	79-43-6
p-Dichlorobenzene	106-46-7
3,3′-Dichlorobenzidine	91-94-1
3,3′-Dichlorobenzidine dihydrochloride	612-83-9
1,4-Dichloro-2-butene	764-41-0
3,3′-Dichloro-4,4′-diaminodiphenyl ether	28434-86-8
1,1-Dichloroethane	75-34-3
Dichloromethane (Methylene chloride)	75-09-2
1,2-Dichloropropane	78-87-5
1,3-Dichloropropene	542-75-6
1,3-Dichloro-2-propanol (1,3-DCP)	96-23-1
Diclofop-methyl	51338-27-3
Dieldrin	60-57-1
Dienestrol	84-17-3
Diepoxybutane	1464-53-5
Diesel engine exhaust	no CAS
Di(2-ethylhexyl)phthalate (DEHP)	117-81-7
1,2-Diethylhydrazine	1615-80-1
Diethylstilbestrol (DES)	56-53-1
Diethyl sulfate	64-67-5
Diglycidyl resorcinol ether (DGRE)	101-90-6
Dihydrosafrole	94-58-6
Diisopropyl sulfate	2973-10-6
3,3′-Dimethoxybenzidine (*o*-Dianisidine)	119-90-4
3,3′-Dimethoxybenzidine dihydrochloride (*o*-Dianisidine dihydrochloride)	20325-40-0
3,3′-Dimethoxybenzidine-based dyes metabolized to 3,3′-dimethoxybenzidine	various CAS
3,3′-Dimethylbenzidine-based dyes metabolized to 3,3′-dimethylbenzidine	various CAS
4-Dimethylaminoazobenzene	60-11-7
trans-2-[(Dimethylamino)methyl-imino]-5-[2-(5-nitr*o*-2-furyl)vinyl]-1,3,4-oxadiazole	55738-54-0
7,12-Dimethylbenz(a)anthracene	57-97-6
3,3′-Dimethylbenzidine (*o*-Tolidine)	119-93-7
3,3′-Dimethylbenzidine dihydrochloride	612-82-8
Dimethylcarbamoyl chloride	79-44-7
1,1-Dimethylhydrazine (UDMH)	57-14-7
1,2-Dimethylhydrazine	540-73-8
Dimethyl sulfate	77-78-1
Dimethylvinylchloride	513-37-1
3,7-Dinitrofluoranthene	105735-71-5
3,9-Dinitrofluoranthene	22506-53-2
1,6-Dinitropyrene	42397-64-8
1,8-Dinitropyrene	42397-65-9
Dinitrotoluene mixture, 2,4-/2,6-	25321-14-6
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
1,4-Dioxane	123-91-1
Diphenylhydantoin (Phenytoin)	57-41-0
Diphenylhydantoin (Phenytoin), sodium salt	630-93-3
Di-*n*-propyl isocinchomeronate (MGK Repellent 326)	136-45-8
Direct Black 38 (technical grade)	1937-37-7
Direct Blue 6 (technical grade)	2602-46-2
Direct Brown 95 (technical grade)	16071-86-6
Disperse Blue 1	2475-45-8
Diuron	330-54-1
Doxorubicin hydrochloride (Adriamycin)	25316-40-9
Epichlorohydrin	106-89-8
Erionite	12510-42-8/ 66733-21-9
Estradiol 17B	50-28-2
Estragole	140-67-0
Estrogens, steroidal	various CAS
Estrone	53-16-7
Estropipate	7280-37-7
Ethinylestradiol	57-63-6
Ethoprop	13194-48-4
Ethyl acrylate	140-88-5
Ethylbenzene	100-41-4
Ethyl-4,4′-dichlorobenzilate	510-15-6
Ethylene dibromide	106-93-4
Ethylene dichloride (1,2-Dichloroethane)	107-06-2
Ethyleneimine	151-56-4
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Ethyl methane sulfonate	62-50-0
Fenoxycarb	72490-01-8
Folpet	133-07-3
Formaldehyde (gas)	50-00-0
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole	3570-75-0
Fumonisin B1	116355-83-0
Furan	110-00-9
Furazolidone	67-45-8
Furmecyclox	60568-05-0
Fusarin C	79748-81-5

Gallium arsenide	1303-00-0
Ganciclovir	82410-32-0
Gasoline engine exhaust (condensates/extracts)	no CAS
Gemfibrozil	25812-30-0
Glasswool fibers (airborne particles of respirable size)	no CAS
Glu-*p*-1 (2-Amin*o*-6-methyldipyrido [1,2- a:3′,2′-d]imidazole)	67730-11-4
Glu-*p*-2 (2-Aminodipyrido [1,2-a:3′,2′-d]imidazole)	67730-10-3
Glycidaldehyde	765-34-4
Glycidol	556-52-5
Griseofulvin	126-07-8
Gyromitrin (Acetaldehyde methylformylhydrazone)	16568-02-8
HC Blue 1	2784-94-3
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Herbal remedies containing plant species of the genus *Aristolochia*	no CAS
Hexachlorobenzene	118-74-1
Hexachlorocyclohexane (technical grade)	608-73-1
Hexachlorodibenzodioxin	34465-46-8
Hexachloroethane	67-72-1
2,4-Hexadienal (89% *trans*, *trans* isomer; 11% *cis*, *trans* isomer)	no CAS
Hexamethylphosphoramide	680-31-9
Hydrazine	302-01-2
Hydrazine sulfate	10034-93-2
Hydrazobenzene (1,2-Diphenylhydrazine)	122-66-7
1-Hydroxyanthraquinone	129-43-1
Indeno[1,2,3-cd]pyrene	193-39-5
Indium phosphide	22398-80-7
IQ (2-Amino-3-methylimidazo [4,5-f] quinoline)	76180-96-6
Iprodione	36734-19-7
Iprovalicarb	140923-17-7/140923-25-7
Iron dextran complex	9004-66-4
Isobutyl nitrite	542-56-3
Isoprene	78-79-5
Isosafrole (*delisted 2006*)	120-58-1
Isoxaflutole	141112-29-0
Lactofen	77501-63-4
Lasiocarpine	303-34-4
Lead (and lead compounds)	7439-92-1
Lead acetate	301-04-2
Lead phosphate	7446-27-7
Lead subacetate	1335-32-6
Lindane (and other hexachlorocyclohexane isomers)	58-89-9
Lynestrenol	52-76-6
Mancozeb	8018-01-7
Maneb	12427-38-2
Me-A-α-C (2-Amin*o*-3-methyl-9H-pyrido [2,3-b]indole)	68006-83-7
Medroxyprogesterone acetate	71-58-9
MeIQ (2-Amino-3,4-dimethyl-imidazo [4,5-f]quinoline)	77094-11-2
MeIQx (2-Amino-3,8-dimethyl-imidazo [4,5-f]quinoxaline)	77500-04-0
Melphalan	148-82-3
Mepanipyrim	110235-47-7
Merphalan	531-76-0
Mestranol	72-33-3
Metam potassium	137-41-7
Metam sodium	137-42-8
5-Methoxypsoralen with ultraviolet A therapy	484-20-8
8-Methoxypsoralen with ultraviolet A therapy	298-81-7
2-Methylaziridine (Propyleneimine)	75-55-8
Methylazoxymethanol	590-96-5
Methylazoxymethanol acetate	592-62-1
Methyl carbamate	598-55-0
3-Methylcholanthrene	56-49-5
5-Methylchrysene	3697-24-3
4,4′-Methylene bis(2-chloroaniline)	101-14-4
4,4′-Methylene bis(*N*,*N*-dimethyl)benzenamine	101-61-1
4,4′-Methylene bis(2-methylaniline)	838-88-0
4,4′-Methylenedianiline	101-77-9
4,4′-Methylenedianiline dihydrochloride	13552-44-8
Methyleugenol	93-15-2
Methylhydrazine (and its salts)	60-34-4
4-Methylimidazole	822-36-6
Methyl iodide	74-88-4
Methylmercury compounds	no CAS
Methyl methane sulfonate	66-27-3
2-Methyl-1-nitroanthraquinone (of uncertain purity)	129-15-7
N-Methyl-*N*′-nitro-*N*-nitrosoguanidine	70-25-7
N-Methylolacrylamide	924-42-5
Methylthiouracil	56-04-2
Metiram	9006-42-2
Metronidazole	443-48-1
Michler's ketone	90-94-8
Mirex	2385-85-5
Mitomycin C	50-07-7
3-Monochloropropane-1,2-diol (3-MCPD)	96-24-2
Monocrotaline	315-22-0
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)-amino]-2-oxazolidinone	139-91-3
Mustard gas	505-60-2
MX (3-chloro-4-(dichloromethyl)5-hydroxy-2(5H)-furanone)	77439-76-0
Nafenopin	3771-19-5
Nalidixic acid	389-08-2
Naphthalene	91-20-3
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
Nickel (Metallic)	7440-02-0
Nickel acetate	373-02-4
Nickel carbonate	3333-67-3
Nickel carbonyl	13463-39-3
Nickel compounds	various CAS

Nickel hydroxide	12054-48-7; 12125-56-3
Nickelocene	1271-28-9
Nickel oxide	1313-99-1
Nickel refinery dust from the pyrometallurgical process	no CAS
Nickel subsulfide	12035-72-2
Niridazole	61-57-4
Nitrapyrin	1929-82-4
Nitrilotriacetic acid	139-13-9
Nitrilotriacetic acid, trisodium salt monohydrate	18662-53-8
5-Nitroacenaphthene	602-87-9
5-Nitro-*o*-anisidine (*delisted 2006*)	99-59-2
o-Nitroanisole	91-23-6
Nitrobenzene	98-95-3
4-Nitrobiphenyl	92-93-3
6-Nitrochrysene	7496-02-8
Nitrofen (technical grade)	1836-75-5
2-Nitrofluorene	607-57-8
Nitrofurazone	59-87-0
1-[(5-Nitrofurfurylidene)-amino]-2-imidazolidinone	555-84-0
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide	531-82-8
Nitrogen mustard (Mechlorethamine)	51-75-2
Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)	55-86-7
Nitrogen mustard *N*-oxide	126-85-2
Nitrogen mustard *N*-oxide hydrochloride	302-70-5
Nitromethane	75-52-5
2-Nitropropane	79-46-9
1-Nitropyrene	5522-43-0
4-Nitropyrene	57835-92-4
N-Nitrosodi-*n*-butylamine	924-16-3
N-Nitrosodiethanolamine	1116-54-7
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
p-Nitrosodiphenylamine	156-10-5
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodi-*n*-propylamine	621-64-7
N-Nitroso-*N*-ethylurea	759-73-9
3-(*N*-Nitrosomethylamino)-propionitrile	60153-49-3
4-(*N*-Nitrosomethylamino)-1-(3-pyridyl)1-butanone	64091-91-4
N-Nitrosomethylethylamine	10595-95-6
N-Nitroso-*N*-methylurea	684-93-5
N-Nitroso-*N*-methylurethane	615-53-2
N-Nitrosomethylvinylamine	4549-40-0
N-Nitrosomorpholine	59-89-2
N-Nitrosonornicotine	16543-55-8
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
N-Nitrososarcosine	13256-22-9
o-Nitrotoluene	88722
Norethisterone (Norethindrone)	68-22-4
Norethynodrel	68-23-5
Ochratoxin A	303-47-9
Oil Orange SS	2646-17-5
Oral contraceptives, combined	no CAS
Oral contraceptives, sequential	no CAS
Oryzalin	19044-88-3
Oxadiazon	19666-30-9
Oxazepam	604-75-1
Oxymetholone	434-07-1
Oxythioquinox (Chinomethionat)	2439-01-2
Palygorskite fibers (>5 μm in length)	12174-11-7
Panfuran S	794-93-4
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenazopyridine	94-78-0
Phenazopyridine hydrochloride	136-40-3
Phenesterin	3546-10-9
Phenobarbital	50-06-6
Phenolphthalein	77-09-8
Phenoxybenzamine	59-96-1
Phenoxybenzamine hydrochloride	63-92-3
o-Phenylenediamine and its salts	95-54-5
Phenyl glycidyl ether	122-60-1
Phenylhydrazine and its salts	no CAS
o-Phenylphenate, sodium	132-27-4
o-Phenylphenol	90-43-7
PhiP(2-Amino-1-methyl-6-phenylimidazol [4,5-b]pyridine)	105650-23-5
Pirimicarb	23103-98-2
Polybrominated biphenyls (PBBs)	various CAS
*List of polybrominated biphenyl (PBB) compounds**	
p-Bromodiphenyl ether	101-55-3
p,*p*′-Didibromodiphenyl ether	2050-47-7
Decabromobiphenyl	13654-09-6
Decabromodiphenyl ether	1163-19-5
Hexabromobiphenyl	59080-40-9
Hexabromo-1,1′-biphenyl	36355-01-8
Hexabromodiphenyl ether	36483-60-0
Nonabromodiphenyl ether	63936-56-1
Octabromobiphenyl	27858-07-7
Octabromobiphenyl	61288-13-9
Octabromodiphenyl ether	32536-52-0
Pentabromodiphenyl ether	32534-81-9
Polybrominated biphenyl	59536-65-1
Polybrominated biphenyl mixture	67774-32-7
Tetrabromodiphenyl ether	40088-47-9
Tribromodiphenyl ether	49690-94-0
Polychlorinated biphenyls (PCBs)	no CAS
*List of polychlorinated biphenyl (PCB) compounds**	
Polychlorinated biphenyls	1336-36-3
Biphenyl	92-52-4
2-Chlorobiphenyl	2051-60-7
4-Chlorobiphenyl	2051-62-9
2,2′-Dichlorobiphenyl	13029-08-8
2,3′-Dichlorobiphenyl	25569-80-6
2,4′-Dichlorobiphenyl	34883-43-7
4,4′-Dichlorobiphenyl	2050-68-2
2,2′,3,3′,4,6-Hexachlorobiphenyl	38380-05-1

2,2′, 3,3′,6,6′-Hexachlorobiphenyl	38411-22-2
2,2′,3,4,4′,5-Hexachlorobiphenyl	35694-06-5
2,2′,3,4,4′,5′-Hexachlorobiphenyl	35065-28-2
2,2′,3′,4,5,6′-Hexachlorobiphenyl	38380-04-0
2,2′,4,4′,5,5′-Hexachlorobiphenyl	35065-27-1
2,2′,3,3′,4,4′,5-Heptachlorobiphenyl	35065-30-6
2,2′,3,3′,4,5,6′-Heptachlorobiphenyl	38441-25-5
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl	35065-29-3
2,2′,3,3′,6-Pentachlorobiphenyl	52663-60-2
2,2′,3,4,5′-Pentachlorobiphenyl	38380-02-8
2,2′,3′,4,5-Pentachlorobiphenyl	41464-51-1
2,2′,3,4′,6-Pentachlorobiphenyl	no CAS
2,2′,3,5′,6-Pentachlorobiphenyl	38379-99-6
2,2′,4,4′,5-Pentachlorobiphenyl	38380-01-7
2,2′,4,5,5′-Pentachlorobiphenyl	37680-73-2
2,3,3′,4,4′-Pentachlorobiphenyl	32598-14-4
2,3,3′,4′,6-Pentachlorobiphenyl	38380-03-9
2,3′,4,4′,5-Pentachlorobiphenyl	31508-00-6
2,2′3,5′-Tetrachlorobiphenyl	41464-39-5
2,2′,4,5′-Tetrachlorobiphenyl	41464-40-8
2,2′,5,5′-Tetrachlorobiphenyl	35693-99-3
2,3,4,4′-Tetrachlorobiphenyl	33025-41-1
2,3′,4,4′-Tetrachlorobiphenyl	32598-10-0
2,3′,4′,5-Tetrachlorobiphenyl	32598-11-1
3,3′,4,4′-Tetrachlorobiphenyl	32598-13-3
2,2′,3-Trichlorobiphenyl	38444-78-9
2,2′,5-Trichlorobiphenyl	37680-65-2
2,3′,4-Trichlorobiphenyl	no CAS
2′,3,4-Trichlorobiphenyl	38444-86-9
2,4,4′-Trichlorobiphenyl	7012-37-5
2,4′,5-Trichlorobiphenyl	16606-02-3
Polychlorinated biphenyls (containing 60 or more % Cl by molecular weight)	various CAS
Polychlorinated dibenzo-*p*-dioxins	various CAS
Polychlorinated dibenzofurans	no CAS
Polygeenan	53973-98-1
Ponceau MX	3761-53-3
Ponceau 3R	3564-09-8
Potassium bromate	7758-01-2
Primidone	125-33-7
Procarbazine	671-16-9
Procarbazine hydrochloride	366-70-1
Procymidone	32809-16-8
Progesterone	57-83-0
Pronamide	23950-58-5
Propachlor	1918-16-7
1,3-Propane sultone	1120-71-4
Propargite	2312-35-8
β-Propiolactone	57-57-8
Propoxur	114-26-1
Propylene glycol mono-*t*-butyl ether	57018-52-7
Propylene oxide	75-56-9
Propylthiouracil	51-52-5
Pyridine	110-86-1
Quinoline and its strong acid salts	no CAS
Radionuclides	no CAS

Reserpine	50-55-5
Residual (heavy) fuel oils	no CAS
Resmethrin	10453-86-8
Riddelliine	23246-96-0
Saccharin (*delisted 2001*)	81-07-2
Saccharin, sodium (*delisted 2003*)	128-44-9
Safrole	94-59-7
Selenium sulfide	7446-34-6
Shale-oils	68308-34-9
Silica, crystalline (airborne particles of respirable size)	no CAS
Soots, tars, and mineral oils (untreated and mildly treated oils and used engine oils)	no CAS
Spirodiclofen	148477-71-8
Spironolactone	52-01-7
Stanozolol	10418-03-8
Sterigmatocystin	10048-13-2
Streptozotocin (streptozocin)	18883-66-4
Strong inorganic acid mists containing sulfuric acid	no CAS
Styrene oxide	96-09-3
Sulfallate	95-06-7
Sulfasalazine (salicylazosulfapyridine)	599-79-1
Talc containing asbestiform fibers	no CAS
Tamoxifen and its salts	10540-29-1
Terrazole	2593-15-9
Testosterone and its esters	58-22-0
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)	1746-01-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene (Perchloroethylene)	127-18-4
p-*a*,*a*,*a*-Tetrachlorotoluene	5216-25-1
Tetrafluoroethylene	116-14-3
Tetranitromethane	509-14-8
Thioacetamide	62-55-5
4,4′-Thiodianiline	139-65-1
Thiodicarb	59669-26-0
Thiouracil	141-90-2
Thiourea	62-56-6
Thorium dioxide	1314-20-1
Tobacco, oral use of smokeless products	no CAS
Tobacco smoke	no CAS
Toluene diisocyanate	26471-62-5
o-Toluidine	95-53-4
o-Toluidine hydrochloride	636-21-5
p-Toluidine (*delisted 1999*)	106-49-0
Toxaphene (Polychlorinated camphenes)	8001-35-2
Toxins derived from *Fusarium moniliforme* (*Fusarium verticillioides*)	no CAS
Treosulfan	299-75-2
Trichlormethine (Trimustine hydrochloride)	817-09-4
Trichloroethylene	79-01-6
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
2,4,5-Trimethylaniline (and its strong acid salts)	137-17-7
Trimethyl phosphate	512-56-1

2,4,6-Trinitrotoluene	118-96-7
Triphenyltin hydroxide	76-87-9
Tris(aziridinyl)-*p*-benzoquinone (Triaziquone) (*delisted 2006*)	68-76-8
Tris(1-aziridinyl)phosphine sulfide (Thiotepa)	52-24-4
Tris(2-chloroethyl)phosphate	115-96-8
Tris(2,3-dibromopropyl)phosphate	126-72-7
Trp-*p*-1 (Tryptophan-*p*-1)	62450-06-0
Trp-*p*-2 (Tryptophan-*p*-2)	62450-07-1
Trypan blue (commercial grade)	72-57-1
Unleaded gasoline (wholly vaporized)	8006-61-9
Uracil mustard	66-75-1
Urethane (ethyl carbamate)	51-79-6
Vanadium pentoxide (orthorhombic crystalline form)	1314-62-1
Vinclozolin	50471-44-8
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
4-Vinylcyclohexene	100-40-3
4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)	106-87-6
Vinyl fluoride	75-02-5
Vinyl trichloride (1,1,2-Trichloroethane)	79-00-5
Wood dust	no CAS
2,6-Xylidine (2,6-Dimethylaniline)	87-62-7
Zalcitabine	7481-89-2
Zidovudine (AZT)	30516-87-1
Zileuton	111406-87-2
Zineb (*delisted 1999*)	12122-67-7

Carcinogen Index by CAS and Name

50-00-0	Formaldehyde (gas)
50-06-6	Phenobarbital
50-07-7	Mitomycin C
50-18-0	Cyclophosphamide (anhydrous)
50-28-2	Estradiol 17B
50-29-3	DDT (Dichlorodiphenyltrichloroethane)
50-32-8	Benzo[a]pyrene
50-55-5	Reserpine
50-76-0	Actinomycin D
51-52-5	Propylthiouracil
51-75-2	Nitrogen mustard (Mechlorethamine)
51-79-6	Urethane (ethyl carbamate)
52-01-7	Spironolactone
52-24-4	Tris(1-aziridinyl)phosphine sulfide (Thiotepa)
52-76-6	Lynestrenol
53-16-7	Estrone
53-70-3	Dibenz[a,h]anthracene
53-96-3	2-Acetylaminofluorene
55-18-5	*N*-Nitrosodiethylamine
55-86-7	Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)
55-98-1	1,4-Butanediol dimethanesulfonate (Busulfan)
56-04-2	Methylthiouracil
56-23-5	Carbon tetrachloride
56-49-5	3-Methylcholanthrene
56-53-1	Diethylstilbestrol (DES)
56-55-3	Benz[a]anthracene
56-75-7	Chloramphenicol
57-14-7	1,1-Dimethylhydrazine (UDMH)
57-41-0	Diphenylhydantoin (Phenytoin)
57-57-8	β-Propiolactone
57-63-6	Ethinylestradiol
57-74-9	Chlordane
57-83-0	Progesterone
57-97-6	7,12-Dimethylbenz(a)anthracene
58-22-0	Testosterone and its esters
58-89-9	Lindane and other hexachlorocyclohexane isomers
59-87-0	Nitrofurazone
59-89-2	*N*-Nitrosomorpholine
59-96-1	Phenoxybenzamine
60-09-3	*p*-Aminoazobenzene
60-11-7	4-Dimethylaminoazobenzene
60-34-4	Methylhydrazine (and its salts)
60-35-5	Acetamide
60-57-1	Dieldrin
61-57-4	Niridazole
61-82-5	Amitrole
62-44-2	Phenacetin
62-50-0	Ethyl methane sulfonate
62-53-3	Aniline
62-55-5	Thioacetamide
62-56-6	Thiourea
62-73-7	DDVP (Dichlorvos)
62-75-9	*N*-Nitrosodimethylamine
63-25-2	Carbaryl
63-92-3	Phenoxybenzamine hydrochloride
64-67-5	Diethyl sulfate
66-27-3	Methyl methane sulfonate
66-75-1	Uracil mustard
67-45-8	Furazolidone
67-66-3	Chloroform
67-72-1	Hexachloroethane
68-22-4	Norethisterone (Norethindrone)
68-23-5	Norethynodrel
68-76-8	Tris(aziridinyl)-*p*-benzoquinone (Triaziquone) (*delisted 2006*)
70-25-7	*N*-Methyl-*N*′-nitro-*N*-nitrosoguanidine
71-43-2	Benzene
71-58-9	Medroxyprogesterone acetate
72-33-3	Mestranol
72-54-8	DDD (Dichlorodiphenyl- dichloroethane)
72-55-9	DDE (Dichlorodiphenyldichloroethylene)
72-57-1	Trypan blue (commercial grade)
74-88-4	Methyl iodide
74-96-4	Bromoethane
75-00-3	Chloroethane (Ethyl chloride)
75-01-4	Vinyl chloride
75-02-5	Vinyl fluoride
75-07-0	Acetaldehyde

75-09-2	Dichloromethane (Methylene chloride)
75-21-8	Ethylene oxide
75-25-2	Bromoform
75-27-4	Bromodichloromethane
75-34-3	1,1-Dichloroethane
75-52-5	Nitromethane
75-55-8	2-Methylaziridine (Propyleneimine)
75-56-9	Propylene oxide
75-60-5	Cacodylic acid
76-44-8	Heptachlor
76-87-9	Triphenyltin hydroxide
77-09-8	Phenolphthalein
77-78-1	Dimethyl sulfate
78-79-5	Isoprene
78-87-5	1,2-Dichloropropane
79-00-5	Vinyl trichloride (1,1,2-Trichloroethane)
79-01-6	Trichloroethylene
79-06-1	Acrylamide
79-34-5	1,1,2,2-Tetrachloroethane
79-43-6	Dichloroacetic acid
79-44-7	Dimethylcarbamoyl chloride
79-46-9	2-Nitropropane
81-07-2	Saccharin (*delisted 2001*)
81-49-2	1-Amino-2,4-dibromo-anthraquinone
81-88-9	D&C Red No. 19
82-28-0	1-Amino-2-methylanthraquinone
84-17-3	Dienestrol
84-65-1	Anthraquinone
86-30-6	*N*-Nitrosodiphenylamine
86-74-8	Carbazole
87-29-6	Cinnamyl anthranilate
87-62-7	2,6-Xylidine (2,6-Dimethylaniline)
87-86-5	Pentachlorophenol
88-06-2	2,4,6-Trichlorophenol
88722	*o*-Nitrotoluene
90-04-0	*o*-Anisidine
90-43-7	*o*-Phenylphenol
90-94-8	Michler's ketone
91-20-3	Naphthalene
91-23-6	*o*-Nitroanisole
91-59-8	2-Naphthylamine
91-94-1	3,3′-Dichlorobenzidine
92-67-1	4-Aminobiphenyl (4-amino-diphenyl)
92-87-5	Benzidine [and its salts]
92-93-3	4-Nitrobiphenyl
93-15-2	Methyleugenol
94-58-6	Dihydrosafrole
94-59-7	Safrole
94-78-0	Phenazopyridine
95-06-7	Sulfallate
95-53-4	*o*-Toluidine
95-54-5	*o*-Phenylenediamine and its salts
95-69-2	*p*-Chloro-*o*-toluidine
95-80-7	2,4-Diaminotoluene
95-83-0	4-Chloro-*o*-phenylenediamine
96-09-3	Styrene oxide
96-12-8	1,2-Dibromo-3-chloropropane (DBCP) (male)
96-13-9	2,3-Dibromo-1-propanol
96-18-4	1,2,3-Trichloropropane
96-23-1	1,3-Dichloro-2-propanol (1,3-DCP)
96-24-2	3-Monochloropropane-1,2- diol (3-MCPD)
96-45-7	Ethylene thiourea
97-56-3	*o*-Aminoazotoluene
98-07-7	Benzotrichloride
98-82-8	Cumene
98-95-3	Nitrobenzene
99-59-2	5-Nitro-*o*-anisidine (*delisted 2006*)
100-00-5	1-Chloro-4-nitrobenzene
100-40-3	4-Vinylcyclohexene
100-41-4	Ethylbenzene
100-44-7	Benzyl chloride
100-75-4	*N*-Nitrosopiperidine
101-14-4	4,4′-Methylene bis(2-chloroaniline)
101-61-1	4,4′-Methylene bis(*N*,*N*-dimethyl)benzenamine
101-77-9	4,4′-Methylenedianiline
101-80-4	4,4′-Diaminodiphenyl ether(4,4′-Oxydianiline)
101-90-6	Diglycidyl resorcinol ether (DGRE)
103-33-3	Azobenzene
106-46-7	*p*-Dichlorobenzene
106-47-8	*p*-Chloroaniline
106-49-0	*p*-Toluidine (*delisted 1999*)
106-87-6	4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)
106-89-8	Epichlorohydrin
106-93-4	Ethylene dibromide
106-99-0	1,3-Butadiene
107-05-1	Allyl chloride (*delisted 1999*)
107-06-2	Ethylene dichloride (1,2-Dichloroethane)
107-13-1	Acrylonitrile
107-30-2	Chloromethyl methyl ether (technical grade)
110-00-9	Furan
110-86-1	Pyridine
111-44-4	Bis(2-chloroethyl)ether
114-26-1	Propoxur
115-02-6	Azaserine
115-28-6	Chlorendic acid
115-96-8	Tris(2-chloroethyl) phosphate
116-14-3	Tetrafluoroethylene
117-10-2	Dantron (Chrysazin; 1,8-Dihydroxy-anthraquinone)
117-79-3	2-Aminoanthraquinone
117-81-7	Di(2-ethylhexyl)phthalate (DEHP)
118-74-1	Hexachlorobenzene
118-96-7	2,4,6-Trinitrotoluene
119-34-6	4-Amino-2-nitrophenol
119-90-4	3,3′-Dimethoxybenzidine (*o*-Dianisidine)
119-93-7	3,3′-Dimethylbenzidine (*o*-Tolidine)
120-58-1	Isosafrole (*delisted 2006*)
120-71-8	*p*-Cresidine
120-80-9	Catechol

121-14-2	2,4-Dinitrotoluene
122-60-1	Phenyl glycidyl ether
122-66-7	Hydrazobenzene (1,2-Diphenylhydrazine)
123-91-1	1,4-Dioxane
124-48-1	Chlorodibromomethane (*delisted 1999*)
125-33-7	Primidone
126-07-8	Griseofulvin
126-72-7	Tris(2,3-dibromopropyl)phosphate
126-85-2	Nitrogen mustard *N*-oxide
126-99-8	Chloroprene
127-18-4	Tetrachloroethylene (Perchloroethylene)
128-44-9	Saccharin, sodium (*delisted 2003*)
129-15-7	2-Methyl-1-nitroanthraquinone (of uncertain purity)
129-43-1	1-Hydroxyanthraquinone
132-27-4	*o*-Phenylphenate, sodium
133-06-2	Captan
133-07-3	Folpet
134-29-2	*o*-Anisidine hydrochloride
134-32-7	1-Naphthylamine
135-20-6	Cupferron
136-35-6	Diazoaminobenzene
136-40-3	Phenazopyridine hydrochloride
136-45-8	Di-*n*-propyl isocinchomeronate (MGK Repellent 326)
137-17-7	2,4,5-Trimethylaniline (and its strong acid salts)
137-41-7	Metam potassium
137-42-8	Metam sodium
139-13-9	Nitrilotriacetic acid
139-65-1	4,4′-Thiodianiline
139-91-3	5-(Morpholinomethyl)-3-[(5-nitrofurfuryl-idene)-amino]-2-oxazolidinone
140-57-8	Aramite
140-67-0	Estragole
140-88-5	Ethyl acrylate
141-90-2	Thiouracil
142-04-1	Aniline hydrochloride
143-50-0	Chlordecone (Kepone)
148-82-3	Melphalan
151-56-4	Ethyleneimine
153-78-6	2-Aminofluorene
154-93-8	Bischloroethyl nitrosourea (BCNU) (Carmustine)
156-10-5	*p*-Nitrosodiphenylamine
189-55-9	Dibenzo[a,i]pyrene
189-64-0	Dibenzo[a,h]pyrene
191-30-0	Dibenzo[a,l]pyrene
192-65-4	Dibenzo[a,e]pyrene
193-39-5	Indeno[1,2,3-cd]pyrene
194-59-2	7H-Dibenzo[c,g]carbazole
205-82-3	Benzo[j]fluoranthene
205-99-2	Benzo[b]fluoranthene
207-08-9	Benzo[k]fluoranthene
218-01-9	Chrysene
224-42-0	Dibenz[a,j]acridine
226-36-8	Dibenz[a,h]acridine
271-89-6	Benzofuran
298-81-7	8-Methoxypsoralen with ultraviolet A therapy
299-75-2	Treosulfan
301-04-2	Lead acetate
302-01-2	Hydrazine
302-70-5	Nitrogen mustard *N*-oxide hydrochloride
303-34-4	Lasiocarpine
303-47-9	Ochratoxin A
305-03-3	Chlorambucil
309-00-2	Aldrin
315-22-0	Monocrotaline
320-67-2	Azacitidine
330-54-1	Diuron
331-39-5	Caffeic acid
366-70-1	Procarbazine hydrochloride
373-02-4	Nickel acetate
389-08-2	Nalidixic acid
434-07-1	Oxymetholone
443-48-1	Metronidazole
446-86-6	Azathioprine
484-20-8	5-Methoxypsoralen with ultraviolet A therapy
492-80-8	Auramine
494-03-1	*N*,*N*-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)
505-60-2	Mustard Gas
509-14-8	Tetranitromethane
510-15-6	Ethyl-4,4′-dichlorobenzilate
512-56-1	Trimethyl phosphate
513-37-1	Dimethylvinylchloride
531-76-0	Merphalan
531-82-8	*N*-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide
540-73-8	1,2-Dimethylhydrazine
542-56-3	Isobutyl nitrite
542-75-6	1,3-Dichloropropene
542-88-1	Bis(chloromethyl)ether
555-84-0	1-[(5-Nitrofurfurylidene)-amino]-2-imidazolidinone
556-52-5	Glycidol
563-47-3	3-Chloro-2-methylpropene
569-57-3	Chlorotrianisene
569-61-9	C.I. Basic Red 9 monohydrochloride
590-96-5	Methylazoxymethanol
592-62-1	Methylazoxymethanol acetate
593-60-2	Vinyl bromide
598-55-0	Methyl carbamate
599-79-1	Sulfasalazine (salicylazosulfapyridine)
602-87-9	5-Nitroacenaphthene
604-75-1	Oxazepam
606-20-2	2,6-Dinitrotoluene
607-57-8	2-Nitrofluorene
608-73-1	Hexachlorocyclohexane (technical grade)
612-82-8	3,3′-Dimethylbenzidine dihydrochloride
612-83-9	3,3′-Dichlorobenzidine dihydrochloride
613-35-4	*N*,*N*′-Diacetylbenzidine
615-05-4	2,4-Diaminoanisole

615-53-2	*N*-Nitroso-*N*-methylurethane
621-64-7	*N*-Nitrosodi-*n*-propylamine
630-93-3	Diphenylhydantoin (Phenytoin), sodium salt
631-64-1	Dibromoacetic acid
636-21-5	*o*-Toluidine hydrochloride
637-07-0	Clofibrate
671-16-9	Procarbazine
680-31-9	Hexamethylphosphoramide
684-93-5	*N*-Nitroso-*N*-methylurea
712-68-5	2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole
759-73-9	*N*-Nitroso-*N*-ethylurea
764-41-0	1,4-Dichloro-2-butene
765-34-4	Glycidaldehyde
794-93-4	Panfuran S
817-09-4	Trichlormethine (Trimustine hydrochloride)
822-36-6	4-Methylimidazole
838-88-0	4,4′-Methylene bis(2-methylaniline)
842-07-9	C.I. Solvent Yellow 14
924-16-3	*N*-Nitrosodi-*n*-butylamine
924-42-5	*N*-Methylolacrylamide
930-55-2	*N*-Nitrosopyrrolidine
1024-57-3	Heptachlor epoxide
1116-54-7	*N*-Nitrosodiethanolamine
1120-71-4	1,3-Propane sultone
1271-28-9	Nickelocene
1303-00-0	Gallium arsenide
1307-96-6	Cobalt[II] oxide
1309-64-4	Antimony oxide (Antimony trioxide)
1313-99-1	Nickel oxide
1314-20-1	Thorium dioxide
1314-62-1	Vanadium pentoxide (orthorhombic crystalline form)
1332-21-4	Asbestos
1333-86-4	Carbon black (airborne, unbound particles of respirable size)
1335-32-6	Lead subacetate
1464-53-5	Diepoxybutane
1596-84-5	Daminozide
1615-80-1	1,2-Diethylhydrazine
1694-09-3	Benzyl violet 4B
1746-01-6	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
1836-75-5	Nitrofen (technical grade)
1897-45-6	Chlorothalonil
1918-16-7	Propachlor
1929-82-4	Nitrapyrin
1937-37-7	Direct Black 38 (technical grade)
2092-56-0	D&C Red No. 8
2312-35-8	Propargite
2385-85-5	Mirex
2425-06-1	Captafol
2429-74-5	C.I. Direct Blue 15
2439-01-2	Oxythioquinox (Chinomethionat)
2475-45-8	Disperse Blue 1
2593-15-9	Terrazole
2602-46-2	Direct Blue 6 (technical grade)
2646-17-5	Oil Orange SS
2784-94-3	HC Blue 1
2973-10-6	Diisopropyl sulfate
3068-88-0	β-Butyrolactone
3296-90-0	2,2-Bis(bromomethyl)-1,3-propanediol
3333-67-3	Nickel carbonate
3468-63-1	D&C Orange No. 17
3546-10-9	Phenesterin
3564-09-8	Ponceau 3R
3570-75-0	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole
3688-53-7	AF-2 [2-(2-furyl)-3-(5-nitro-2-furyl)]acrylamide
3697-24-3	5-Methylchrysene
3761-53-3	Ponceau MX
3771-19-5	Nafenopin
4342-03-4	Dacarbazine
4549-40-0	*N*-Nitrosomethylvinylamine
5160-02-1	D&C Red No. 9
5216-25-1	*p-a,a,a*-Tetrachlorotoluene
5522-43-0	1-Nitropyrene
5589-96-8	Bromochloroacetic acid
6055-19-2	Cyclophosphamide (hydrated)
6109-97-3	3-Amino-9-ethylcarbazole hydrochloride
6164-98-3	Chlordimeform
6358-53-8	Citrus Red No. 2
6459-94-5	C.I. Acid Red 114
7280-37-7	Estropipate
7439-92-1	Lead (and lead compounds)
7440-02-0	Nickel (Metallic)
7440-38-2	Arsenic (inorganic arsenic compounds)
7440-41-7	Beryllium (and beryllium compounds)
7440-43-9	Cadmium (and cadmium compounds)
7440-48-4	Cobalt metal powder
7446-27-7	Lead phosphate
7446-34-6	Selenium sulfide
7481-89-2	Zalcitabine
7496-02-8	6-Nitrochrysene
7758-01-2	Potassium bromate
8001-35-2	Toxaphene (Polychlorinated camphenes)
8006-61-9	Unleaded gasoline (wholly vaporized)
8018-01-7	Mancozeb
9004-66-4	Iron dextran complex
9006-42-2	Metiram
10026-24-1	Cobalt sulfate heptahydrate
10034-93-2	Hydrazine sulfate
10048-13-2	Sterigmatocystin
10124-43-3	Cobalt sulfate
10418-03-8	Stanozolol
10453-86-8	Resmethrin
10540-29-1	Tamoxifen and its salts
10595-95-6	*N*-Nitrosomethylethylamine
12035-72-2	Nickel subsulfide
12054-48-7; 12125-56-3	Nickel hydroxide
12122-67-7	Zineb (*delisted 1999*)
12174-11-7	Palygorskite fibers (>5 μm in length)
12427-38-2	Maneb

12510-42-8/ 66733-21-9	Erionite
13010-47-4	1-(2-Chloroethyl)-3-cyclohexylnitrosourea (CCNU) (Lomustine)
13194-48-4	Ethoprop
13256-22-9	*N*-Nitrososarcosine
13463-39-3	Nickel carbonyl
13552-44-8	4,4′-Methylenedianiline dihydrochloride
13909-09-6	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)
14901-08-7	Cycasin
15541-45-4	Bromate
15663-27-1	Cisplatin
15972-60-8	Alachlor
16071-86-6	Direct Brown 95 (technical grade)
16543-55-8	*N*-Nitrosonornicotine
16568-02-8	Gyromitrin (Acetaldehyde methylformylhydrazone)
18662-53-8	Nitrilotriacetic acid, trisodiumsalt monohydrate
18883-66-4	Streptozotocin (streptozocin)
19044-88-3	Oryzalin
19666-30-9	Oxadiazon
20265-96-7	*p*-Chloroaniline hydrochloride
20325-40-0	3,3′-Dimethoxybenzidine dihydrochloride(*o*-Dianisidine dihydrochloride)
20830-81-3	Daunomycin
21739-91-3	Cytembena
22398-80-7	Indium phosphide
22506-53-2	3,9-Dinitrofluoranthene
23103-98-2	Pirimicarb
23246-96-0	Riddelliine
23950-58-5	Pronamide
25013-16-5	Butylated hydroxyanisole
25316-40-9	Doxorubicin hydrochloride (Adriamycin)
25321-14-6	Dinitrotoluene mixture, 2,4-/2,6-
25812-30-0	Gemfibrozil
26148-68-5	A-α-C (2-Amino-9H-pyrido [2,3-b]indole)
26471-62-5	Toluene diisocyanate
28407-37-6	C.I. Direct Blue 218
28434-86-8	3,3′-Dichlor*o*-4,4′-diaminodiphenyl ether
30516-87-1	Zidovudine (AZT)
32809-16-8	Procymidone
34256-82-1	Acetochlor
34465-46-8	Hexachlorodibenzodioxin
36734-19-7	Iprodione
39156-41-7	2,4-Diaminoanisole sulfate
42397-64-8	1,6-Dinitropyrene
42397-65-9	1,8-Dinitropyrene
50471-44-8	Vinclozolin
51264-14-3	Amsacrine
51338-27-3	Diclofop-methyl
53973-98-1	Polygeenan
54749-90-5	Chlorozotocin
55738-54-0	*trans*-2-[(Dimethylamino)methyl-imino]-5-[2-(5-nitr*o*-2-furyl)vinyl]-1,3,4-oxadiazole
57018-52-7	Propylene glycol mono-*t*-butyl ether
57835-92-4	4-Nitropyrene
59669-26-0	Thiodicarb
59865-13-3; 79217-60-0	Ciclosporin (Cyclosporin A; Cyclosporine)
60153-49-3	3-(*N*-Nitrosomethylamino)-propionitrile
60391-92-6	*N*-Carboxymethyl-*N*-nitrosourea
60568-05-0	Furmecyclox
62450-06-0	Trp-*p*-1 (Tryptophan-*p*-1)
62450-07-1	Trp-*p*-2 (Tryptophan-*p*-2)
62476-59-9	Acifluorfen sodium
64091-91-4	4-(*N*-Nitrosomethylamino)-1-(3-pyridyl)1-butanone
67730-10-3	Glu-*p*-2(2-Aminodipyrido[1,2-a:3′,2′-d] imidazole)
67730-11-4	Glu-*p*-1(2-Amino-6-methyldipyrido [1,2- a:3′,2′-d]imidazole)
68006-83-7	Me-A-α-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole)
68308-34-9	Shale-oils
72490-01-8	Fenoxycarb
76180-96-6	IQ (2-Amino-3-methylimidazo [4,5-f] quinoline)
77094-11-2	MeIQ(2-Amino-3,4-dimethyl-imidazo[4,5-f]quinoline)
77439-76-0	MX (3-chloro-4-(dichloromethyl) 5-hydroxy-2(5H)-furanone)
77500-04-0	MeIQx (2-Amino-3,8-dimethyl-imidazo[4,5-f]quinoxaline)
77501-63-4	Lactofen
79748-81-5	Fusarin C
82410-32-0	Ganciclovir
105650-23-5	PhiP(2-Amino-1-methyl-6-phenylimidazol[4,5-b]pyridine)
105735-71-5	3,7-Dinitrofluoranthene
108171-26-2	Chlorinated paraffins (Average Chain length, C12; approximately 60% chlorine by weight)
110235-47-7	Mepanipyrim
111406-87-2	Zileuton
113852-37-2	Cidofovir
116355-83-0	Fumonisin B1
140923-17-7/140923-25-7	Iprovalicarb
141112-29-0	Isoxaflutole
148477-71-8	Spirodiclofen
177406-68-7	Benthiavalicarb-isopropyl
no CAS	Silica, crystalline (airborne particles of respirable size)
no CAS	Soots, tars, and mineral oils (untreated and mildly treated oils and used engine oils)
no CAS	Strong inorganic acid mists containing sulfuric acid
no CAS	Phenylhydrazine and its salts
no CAS	Toxins derived from *Fusarium moniliforme* (*Fusarium verticillioides*)
no CAS	Nickel refinery dust from thepyrometallurgical process
no CAS	Oral contraceptives, combined
no CAS	Diesel engine exhaust

no CAS........Wood dust
no CAS........Ceramic fibers (airborne particles of respirable size)
no CAS........Oral contraceptives, sequential
no CAS........Residual (heavy) fuel oils
no CAS........Radionuclides
no CAS........Certain combined chemotherapy for lymphomas
no CAS........Talc containing asbestiform fibers
no CAS........Aflatoxins
no CAS........Diaminotoluene (mixed)
no CAS........Alcoholic beverages, when associated with alcohol abuse
no CAS........Bracken fern
no CAS........Bitumens, extracts of steam-refined and air refined
no CAS........Bis(2-chloro-1-methylethyl) ether, technical grade
no CAS........Tobacco smoke
no CAS........2,4-Hexadienal (89% *trans*, *trans* isomer; 11% *cis*, *trans* isomer)
no CAS........Tobacco, oral use of smokeless products
no CAS........Betel quid without tobacco
no CAS........5-Chloro-*o*-toluidine and its strong acid salts
no CAS........Herbal remedies containing plant species of the genus *Aristolochia*
no CAS........Creosotes
no CAS........Polychlorinated dibenzofurans
no CAS........Betel quid with tobacco
no CAS........Methylmercury compounds
no CAS........Conjugated estrogens
no CAS........Chromium (hexavalent compounds)
no CAS........Glasswool fibers (airborne particlesof respirable size)
no CAS........Gasoline engine exhaust (condensates/extracts)
no CAS........Coke oven emissions
no CAS........Quinoline and its strong acid salts
no CAS........Areca nut
no CAS........Aristolochic acids
no CAS........Carbon-black extracts
no CAS........Benzidine-based dyes
no CAS........3,3′-Dimethoxybenzidine-based dyesmetabolized to 3,3′-dimethylbenzidine
no CAS........3,3′;-Dimethoxybenzidine-based dyesmetabolized to 3,3′-dimethoxybenzidine
various CAS........Nickel compounds
various CAS........*p*-Chloro-*o*-toluidine, strong acid salts of
various CAS........Analgesic mixtures containing phenacetin
various CAS........Polybrominated biphenyls (PBBs)
various CAS........Polychlorinated dibenzo-*p*-dioxins
various CAS........Polychlorinated biphenyls (containing 60 or more percent Cl by molecular weight)
various CAS........Polychlorinated biphenyls
Various CAS........Estrogens, steroidal

Appendix 3: Glossary

A

absorbent material Commercially packaged clay, kitty litter, or other material used to soak up liquid hazardous materials.

absorption Penetration of a substance across a biologic barrier (such as the skin) and into either the lymphatic system or bloodstream.

acaricide A chemical substance used to kill ticks and mites.

accident An unplanned energy transfer causing property damage and/or human injury. See also “incident.”

accumulative effect The effect of a chemical substance on a biologic system when the substance is being absorbed at a rate that exceeds the body’s ability to eliminate it from the system. Excessive accumulation of the substance in the system can lead to toxicity.

acid Any compound containing hydrogen replaceable by metals, and having a pH of zero to 6. Strong acids in the pH range of zero to 2 are corrosive and will cause chemical burns to the skin, eyes, and mucous membranes. Acids turn litmus red. See also “pH” and “strong acids.”

acid gas A gas that forms an acid when dissolved in water.

acidosis A pathologic condition resulting from accumulation of acid in, or loss of base from, the body.

acrid Having a biting taste; sharp; pungent.

active ingredient The component that actually performs the primary function of a product. Products generally contain both active and inert ingredients, and both may be harmful. For example, insecticides in spray cans contain both chemicals having pesticidal action (active) and propellent gas (inert). Active ingredients are listed on product labels as percentage by weight or as pounds per gallon of concentrate.

acute The clinical term for a disease having a short and relatively severe course, measured in seconds, minutes, hours, or days, following exposure to a health hazard. Also, in animal testing, pertains to administration of an agent in a single dose.

acute effect Refers to an adverse health effect that usually occurs rapidly, sometimes immediately, as a result of a single, short significant exposure to a health hazard, without implying a degree of severity. Acute effects may include irritation, corrosivity, narcosis, and death. See also “chronic.”

acute exposure Refers to a single exposure to a toxic substance that results in death or severe biological harm. Acute exposures are characterized as lasting no longer than 1 day.

acidosis A pathologic condition resulting from accumulation of acid in, or loss of base from, the body.

adrenal gland A hormone-secreting organ located above each kidney.

AEGL Acronym for Acute Emergency Guideline Levels. AEGLs represent threshold airborne exposure limits for the general public and are applicable to emergency exposures ranging from 10 min to 8 h. Three levels—AEGL-1, AEGL-2, AEGL-3—are developed for each of five exposure periods (10 min, 30 min, 1 h, 4 h, and 8 h) and are distinguished by varying degrees of severity of toxic effects. DOE guidance is to use the 1-h AEGL values, which appear in this database.[DOE] AEGL values are developed and published by the US Environmental Protection Agency (EPA). See also “How to Use this Book” in the front matter of this book.

aerosol A dispersed suspension of fine particles suspended in air (dispersed in a gas), the particle size often being in the 0.01−100 μm range. Natural aerosols include smoke (solid particles) and fog (liquid particles). Man-made aerosols are manufactured by filling a valved container, usually a can, with a suspension (e.g., paint, insecticides, cosmetics) in a gas under pressure.

aliphatic Pertaining to an open-chain hydrocarbon compound. Substances such as methane and ethane are typical aliphatic hydrocarbons.

alkali Any ACID destroying compound having a pH of 8−14. Strong alkalis (or bases) in the pH range of 12−14 are considered corrosive and will cause chemical burns to the skin, eyes, and mucous membranes. Alkalis turn litmus blue. Widely used industrial alkali substances include sodium hydroxide, sodium carbonate, potassium hydroxide, and potassium carbonate. Common household products include DRANO™ and lye. See also “acid,” “base,” and “pH.”

alkaloid An organic nitrogen base, of vegetable origin, usually toxic.

allergen A substance that causes the body to produce an antibody and which results in an allergy in hypersensitive people.

allergy A hypersensitive reaction of body tissues to specific substances. In similar concentrations and circumstances these same substances do not affect other persons. Allergic reactions in the workplace tend to affect the skin (see dermatitis) and lungs (see asthma).

ambient air concentration The concentration of a material in environmental air outside of buildings, that is, air to which the general public is exposed.

amine An organic compound that may be derived from ammonia (NH_3) by the replacement of one or more hydrogen atoms (H) by hydrocarbon groups or other chemical moieties; replacing one, two, or three hydrogen atoms gives primary, secondary, or tertiary amines, respectively; if a fourth group is added to a tertiary amine (R_3N), the compound formed is called a quaternary amine (R_4N+) and the nitrogen carries a positive charge.

anaerobic conditions Refers to the absence of oxygen.

amnesia Total or partial memory loss.

analgesia A pain-relieving agent that causes insensibility to pain without loss of consciousness.

analogue A compound that resembles another in structure; may be an isomer, but not necessarily.

analytical grade The highest available purity of a chemical.

anemia A deficiency of the blood caused by reduced red blood cell count or a reduction in the amount of hemoglobin per unit volume of blood.

anesthesia Total or partial loss of sensation with or without loss of consciousness.

angina pectoris Pain in chest caused by inadequate supply of blood to the heart.

anhydrous Containing no water.

anorexia Loss or reduction of appetite for food.

anosmia Total or partial loss of the sense of smell.

anoxia A reduction in the quantity of oxygen supplied by blood to cells or tissues.

anticonvulsant A substance that lessens the severity of convulsions.

antidote A remedy to relieve, prevent, or counteract the effects of a poison; that which counteracts anything noxious.

antiepileptic A substance that lessens the severity of epileptic seizures.

anuria Absence of urine in the bladder caused by the failure of the kidneys to produce urine. This is a possible symptom of chlorate or inorganic mercury poisoning.

apathy Reduced emotions with lack of interest in outside stimuli.

apnea Temporary cessation of breathing. A possible symptom of poisoning.

aquatic toxicology A branch of toxicology that deals with water pollution and its ecological effects.

aqueous Watery or water like.

aromatic compound Pertaining to a molecular ring structure hydrocarbon compound, characterized by the presence of the benzene nucleus.

aromatic hydrocarbon An organic chemical compound formed primarily from carbon (C) and hydrogen (H) atoms with a structure based on benzene rings *and* resembling benzene in chemical behavior; substituents on the rings(s) may contain atoms other than C or H.

arrhythmia Disturbed heartbeat.

arsenical A compound containing arsenic.

arylamine An organic compound formed from an aromatic hydrocarbon that has at least one amine group joined to it.

ataxia Unsteady walk or shaky movements due to neurological problems. May be a symptom of poisoning.

asphyxia Difficulty in breathing or respiratory arrest; suffocation.

asphyxiant Refers to a substance, usually a vapor or gas, that can cause suffocation, unconsciousness, or death by preventing the blood from carrying oxygen. Most simple asphyxiants (which have no inherent toxicity) are harmful to the body only when they become so concentrated that oxygen in the air is reduced (normally about 21%) to dangerous levels (18% or lower).

asthenia Reduced physical and psychological strength.

asthma Respiratory problem characterized by attacks of wheezing, shortness of breath, and/or coughing and resulting in difficult breathing due to contraction of air passages.

ataxia Loss or failure of muscular coordination, voluntary movement, or muscle control.

atrophy A loss of weight, volume, and activity of an organ, tissue, or cell; shrinkage.

autoignition temperature The minimum temperature at which a substance will ignite spontaneously, or cause self-sustained combustion in the absence of any heated element, spark, or flame. The closer the autoignition temperature is to room temperature, the greater the risk of fire.

awareness level (trained) First responders at the awareness level are those persons who, in the course of their normal duties, may be the first on the scene of an emergency involving hazardous materials. First responders at the awareness level are expected to recognize hazardous materials presence, protect themselves, call for trained personnel, and secure the area (ANSI/NFPA 472).

azide A compound that contains the monovalent $-N_3$ group.

azo- A prefix denoting the presence in a molecule of the group $-N = N-$. See also “diazo-.”

B

bactericidal Destructive to bacteria. An agent (e.g., heat, light, or osmotic pressure) or a chemical, such as a pesticide, that kills bacteria or inhibits their growth is called a bactericide.

barbiturate A drug used as a sedative or hypnotic.

base A substance that reacts with acids to form salts and water. All bases create solutions having a pH of more than 7.0, the neutral point, and may be corrosive to skin and other human tissue. The terms alkali and caustic are closely related in meaning. See also “acid,” “alkali,” and “pH.”

BEI Biological Exposure Index. The maximum recommended value of a substance in blood, urine, or exhaled air, recommended by the ACGIH. See “Threshold Limit Values and Biological Exposure Indices,” published by the ACGIH, for an explanation.

benign Not harmful.

bile A yellow-green, bitter fluid secreted by the liver. Also called gall.

bioaccumulation The process by which a material in an organism’s environment progressively concentrates within the organism.

bioassay The determination of the potency or concentration of a compound by its effect upon animals, isolated tissues, or microorganisms, as compared with a chemical or physical assay.

biodegradation Biotransformation; the conversion within an organism of molecules from one form to another, a change often associated with change in pharmacologic activity.

bld Blood effects. A toxicology term describing the effect on all blood elements including oxygen carrying or releasing capacity, pH, protein, and electrolytes.

blepharospasm Abnormal contraction of eyelid muscles.

BOD Biological oxygen demand. A test that measures the dissolved oxygen consumed by microbial life while assimilating and oxidizing the organic matter present in organic waste discharges. This test permits calculation of the effect of the discharges on the oxygen resources of the receiving water.

boiling point The temperature at which a product changes from a liquid to a vapor at normal atmospheric pressure (760 mmHg). Mixtures may not have a specific boiling point. As a general rule, material safety data sheets (MSDS) carry the initial boiling point or a boiling range for a mixture.

bowel The intestine, or the part of the digestive tract extending from the stomach to the anus.

bradycardia A decrease in the heartbeat rate to less than 60 beats per minute.

breakthrough time The time from initial chemical contact to detection.

breathing zone sample An air sample collected from the area around the nose of a worker to assess exposure to airborne contaminants.

bronchoconstriction Contraction with narrowing of bronchia.

bronchospasm Spasmodic contraction of the muscles surrounding the bronchia.

bulk density Mass of powdered or granulated solid material per unit of volume.

by-product Any material, other than the principal product, generated as a consequence of an industrial process.

C

C Symbol for Celsius or Centigrade, a unit of temperature in which the interval between the freezing point of water and the boiling point is divided into 100 units, or degrees, with 0°C representing the freezing point and 100°C the boiling point.

cancer A general term used to indicate any of various types of malignant neoplasms.

canister A personal air cleaning device usually worn by the user. The canister contains sorbents, catalysts, or other filter materials designed to remove gases, vapors, and liquid and solid particles from air drawn through it.

carcinogen Any substance causing the promotion or initiation of malignant or benign neoplasia (cancer) in humans or animals. A material is considered carcinogenic if (a) it is found to be a carcinogen or potential carcinogen by the International Agency for Research on Cancer (IARC); or, (b) if it is listed in the latest edition of the "Annual Report on Carcinogens," published by the National Toxicology Program (NTP); or, (c) it is regulated by OSHA as a carcinogen.

carcinogenesis The process by which normal tissue becomes cancerous.

carcinogenicity The power, ability, or tendency to produce cancerous tissue from normal tissue.

carcinoma A malignant neoplasm of the epithelium.

carcinoma in situ Noninvasive cancer.

carcinoma A malignant tumor; a type of cancer.

cardio A medical prefix that refers to the heart.

cardiovascular A medical term that refers to the heart and blood vessel system.

catalyst A substance that affects the rate of a chemical reaction, but that is neither changed nor consumed by the reaction.

cataract A disease of the eye in which the lens becomes gray-white and loses its clearness.

cathartic Substance that aids bowel movement and stimulates evacuation of the intestine.

cation An ion that carries a positive charge, e.g., sodium (N^{+}), (calcium Ca^{2+}), and ammonium ($NH_4{}^{+}$); the corresponding hydroxide is formed when combined with hydroxyl (OH^{-}) ions.

caustic Any strongly alkaline substance that has a corrosive effect on living tissue. See also "alkali."

ceiling limit The concentration of a substance that should not be exceeded, even for an instant. Also called ceiling concentration.

central nervous system (CNS) Refers to the brain and spinal cord, the main network of coordination and control for the entire body. Chemicals acting on the brain may cause CNS depression with symptoms of dizziness, headache, and drowsiness; higher exposure may cause unconsciousness, coma, and death.

characteristic hazardous waste An RCRA regulated waste classified as "hazardous" because of its ignitability, corrosivity, reactivity, or toxicity as determined by the Toxicity Characteristic Leachate Procedure (TCLP). It has an EPA Waste Code ranging from "D001" to "D043."

chelation A complex formation involving a metal ion and two or more polar groupings of a single molecule; chelation can be used to remove an ion from participation in biological reactions, as in the chelation of Ca^{2+} in blood by EDTA.

chemical Any element, chemical compound, or mixture of elements and/or compounds.

chemical burn Similar to a thermal burn from heat or fire, but caused by contact with a chemical substance.

chemical family A group of single elements or groups of compounds having a common chemical structure and name. Also known as chemical class. As used on a Material Safety Data Sheet (MSDS), more than one chemical family may be used if applicable.

chemical formula The chemical makeup of a substance using accepted written symbols. Although several kinds of formulas are used to indicate chemical constitution and physical structure, the *molecular formula* showing the actual kinds and numbers of atoms that comprise a molecule of a chemical substance is most commonly used in Material Safety Data Sheet (MSDS).

chemical hygiene plan A written action plan required by OSHA's regulation 29CFR1910, Occupational Exposures to Hazardous Chemicals in Laboratories.

chemical intermediate A chemical formed or used during the process of producing another chemical.

chemically active metals Usually refers (but not restricted) to chemicals such as sodium, potassium, beryllium, calcium, powdered aluminum, zinc, and magnesium. These metals can cause violent reactions with certain other substances and materials.

chemical name The scientific designation of a chemical as outlined by the Chemical Abstract Service (CAS) rules of nomenclature and the nomenclature system developed by the International Union of Pure and Applied Chemistry. Also defined by the OSHA Hazard Communication Standard (HCS) as a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation. By this definition, more than one valid name for many chemicals is permitted. However, when chemicals with more than one valid name appears on the OSHA (29CFR1910 Table Z-1) or CERCLA (40CFR302.4) lists, this name is generally used as the chemical name on material safety data sheets (MSDS). If a chemical does not appear on these lists, then the most common chemical name should be used. Trade names that adequately identify a chemical may be used.

chemical manufacturer Defined in the OSHA Hazard Communication Standard (HCS) as an employer with a workplace where chemical(s) are produced for use or distribution.

chemical reaction Any chemical change, regardless of rate, or whether it occurs naturally or induced by human. There are many types of chemical reactions including decomposition, explosion, combustion, condensation, polymerization, neutralization.

chemical resistance The ability of a material to resist chemical reaction.

chemosterilant A chemical compound that causes an organism to become sterile after exposure to it.

chlorofluorocarbons (CFCs) A group of chemicals that depletes the earth's protective ozone layer. Chemical substance often used as refrigerants, solvents, and propellants as propellants in spray cans. CFCs are not destroyed in the lower atmosphere; they drift into the upper atmosphere where their chlorine components are released and destroy the ozone layer.

chloracne A severe acne-like affliction of the skin resulting from excessive exposure to certain chlorinated or halogenated chemical compounds, such as carbon tetrachloride, chloroform, trichloroethylene, biphenyls, dioxins, naphthalenes, and DDT.

chronic Refers to a change to an organism over a long period of time, measured in weeks, months, or years following repeated exposure to a health hazard.

chronic effect of overexposure Refers to an adverse health effect that develops slowly over a long period of time or from prolonged exposure to a health hazard without implying a degree of severity.

chronic toxicity Refers to permanent and irreversible health effects resulting from prolonged exposure to a toxic substance.

circulatory system The system consisting of the blood, blood vessels, lymph vessels, and heart; involved in circulating blood and lymph throughout the body.

cirrhosis Chronic progressive illness affecting the structure and function of the liver. Replacement of normal liver tissue with bands of fibrous tissue surrounding nodules of regenerating liver tissue.

closed cup Test for the flash point of a substance.

coagulant An agent that causes, stimulates, or accelerates coagulation, especially with reference to blood.

co-carcinogen Any substance, not itself carcinogenic, capable of enhancing the carcinogenic effect of another substance.

Code of Federal Regulations (CFR) A publication of the regulations promulgated under United States federal law. Changes to CFR are published in the "Federal Register" (FR). The CFR is divided into titles as follows:

Title 29: OSHA regulations, including the Hazard Communication Standard (HCS).

Title 40: EPA regulations, including TSCA.

Title 49: DOT regulations.

colic A sharp, crampy, and possibly painful disorder of the abdomen resulting from blockage, twisting, or muscle spasm.

collapsus Rapid decrease in strength or collapse of an organ.

coma A state of deep unconsciousness from which a victim cannot be wakened by external stimulants.

combustible liquid A material having a flash point at or above 37.8°C/100°F, but below 93.3°C/200°F, except that this term does not include any liquid mixture that has one or more components with a flash point above 93.3°C/200°F, which make up 99% or more of the total volume of the mixture as determined by tests listed in 49CFR173.115(d). Exceptions to this are found in 49CFR173.115(b).

commercial grade Less than the purest available form of a chemical; the purity normally produced for and adequate for commercial uses.

common name Any designation or identification such as a code name, code number, trade name, or generic name used to identify a chemical other than by its chemical name (OSHA).

component An ingredient or constituent part.

compound A substance consisting of two or more elements that have united chemically.

compressed gas Any material or mixture having in the container a pressure exceeding 40 psi at 70°F/21.1°C, or a pressure exceeding 104 psi at 130°F/54.4°C, regardless of the pressure at 70°F/21.1°C; or any liquid flammable material having a vapor pressure exceeding 40 psi absolute pressure at 100°F/37.8°C as determined by the American National Standard Method of Tests for Vapor Pressure of Petroleum Products (Reid Method) Z11.44-1973 (ASTM—American Society for Testing Materials D 323-72).

congenital A condition that begins to develop in the uterus and is existing at birth.

congestion Abnormal accumulation of blood in the vessels of tissue, an organ or other part of the body.

conjugated Bound together; in organic chemistry, conjugated refers to a molecular structure or substructure containing alternating double and single bonds between pairs of adjacent atoms.

conjunctivitis Irritation and inflammation of the conjunctiva, a part of the inner lining of the eyelids.

container Defined by OSHA as any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. Pipes and piping systems and engines, fuel tanks or other operating systems in a vehicle, are not considered containers (29CFR).

contaminant An impurity; in the environment, a chemical that is not ordinarily present and that may have deleterious effects.

contraindication Any condition that renders some particular treatment of disease improper or undesirable.

convulsions Violent, involuntary spasms or muscle contractions.

copolymer A chemical (polymer) made up of repetitive subunits (monomers) that are not all alike.

corrosive material Any liquid or solid with pH ranges of 2−6 or 12−14, and that cause visible destruction or irreversible alteration of living tissue, or a liquid that has a severe corrosion rate on steel. To determine whether a material is destructive or to cause irreversible alteration of human skin, refer to the method described in Appendix A of 49CFR173. A liquid is considered to have a severe corrosion rate if its corrosion rate exceeds 0.250 inch per year (IPY) on steel [Society of Automotive Engineers (SAE) 1020] at a test temperature of 130°F/54.4°C. Also see test described in NACE Standard TM-01-69.

cryogenic liquid Defined by DOT as a refrigerated liquefied gas having a boiling point colder than −130°F/−90°C at one atmosphere, absolute.

cutaneous Pertaining to the skin. See also "dermal."

cyanosis A bluish discoloration of the skin, lips, and mucous membrane, resulting from lack of oxygen in the blood hemoglobin, or excessive concentration of reduced hemoglobin in the blood.

cytotoxic Having a poisonous effect on cells.

D

decomposition Breakdown of a material or substance into parts, elements, or simpler compounds that may be caused by heat, chemical reaction, electrolysis, decay, biodegradation, or other process.

decontamination The removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.

degradation The destructive effect a chemical may have on chemical-protective clothing, reducing its strength and flexibility, and permitting a direct route to skin contact.

defoliant A chemical spray or dust that causes leaves to drop off plants prematurely.

dermal penetration The act of entering the body by penetrating the layers of the skin.

dermatitis An inflammation of the skin.

delayed hazard The potential to cause an adverse effect which may not appear until after a long period of time. Carcinogenicity, teratogenicity, and certain target organ/system effects are examples of delayed hazards (ANSI).

deliquescent Substance which absorbs moisture from the air to the point of becoming liquid.

delirium A mental state of great excitement or confusion marked by speech disorders, anxiety, and often hallucinations.

density The mass (weight) per unit volume of a substance. For example, lead has much greater density than aluminum.

dermal Pertaining to the skin. See also "cutaneous."

dermatitis Inflammation of the skin from any cause.

dermatosis Generic name for all skin disorders.

desquamation Abnormal elimination of surficial layers of skin in small flakes.

diabetes A disease in which the body's ability to use sugar is impaired and which usually involves the abnormal appearance of sugar in the urine; characterized by excessive urination.

diamine An organic compound containing two amine groups, e.g., ethylenediamine, $H_2NCH_2CH_2NH_2$.

diarrhea Abnormally frequent discharge of loose, watery feces from the large intestine (colon). May be a symptom of poisoning.

diazo- A prefix denoting a compound containing the $-N'N-$ or $-N,N^+$ group. See also "azo-."

dimer A compound or unit produced by the combination of two like molecules.

diuretic That which increases volume of urine.

DL- Used separately, prefixes of D- for dextrorotary (rotated to the right) and L- for levorotary (rotated to the left) before the same chemical name refer to designations for optically active isomers that are chemically identical but that rotate plane polarized light in opposite directions; the isomers are mirror images of each other; when used together, DL designates a racemic mixture of the two isomers, whose optical activities cancel each other.

dose The amount of a chemical substance or drug to which a person has been exposed or absorbed into the body.

dysplasia Malformation; abnormal development.

dyspnea Difficulty or labored breathing. Shortness of breath. A possible symptom of poisoning.

dysuria Painful or difficulty in urinating.

E

easily oxidized materials A broad range of materials that includes combustible materials, organic materials, paper, wood, sulfur, aluminum, acetic acid, alcohols, fuels, oils, plastics, hydrazine, acetic anhydride, sulfuric acid, and many other chemicals. Easily oxidized materials can cause violent reactions with other substances and materials. See also "oxidizer," "strong oxidizers."

eczema Not a distinct disease but a general medical description for swelling of the skin, or rash of unknown cause. An inflammation of the outer layer of skin, characterized by redness, itching, crusting, and scaling.

edema Swelling caused by infiltration of fluid into the tissues or intercellular spaces.

effluent Wastewater discharged from a treatment plant, sewer, or industrial outfall into the environment, usually to surface waters.

effluent guidelines (listed as a toxic pollutant) Under the Clean Water Act, pollutants that are subject to technology-based standards (application of best available technology) developed for selected groups of industries.

electrolyte a substance, such as sodium chloride (NaCl), that dissociates into ions when fused (melted) or in solution, thereby becoming capable of conducting an electric current.

EIS Environmental Impact Statement. The results of a study to determine the probable effects of a proposed activity on the surrounding environment.

element The simplest form of a pure substance that cannot be broken down into simpler substances by chemical means.

embryotoxic Toxic effect on the embryo.

emphysema A condition of the lungs characterized by dilation or destruction of the pulmonary areola. An illness characterized by plugged passageways and a difficulty in exhaling.

employer Defined by OSHA as a person (including contractor or subcontractor) engaged in business, where chemicals are either used, distributed, or produced for use or distribution.

encephalopathy Generic name given to illnesses affecting the brain in general.

environment Includes water, air, and land and their interrelationship which exists among and between water, air, and land and all living things (EPA).

EP Extraction Procedure toxicity characteristics. Toxicity test performed on RCRA wastes.

environmental fate The distribution and transformation of a chemical from its first release until its ultimate removal from or recycling through the environment.

enzyme A protein produced in organisms capable of accelerating a particular biochemical reaction; a biological catalyst.

epidemiology Science concerned with the study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (as by age, sex, or occupation), which may provide information about the cause of the disease.

ergonomics The activity dealing with interactions between workers and their total working environment and their stresses relating to the elements of the environment, their tools and equipment.

ERPG Acronym for Emergency Response Planning Guidelines. Exposure limit values produced by the American Industrial Hygiene Association (AIHA). See also "How to Use this Book" in the front matter of this book.

erythema Abnormal flushing or redness of the skin due to increase in blood flow.

etiologic agents Airborne microorganisms capable of causing disease. These agents are the only nonchemical materials regulated by the US Department of Transportation (DOT).

etiology The science and study of all the factors that contribute to the development of a disease.

euphoria Intense feeling of well-being or elation.

evaporation rate A measure of the time required for a given amount of a substance to evaporate, compared with the time required for an equal amount of butyl acetate or ether to evaporate.

exothermic Heat producing.

expectoration Expulsion from the mouth of secretions from the respiratory tract.

explosive Any chemical compound, mixture, or device that produces a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, ignition source, pressure, or high temperature.

explosive limits Defined by the NFPA as the boundary-line mixture of vapor or gas with air, which, if ignited will just propagate the flame. They are known as the "lower and upper explosive limits," and are usually expressed in terms of percentage by volume of gas or vapor in air. Same as flammable limits. See also "LEL" and "UEL."

exposure People, property, or the environment that are subjected to the harmful effects of a hazardous material. Defined by OSHA as meaning an employee subjected to a hazardous chemical in the course of employment through a ROUTE OF ENTRY (e.g., ingestion, inhalation, skin contact, or absorption) and includes potential (e.g., accidental or possible) exposure.

exposure limits Concentrations of substances and conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects. Standard limits are established by ACGIH and OSHA.

F

F Degree Fahrenheit, a unit for measuring temperature. On the Fahrenheit scale, water boils at 100°C or greater.

Federal Register (FR) A daily publication of all US government documents required by law. It is the daily supplement to the Code of Federal Regulations (CFR).

fibrillation Rapid and chaotic contractions of many individual muscle fibers of the heart in the area of the ventricles, capable of causing cardiac arrest.

fibrosis Chronic lung affliction or scarring of the lung caused by an unusual increase of fibrous tissue, causing progressive respiratory problems, and often occurring after exposure to certain chemical substances.

fire diamond A visual hazard rating system of the National Fire Protection Association (NFPA). Provides general information about inherent hazards of materials: Health, Flammability, Reactivity and Special.

flammable Catches on fire and burns rapidly. The National Fire Protection Association and the US Department of Transportation define a flammable liquid as having a flash point below 100°F/37.8°C.

flammable aerosol An aerosol that, when tested by the method described in 16CFR1500.45, yields a flame projection exceeding 18 in at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening (29CFR).

flammable limits Range of gas or vapor concentrations (percent by volume) in air which will burn or explode if an ignition source is present. See also “LEL” and “UEL.”

flash back A phenomenon characterized by vapor ignition and flame traveling back to the source of the vapor.

flash point The minimum temperature at which a substance gives off flammable vapors that are in contact with spark or flame will easily ignite and burn rapidly. The flash point is established by one of the two following methods: in a closed cup (see also “Pensky-Martens”), or inside its container; or in an open cup, or near the surface of the liquid. The lower the flash point of a liquid, the higher the risk of fire.

flatulence Accumulation of gas in the digestive tract.

fluorosis Characteristic chronic intoxication caused by fluorine and its derivatives.

foreseeable emergency Any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, that could result in an uncontrolled release of a hazardous chemical into the workplace (OSHA).

Form R Forms that must be completed annually for the EPA by reporting industrial facilities for chemicals used above the threshold amount.

fume A suspension of very fine solid particles in air, or vapors from a volatile liquid.

fumigant A pesticide in vapor or gaseous form used to kill pests or disinfect materials.

fungicide A pesticide used to control, prevent, or kill fungi.

fungus A lower plant that feeds on other organic matter and lacks the chlorophyll and tissue differentiation of higher plants.

G

gas An air-like, formless fluid having the property of uniformly distributing itself throughout a space in air. A state of matter.

gastric lavage Washing out the stomach.

gastrointestinal (GI) Refers to the organs of stomach, intestines, and/or other organs from mouth to anus.

gene Heredity-carrying material that is part of the chromosome.

genotoxic Causing genetic damage.

gestation The development of the fetus in the uterus from conception to birth; during pregnancy.

glycosuria Abnormal presence of glucose in the urine.

granulomatosis Pulmonary lesion characterized by the formation of small nodules.

granulometry Indicates the size of powder, and usually expressed in microns (1 micron is 0.000001 meters, or about 1,000 times smaller than a grain of sand). Particles of less than 10 microns are capable of deep penetration and becoming deposited in the respiratory tract. Larger particles can deposit in the upper respiratory area such as the bronchia, and although they may be expulsed, they can be dissolved by the organism. Particle size makes it possible to deduce the method to be adopted for corrective action (e.g., ventilation, respirator).

H

halogens Refers to inorganic compounds containing astatine, bromine, chlorine, fluorine, and iodine.

hazardous classes A collection of terms established the United Nations Committee of Experts to categorize hazardous materials. The specific categories are: flammable liquids, explosives, gases, oxidizers, radioactive materials, corrosives, flammable solids, poisonous and infectious substances, and dangerous substances.

hazardous constituent of waste A list of chemicals which is referenced under certain Conservation and Recovery Act (RCRA) provisions to determine if a solid waste is a hazardous waste.

hazardous materials Refers generally to hazardous substances, petroleum, natural gas, synthetic gas, acutely toxic chemicals, and other toxic chemicals. Substances or materials which have been determined to be capable of posing an unreasonable risk to health, safety, and property.

hazardous waste Defined by RCRA as any solid or combination of solid wastes, which because of its physical, chemical, or infectious properties, may pose a health hazard when improperly managed. It must possess at least one of four characteristics—ignitability, corrosivity, reactivity, toxicity—or appears on special EPA lists.

hazardous waste code The number assigned to every hazardous waste listed under the Resource Conservation and

Recovery Act (RCRA); the code is used for notification, recordkeeping, and reporting requirements.

hazard warning The OSHA definition means any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning that conveys the hazards of the chemical(s) in the container(s).

health hazard Evidence based on scientific data (human or animal) that acute or chronic effects may occur (29CGR1910.1200).

hematoma Localized bleeding into tissue.

hematuria Presence of blood in the urine.

heme The prosthetic, oxygen-carrying, color-furnishing constituent of hemoglobin.

hemoglobin The red, respiratory protein of erythrocytes; transports oxygen from the lungs to the tissues.

hemolysis Destruction of red blood cells, releasing hemoglobin.

hematopoietic system System responsible for formation of blood cells (includes bone marrow and lymphatic organs).

hemorrhage Loss of a significant amount blood. Can be external or internal bleeding.

hepatic Referring to the liver.

hepatitis An inflammation of the liver.

hepatoma Tumor of the liver.

hepatomegalia Increase in liver volume.

hepatotoxic Refers to a substance that is toxic to the liver.

hormone Any of various chemical substances that are produced by the endocrine glands and that have specific regulatory effects on the activity of certain organs.

hydrolysis A chemical process whereby a compound is cleaved into two or more simpler compounds with the uptake of the H and OH parts of a water molecule on either side of the chemical bond cleaved.

hydrolyze To subject to hydrolysis.

hydroxyl The atom group or radical, OH.

hypnotic Sleep inducing. Also, a drug that induces sleep.

hot zone The area immediately surrounding the incident site. Appropriate protective clothing and equipment must be worn by all personnel in the hot zone. AWARENESS LEVEL and OPERATIONAL LEVEL trained personel are not permitted in the hot zone.

hydrate Chemical substance combined with water in a specific proportion.

hydrocarbons Chemical compounds that consist entirely of carbon and hydrogen.

hydrochlorofluorocarbons (HCFCs) A group of chemicals having a weaker negative impact on the ozone layer and developed as temporary substitutes for ozone-depleting chemicals, such as CFCs.

hydrolysis Chemical change to a substance in an aqueous environment leading to the formation of new products.

hygroscopic Substances with a tendency to absorb moisture from the air.

hyperkeratosis Increased thickness of the cornified layer of the epidermis such as a corn.

hyperpigmentation Excessive pigmentation of the skin.

hyperplasia Abnormal growth of normal tissue.

hyperreflexia Excessive reflexes.

hypertension Increased blood pressure.

hypotension Decreased blood pressure.

hypothermia Lowering of body temperature to below normal.

I

icterus Yellow coloration of the skin and mucosa.

ignition temperature The minimum temperature required to initiate or cause self-sustained combustion independent of a heat source.

incident An unplanned event that could have resulted in an accident or which diminishes efficiency or production. See "accident."

inhibitor A chemical that is added to another substance to prevent unwanted chemical change from occurring.

immediate hazard A hazard with immediate effects. See "acute effect."

immediate use The hazardous chemical that will only be used by the individual who transfers it from a labeled container (29CFR1910.1200).

immunosuppression Decrease in the immune response. Artificial prevention or diminution of the (natural) immune response, e.g., by irradiation or by administration of substances such as pharmaceutical antimetabolites or specific antibodies to prevent sensitization; immunosuppression, or immunodeficiency may also be used to describe the condition of acquired or congenital lowered immune response.

incompatibility Indicates whether a material can be placed in contact with certain other products or materials. The direct contact of incompatible materials can cause dangerous reactions and give off heat and toxic vapors.

inflammation The response of the tissues of the body to injury, infection, or irritation. Its chief symptoms are redness, heat, swelling, and pain.

ingestion Taking in by the mouth; swallowing.

inhalation Breathing into the lungs of a (contaminated) substance in the form of a gas, vapor, fume, mist, or dust.

initiator A chemical that permanently alters a cell or group of cells and, in the case of carcinogens, is tumor producing.

inorganic chemical Those chemical substances not containing carbon.

insoluble Products that cannot be dissolved in each other.

interaction Modification of the toxic effects of one substance by another. Depending on the substances involved, the effects of interaction can be amplified or mitigated.

irritant A substance or material capable of causing irritation to organs and body parts.

irritating material Any substance that upon contact with fire or air produces irritating fumes.

invasive Spreading beyond specific body tissues.

isomer One of two or more variations of a chemical, each of which has the same chemical formula but a different structural arrangement.

J

jaundice Yellowing of the skin or eyes caused by too much bilirubin in the blood, and indication of liver diseases, biliary obstructions, and hemolysis.

K

keratitis Inflammation of the cornea of the eye.
keratoconjunctivitis Inflammation of the cornea and the conjunctiva of the eye.
K_{ow} See "partition coefficient."

L

lacrimation Production or discharge of excess tears from the eyes.
lacrimator A chemical substance that causes the secretion of excess tears from the eyes.
laryngitis Inflammation of the larynx.
latency period A seemingly inactive period, as that between the exposure of tissue to an injurious agent and a manifest response; often used to identify the period between exposure to a carcinogen and development of a tumor.
LEL Lower Explosive Limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At lower concentrations, the mixture is too "lean" to burn. See "UEL."
lethargy Deep and prolonged sleep, or extreme indifference.
leukemia A cancer of the blood-forming tissues that is characterized by a marked increase in the number of abnormal white blood cells (leukocytes).
listed hazardous waste under the Resource Conservation and Recovery Act (RCRA), wastes from generic industrial processes, wastes from certain sectors of industry, and unused pure chemical products that have been shown to generally contain toxic chemicals that could pose a threat to human health and the environment, or that generally exhibit one of the characteristics of ignitability, corrosivity, reactivity, or toxicity are considered hazardous and must adhere to RCRA provisions.
lymph A clear liquid that is collected from the tissues throughout the body and that flows in lymphatic vessels.
lymphatic A medical term describing a small sac or node in which lymph is stored; pertaining to the lymph, lymph nodes, or vascular channels that transport lymph to the lymph nodes.

M

malaise A feeling of general discomfort, distress, or uneasiness; an out-of-sorts feeling.
malignant Tending to become progressively worse; life-threatening.
manganism Chronic intoxication caused by manganese and its derivatives.
maximum contaminant levels (MCLs) The maximum level of a contaminant permissible in a public water system.
MCL The Maximum Contaminant Level; the maximum allowable of a contaminant in public drinking water supplies under the Safe Drinking Water Act.
melanoma A neoplasm derived from cells that are capable of forming the pigment melanin.
meta- In chemistry, a prefix denoting that a compound is formed by two substitutions in the benzene ring separated by one carbon atom, i.e., linked to the first and third, second and fourth, etc., carbon atoms of the ring; usually abbreviated *m*-.
metastasis The appearance of a neoplasm in a part of the body remote from the site of its origin.
methemoglobinemia Presence of an abnormal concentration and form of hemoglobin which will not carry oxygen to the blood, resulting in anemia or cyanosis.
miscible Products capable of being completely mixed and staying mixed with each other (without separation into distinct components) under normal conditions.
mist Liquid droplets suspended in air.
molecular weight Weight (mass) of a molecule based on the sum of the atomic weights of the atoms that make up the molecule.
mucous membranes Membranes lining body cavities and covered by a viscous substance called mucus.
myosis Reduction in diameter of pupils of the eye.
melting point The temperature at which a product changes from the solid to liquid state at normal atmospheric pressure (760 mmHg).
Montreal Protocol A 1987 agreement made by 25 countries to reduce the production and consumption of ozone depleting chemicals. Since 1987, additional countries have joined this agreement.
mutagen A chemical substance or physical effect capable of inducing transmissible changes in the genetic material of a living cell that results in physical and functional changes in the descendants. Depending on the type of cells affected, ova or spermazoids, both male and female can be affected. Mutations can lead to birth defects, miscarriage, or cancer.
mutagenic Capable of causing mutations.
mutagenicity The capability to induce mutation, or permanent change, in genetic material.

N

narcosis A stupor, drowsiness, arrested activity or unconsciousness produced by the influence of narcotics or other chemical substances. Artificially induced sleep.
narcotic Any substance that induces narcosis.
National Fire Protection Association (NFPA) This international membership organization promotes/improves fire protection and prevention and establishes safeguards against loss of life and property by fire. Best known in industry for

the National Fire Codes. Among these codes is the NFPA 704M, the code for classifying substances according to their fire and explosion hazard (as they might be encountered under fire or related emergency conditions) using the familiar diamond-shaped label or placard with appropriate color, numbers, or symbols.

nausea The urge to vomit; a feeling of sickness in the stomach.

necrosis Cellular or tissue death.

neonatal Relating to or affecting the first 4 weeks after birth.

neoplasm Presence of a new growth of abnormal cells. A tumor.

nephritis Inflammation of the kidney.

nephropathy Any affliction of the kidneys.

nephrotoxic Toxic to the kidneys.

NESHAP (National Emission Standards for Hazardous Air Pollutants) Under the Clean Air Act, regulations set for industries that emit one of more of the listed hazardous air pollutants in significant quantities.

neuropathy Any affliction of the nervous system.

neurotoxic Toxic to nerve cells and the nervous system. The effect may produce emotional or behavioral abnormalities.

neuritis Inflammation of a nerve.

neural Refers to a nerve or the nervous system.

neutralize To eliminate potential hazards by inactivating strong acids, caustics, and oxidizers. For example, acid spills can be neutralized by adding an appropriate amount of caustic or alkali substances.

NIOSH National Institute for Occupational Safety and Health. Tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

nitrogen mustard A substituted mustard gas in which sulfur is replaced by an amino nitrogen.

nitrogen oxides (NO_x) Gases associated with the breakdown of the earth's protective ozone layer that are released primarily from the burning of fossil fuels.

nitroparaffin An organic compound in which one or more hydrogen molecules of an alkane are replaced by a nitro group.

nitrosamine A class of organic compounds that contain a $-NH_2$ and a $-NO$ radical.

non-liquefied compressed gas DOT describes as a gas, other than gas in solution, which under the charged pressure is entirely gaseous at a temperature of 21°C. (Code of Federal Regulations, Title 49, Department of Transportation).

O

oncogenicity The capacity to induce tumors.

operations level (trained) First responders at the operational level are those persons who respond to releases or potential releases of hazardous materials as part of the initial response to the incident for the purpose of protecting nearby persons, the environment, or property from the effects of the release. They shall be trained to respond in a defensive fashion to control the release from a safe distance and keep it from spreading (ANSI/NFPA 472).

optic nerve Nerve running from the eye to the centers of vision in the brain.

oral Used or taken into the body through the mouth.

organic compound A class of chemical compounds containing mainly carbon atoms.

organic peroxide An organic compound containing the bivalent $-O-O-$ structure and which may be considered a structural derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by organic radicals (49CFR173.151).

ortho- In chemistry, denoting that a compound has two substitutions on adjacent carbon atoms in a benzene ring; usually abbreviated *o*-.

oxidant The substance that is reduced and that, therefore, oxidizes the other component of an oxidation–reduction system.

oxidase One of a group of enzymes now termed oxidoreductases that bring about oxidation by the addition of oxygen to a metabolite or by the removal of hydrogen or of one or more electrons.

oxidation The act of combining or causing to combine with oxygen or to lose electrons.

oxidize Oxygenize; to combine or cause an element or radical to combine with oxygen or to lose electrons.

oxidizing agent or oxidizer A substance other than a blasting agent or explosive such as chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen or other gases readily, thereby causing fire of other, usually organic, materials. Perchlorates, peroxides, permanganates, chlorates, and nitrates are examples of oxidizers.

ozone layer The protective layer of molecules surrounding the earth. The ozone layer reduces the amount of high-energy ultraviolet radiation that reaches the earth's surface.

P

PAC Acronym for Protective Action Criteria exposure limits developed by the US Department of Energy (DOE) for hazardous chemicals. These exposure limits include TEELs, AEGLs, and ERPGs and are used to estimate the consequence of uncontrolled releases of hazardous materials and to plan for emergency response. See also definitions in the glossary.

para- In chemistry, a prefix designating two substitutions in the benzene ring arranged symmetrically, i.e., linked to opposite carbon atoms in the ring; usually abbreviated *p*-.

particulate Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog suspended in air or atmospheric emissions.

partition coefficient The ratio of a substance's distribution between oil and water when they are in contact. A value of less than 1 indicates better solubility of the substance in oils and greases. Such a product is therefore likely to be absorbed by the skin. A value greater than 1 indicates a better solubility in water, and, therefore, can be absorbed by the mucosa. This information can be useful in assessing first aid requirements, and can help in the selection of proper protective equipment. Also known as the coefficient of water/oil distribution. Usually abbreviated K_{ow}.

palpitation Perception of one's own heartbeat. A racing, irregular beat, or pounding of the heart.

paralysis The loss of function and/or feeling.

pathology The study of the nature of diseases, especially of the structural and functional changes in body tissues, organs, or fluids caused by disease, physical and biological agents, and toxic substances.

Pensky-Martens A closed cup method for determining flash point.

percutaneous absorption Absorption through the skin.

peritonitis Inflammation of the peritoneum or the membrane lining the abdominal cavity and the organs contained within it.

permissible exposure limit (PEL) A legal occupational limit of exposure established and defined by OSHA. The limit of allowable exposure to a chemical contaminant expressed as a Time-Weighted Average (TWA) concentration during a work-day of 8 h within, or as a maximum concentration never to be exceeded either instantaneously (ceiling) or a Short Term Exposure Limit (STEL) during any maximum period of 15 min. The exposure, inhalation, or dermal permissible exposure limit specified in 29CFR1910, Subparts G and Z. These concentrations are expressed in parts per million (ppm) and or milligrams of the product per cubic meter of air (mg/m^3) at 25°C. Exposure limits published in 29CFR1910.1000.

peroxide Compounds containing two oxygen atoms bound together. The oxide of any series that contains the greatest number of oxygen atoms; applied most correctly to compounds containing an −O−O-link, as in hydrogen peroxide (H−O−O−H).

peroxy- Prefix denoting the presence of an extra O atom, as in peroxides, peroxy acids (e.g., hydrogen peroxide, peroxyformic acid).

pesticide As defined by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), a pesticide includes "any substance or mixture of substances intended for preventing, killing, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant."

petroleum distillate A material produced by a combination of vaporization and condensation of petroleum.

personal protection equipment (PPE) Safety equipment designed to protect parts or all of the body from workplace hazards. Such protective equipment includes chemical resistant clothing, gloves, respirators, and eye protection.

pH A symbol representing the concentration in hydrogen ions (H^+) in aqueous solution. This logarithmic scale is expressed as a numerical value usually between 0 and 14. A pH of 7 indicates a neutral or noncorrosive substance. A pH between 0 and 7 indicates greater acidity. A pH between 7 and 14 indicates greater alkalinity. A pH of 0 (very acid) or 14 (very basic) are highly corrosive. The symbol is useful in the identification of the appropriate type of protective equipment necessary for handling a chemical material.

pharyngitis Inflammation of the throat or pharynx.

phlegm Thick mucus produced in the breathing passages.

photophobia Unpleasant to painful feeling in the eyes, caused by light.

photosensitive Substances that change in the presence of light.

photosensitization Abnormal reaction of the skin to sunlight.

physical hazard A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

pituitary gland A small gland at the base of the brain that secretes several important hormones.

plasma The fluid part of blood or lymph, as distinguished from suspended material.

platelet An irregularly shaped disk found in blood, containing granules in the central part and, peripherally, clear protoplasm, but no definite nucleus; it is about one-third to one-half the size of an erythrocyte, and contains no hemoglobin.

pneumoconiosis Chronic affliction of the lungs due to the inhaling of certain types of dust.

pneumonia Acute infection of the lung, characterized by inflammation.

pneumonitis (chemical) Inflammation of the lungs, resulting from chemical irritation.

pneumopathy Any pulmonary affliction.

point source contamination Contamination to the environment from a specific source such as a smokestack or sewer pipe.

polychlorinated biphenyl (PCBs) A pathogenic and teratogenic industrial compound used as a heat-transfer agent, primarily in transformers. PCBs may accumulate in human or animal tissue. PCBs are banned from production in the United States.

polymer A chemical formed by the joining together of similar chemical subunits.

polymerization A chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is a reaction that takes place at a rate that releases large amounts of energy. If hazardous polymerization can occur with a given material, the MSDS usually will list conditions that could start the reaction and—since the material usually will list conditions that could start the reaction, and since the material usually contains a polymerization inhibitor—the length of time during which the inhibitor will be effective. The heat given off or the expansion in volume, or both, caused by the polymerization reaction could cause the container holding the product to break and the unpolymerized residual product to be spilled.

polyneuritis Inflammation of several nerves.

polyuria Elimination of an abnormally large amount of urine over a given period.

pro-carcinogen Product that must be changed by the organism in order to become a carcinogen.

promoter (of carcinogenesis) Substance capable of enhancing the carcinogenic effect of another substance.

prostration Extreme exhaustion, physical or mental.

pulmonary Pertaining to the lungs.

pulmonary edema A buildup of fluid in the lungs caused by congestive heart failure, lung damage, side effects of drugs, infections, or kidney failure.

pyrophoric Any chemical substance or mixture that ignites spontaneously in dry or moist air at or below 130°F/54.4°C.

pyrolysis Decomposition of a substance by heat in the absence of air.

psychosis A group of mental illnesses characterized by a change in personality and loss of contact with reality.

Q

quaternary In chemistry, the term used to describe a substance with four chemical groups attached to a central atom; when the central atom is a trivalent nitrogen atom (N), adding the fourth group places a positive charge on N; compounds thus formed are called quaternary ammonium compounds.

R

racemate A mixture of equal parts of isomers of opposite rotation.

racemic Denoting a mixture that is optically inactive, being composed of an equal number of dextro- and levorotary substances (see DL-), which are separable.

radioactive Having the property of emitting radiation (such as alpha, beta, or gamma rays) from an atomic nucleus.

radioactive material Any material, or combination of materials, that spontaneously emits ionizing radiation, and having a specific activity greater than 0.002 microcuries per gram.

radionuclides Radioactive-decay particles emitted from natural and manufactured sources, including cosmic rays, X-rays, radon, and coal-fired utilities.

radon A colorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium atoms in soil or rocks.

reactive Unstable.

reactivity Chemical reaction with the release of energy. Undesirable effects such as pressure buildup, temperature increase, formation of noxious, toxic, or corrosive by-product, may occur because of the reactivity of a substance to heating, burning, direct contact with other materials, or other conditions in use or in storage.

Recommended Exposure Limit (REL) A 10-h average exposure limit during a 40-h work-week recommended by the National Institute for Occupational Safety and Health (NIOSH) for occupational exposures.

reducing agent In a reducing reaction (which occurs simultaneously with an oxidation reaction) the reducing agent is the chemical or substance which (1) combines with oxygen or (2) loses electrons to the reaction. Reducing agents react violently with oxidizing agents or oxidizers.

Registry of Toxic Effects of Chemical Substances (RTECS) Published by NIOSH, RTECS is a compendium of the known toxic and biological effects of many chemical substances.

regulated material A substance or material that is subject to regulations promulgated by any government agency.

relative density The ratio of the density of a material to the density of a standard material, such as water at a specified temperature.

remedial action The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.

renal Pertaining to the kidney.

reportable quantity (RQ) An amount of a hazardous substance or "extremely hazardous substance" that, if released, requires notification to the National Response Center (800/424-8802) under the emergency release reporting requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA) or under those of CERCLA (Superfund). For the purposes of the Department of Transportation, RQ means the quantity specified for the substance in the Appendix to the Hazardous Materials Table. For the purposes of SARA Title III, RQ means, for any CERCLA hazardous substance the reportable quantity established therein for such a substance, for any other substance the RQ is one pound.

respirator A devise worn by a person to filter dust particles or gas out of surrounding air before inhalation of air.

respiratory tract The structures and organs involved in breathing; includes the nose, larynx, trachea, bronchi, bronchioli, and lungs.

respiratory tract filters Those anatomical structures that remove particles from inhaled air.

responsible party Someone who can provide additional information on the substance if needed (29CFR1910.1200).

rhinitis Inflammation of mucosa of the nasal passages.

rheumatoid arthritis A chronic disease of the joints, marked by inflammatory changes of joint structures.

rodenticide Chemical substances used to kill mice, rats, and other rodents.

route of entry The means or natural route by which hazardous chemicals or other contaminants can penetrate the body. For example, the skin (by cutaneous absorption), the digestive system (by ingestion), or the respiratory system (by inhalation).

routes of exposure Also known as routes of entry, any one of the ways by which substances enter the body, such as through the skin, ingestion, eye contact, or by breathing.

S

sensitization Defense reaction by the organism following exposure to a contaminant, resulting in an allergy.
senstitizer A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.
shock An abnormal condition resulting from not enough blood flowing through the body causing reduced blood pressure and interference with bodily functions.
Short Term Exposure Limit (STEL) A 15-min time-weighted-average exposure limit that should not be exceeded at any time during a work-day, recommended by the National Institute for Occupational Safety and Health (NIOSH) or a concentration that it is believed a worker can be exposed to continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency, recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).
silicosis Chronic disease of the lungs (fibrosis) provoked by inhaling dust of crystalline silica. See “pneumoconiosis.”
solid waste Any garbage, refuse or sludge, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, agricultural, and mining operations, and community activities (excluding material in domestic sewage); discharges subject to regulation as point sources under the Federal Water Pollution Control Act, or any nuclear material or byproduct regulated under the Atomic Energy Act of 1954.
solubility The property of a substance describing the degree to which one material may be completely mixed or dissolved in another material. The degree of solubility of most substances increases with the rise in temperature; however, in the case of organic salts of calcium the substance may be more soluble in cold than in hot solvents.
solution Any homogeneous liquid mixture of two or more chemical compounds or elements that will not undergo any segregation normal to transportation (CFR, Title 49, DOT).
solvent A chemical liquid, capable of dissolving another substance. A term generally used to describe organic solvents.
spasm Involuntary muscle contraction.
specific gravity The weight of a material compared to the weight of an equal volume of water is an expression of the density (or heaviness) of a material. Insoluble materials with specific gravity of less than 1.0 will float in (or on water). Insoluble materials with specific gravity greater than 1.0 will sink in water. Most (but not all) flammable liquids have specific gravity less than 1.0 and, if not soluble, will float on water—an important consideration for fire suppression.
spill Another name for a leak. The methods, equipment, and precautions that should be used to control or clean up a leak or spill.
stability Relates to a material’s ability to resist change in form or chemical nature (e.g., xylene decomposes when strongly heated, and gives off toxic fumes). For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions that may cause instability (dangerous change) are stated; for example, temperature above 150°F/66°C; shock from dropping.
stabilized Containing a small amount of another substance included to keep the first material from changing form.
stool Discharge from the bowels.
stratosphere That part of the earth’s atmosphere, located above the troposphere, containing the ozone layer.
strong acids Refers, but not restricted, to chemicals such as hydrochloric, sulfuric, and nitric acids. Strong acids can cause violent reactions with certain other substances and materials.
strong bases Refers, but not restricted, to chemicals such as sodium hydroxide and potassium hydroxide. Strong bases can cause violent reactions with certain other substances and materials.
strong oxidizers Refers, but not restricted, to chemicals such as chlorine, bromine, and fluorine and many of their compounds Strong oxidizers can cause violent reactions with certain other substances and materials. See also “oxidizers,” “oxidizing agent,” “easily oxidized materials.”
sublimate To go directly from the solid to the gaseous state without passing through the liquid state.
Superfund Amendments and Reauthorization Act (SARA) Title III of SARA establishes the first national program of emergency planning for dealing with hazardous chemicals. Includes detailed provisions for community planning and annual submission of information about hazardous chemicals to the EPA, states and local communities.
suspected carcinogen A substance which is known to cause cancer in test animals, but is only suspected of causing cancer in humans. Also referred to as an experimental or potential carcinogen.
systemic toxicity Adverse effects caused by a substance that affects the body as a whole rather than local or individual parts or organs.

T

tachycardia Increased speed of heart beat.
tachypnea Abnormally rapid breathing.
target organ The body affected by a specific chemical in a specific species.
TCLP (toxicity characteristics leaching procedure) Under the Resource Conservation and Recovery Act (RCRA), wastes are subject to this laboratory procedure to determine if they can be disposed of in Subtitle D landfills or if they require Subtitle C disposal (i.e., considered a hazardous waste).

technical grade A purity standard applied to a chemical that may contain multiple impurities.

TEEL Acronym for Temporary Emergency Exposure Limit. Airborne exposure limits, TEELs are intended for use until AEGLs or ERPGs are adopted for chemicals. Temporary emergency exposure limit (TEEL) values developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) which provides the US Department of Energy (DOE)/National Nuclear Security Administration (NNSA) and its contractors with technical information and recommendations for emergency preparedness to assist in safeguarding the health and safety of workers and the public. See also "How to Use this Book" in the front matter of this book.

teratogen A substance that has been demonstrated to cause birth defects by causing malformations in the fetus. Teratogenic contaminants can be qualified as being "proven" when an effect has been shown in humans, "possible" when an effect has been shown in animals, or suspected in humans, and "suspected" when an effect is suspected in animals.

tetanic Refers to persistence in a muscle contraction.

***Threshold Limit Value®—Time-Weighted Average limit* (TLV®—TWA)** An 8-h average exposure limit during a 40-h work-week recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for occupational exposures.

Threshold Planning Quantity (TPQ) Under the Emergency Planning and Community Right-to-Know-Act, the presence of a chemical at or above this level requires certain emergency planning activities to be conducted. The quantity of a SARA extremely hazardous substance present at a facility above which the facility's owner/operator must give emergency planning notification to the SERC and LEPC.

Tier I or Tier II Describes hazardous substances inventory forms required under SARA Title III. These forms report quantities and locations of hazardous substances to various state agencies and planning committees.

Time-Weighted Average (TWA) The average concentration of a substance in air over the total time of exposure, usually expressed as an 8-h day.

tinnitus Ringing in one or both ears. May be a sign of hearing injury.

Title III The third part of SARA, also known as EPCRA, the Emergency Planning and Community Right-to-Know Act of 1986. Specifies requirements for organizing the planning process at the state and local levels for extremely hazardous substances; minimum plan content; requirements for fixed facility owners and operators to inform officials about extremely hazardous substances present at the facilities; and mechanisms for making information about extremely hazardous substances available to citizens.

tolerance Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the amount of pesticide residues allowed to remain in or on each treated food commodity.

topical Designed for direct application to a specific part of the body.

toxic Any substance capable of causing human injury or damage to living body tissue, impairment to the central nervous system, severe illness, and, in severe cases, death. A poison.

toxicology The branch of chemistry that deals with poisons.

toxicologist One who studies the nature, effects, and detection of poisons and the treatment of poisoning.

toxic pollutant Pollutants, which after discharge and upon exposure, cause adverse health effects.

Toxic Release Inventory (TRI) (Listed substance subject to reporting requirements.) An EPA database of release quantities by facilities of a growing list of chemicals and chemical categories into the nation's air, water, and land, and transfers to off-site locations for treatment or disposal, or for recycling and energy recovery. Under the Emergency Planning and Community Right-to-Know Act, certain industries are required on an annual basis to complete a Toxic Chemical Release Inventory Form for these chemicals.

trade name The manufacturer's commercial name for a chemical substance or product. A registered trade name contains the symbol "®".

trade secret Any confidential formula or information used to give the manufacturer, etc. an (economic) advantage over others who do not have the information (29CFR 1910.1200).

tumor A neoplasm; a mass of new tissue that persists and grows independently of its surrounding structures and that has no physiological use; it may be benign or malignant.

tumorigenic That which causes or produces tumors.

U

UEL Upper Explosive Limit of a vapor or gas; the highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At higher concentrations, the mixture is too "rich" to burn. See also "LEL."

UN identification number An international four digit number assigned to all hazardous materials regulated by the United Nations.

unstable A chemical in the pure state which will become self-reactive under conditions of shocks, pressure, or temperature (29CFR1910.1200).

UST Underground Storage Tank regulated under RCRA. A tank used to store CERCLA-regulated chemicals or petroleum products, with 10% or more of its volume underground, having connected piping.

ulceration Creation of an ulcer.

urban air toxics Under the Clean Air Act, the 33 air toxics that have been identified as posing the greatest potential health threat in urban areas.

V

vapor density Indicator of the number of times that the vapors of a substance are heavier or lighter than air. Vapor density measurement is taken at the boiling point. If the vapor density is greater than 1, the vapor will tend to collect at floor level. If the vapor density is less than 1, the vapor will rise in air.

vapor pressure When a substance evaporates, its vapors create a pressure in the surrounding atmosphere; therefore, vapor pressure is a measurement of how readily a liquid or a solid mixes with air at its surface. This measurement is expressed in millimeters of mercury (mmHg), at 68°F/20°C and normal atmospheric pressure (760 mmHg). A vapor pressure above 760 mm indicates a substance in the gaseous state. The higher a product's vapor pressure, the more it tends to evaporate, resulting in a higher concentration of the substance in air and therefore increases the likelihood of breathing it in.

vascular Pertaining to vessels or ducts that convey fluids such as blood, lymph, or sap; in human or veterinary medicine, vascular pertains to blood vessels.

vascular constriction Constriction with narrowing of blood vessels.

vascular dilation Dilation of the blood vessels.

vertigo Dizziness; giddiness.

volatiles A substance, usually a liquid, that easily vaporizes or evaporates to form a gas or vapor.

W

waste code Identifier assigned by the EPA consisting of a single letter (D, F, P, U, K) and three numbers in the format "Dxxx." This code identifies the type of hazardous waste stream being reported.

waste management Describes activities undertaken by facilities to treat, recycle or otherwise manage generated waste, including disposal and energy recovery.

waste stream Under RCRA, solid or liquid materials containing hazardous materials and generated as waste.

water reactive A chemical which reacts with water to release flammable or hazardous gas (29CFR1910.1200).

work area A defined space where hazardous substances are produced or used when employees are present (29CFR 1910.1200).

Appendix 4: European/International Hazard Codes, Risk Phrases, and Safety Phrases

Note: Followed by the GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELING OF CHEMICALS (GHS)

Hazard Codes

Explosive (E)
Oxidizing (O)
Highly flammable (F)
Extremely flammable (F+)
Toxic (T)
Very toxic (T+)
Harmful (Xn)
Irritant (Xi)
Corrosive (C)
Dangerous to the environment (N)

(List of R-phrases) Risk Precaution Codes and Statements

R1—Explosive when dry.
R2—Risk of explosion by shock, friction, fire, or other sources of ignition.
R3—Extreme risk of explosion by shock, friction, fire, or other sources of ignition.
R4—Forms very sensitive metallic compounds.
R5—Heating may cause an explosion.
R6—Explosive when mixed with combustible materials.
R7—May cause fire.
R8—Contact with combustible material may cause fire.
R9—Explosive when mixed with combustible material.
R10—Flammable.
R11—Highly flammable.
R12—Extremely flammable.
R13—Extremely flammable liquefied gas.
R14—Reacts violently with water.
R14/15—Reacts violently with water, liberating extremely flammable gases.
R14/15—Reacts violently with water, liberating highly flammable gases.
R14/15—Reacts violently with water, liberating extremely flammable gases.
R15—Contact with water liberates highly flammable gases.
R15/29—Contact with water liberates toxic, highly flammable gas.
R16—Explosive when mixed with oxidizing substances.
R17—Spontaneously flammable in air.
R18—In use, may form flammable/explosive vapor−air mixture.
R19—May form explosive peroxides.
R20—Harmful by inhalation.
R20/21—Harmful by inhalation and in contact with the skin.
R20/21/22—Harmful by inhalation, in contact with skin and if swallowed.
R20/22—Harmful by inhalation and if swallowed.
R21—Harmful in contact with skin.
R21/22—Harmful in contact with the skin and if swallowed.
R22—Harmful if swallowed.
R23—Toxic by inhalation.
R23/24—Toxic by inhalation and in contact with skin.
R23/24/25—Toxic by inhalation, in contact with skin and if swallowed.
R23/25—Toxic by inhalation and if swallowed.
R24—Toxic in contact with skin.
R24/25—Toxic in contact with skin and if swallowed.
R25—Toxic if swallowed.
R26—Very toxic by inhalation.
R26/27—Very toxic by inhalation and in contact with the skin.
R26/27/28—Very toxic by inhalation, in contact with the skin and if swallowed.
R26/28—Very toxic by inhalation and if swallowed.
R27—Very toxic in contact with skin.
R27/28—Very toxic in contact with skin and if swallowed.
R28—Very toxic if swallowed.
R29—Contact with water liberates toxic gas.
R30—Can become highly flammable in use.
R31—Contact with acids liberates toxic gas.
R32—Contact with acids liberates very toxic gas.
R33—Danger of cumulative effects.
R34—Causes burns.
R35—Causes severe burns.
R36—Irritating to eyes.
R36/37—Irritating to eyes and respiratory system.
R36/37/38—Irritating to eyes, respiratory system and skin.
R36/38—Irritating to eyes and skin.
R37—Irritating to respiratory system.
R37/38—Irritating to respiratory system and skin.
R38—Irritating to skin.
R39—Danger of very serious irreversible effects.
R39/23—Toxic: danger of very serious irreversible effects through inhalation.
R39/23/24—Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/23/24/25—Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

R39/23/25—Toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/24—Toxic: danger of very serious irreversible effects in contact with skin.
R39/24/25—Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/25—Toxic: danger of very serious irreversible effects if swallowed.
R39/26—Very toxic: danger of very serious irreversible effects through inhalation.
R39/26/27—Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/26/27/28—Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R39/26/28—Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/27—Very toxic: danger of very serious irreversible effects in contact with skin.
R39/27/28—Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/28—Very toxic danger of very serious irreversible effects if swallowed.
R40—Possible risks of irreversible effects.
R40/20—Harmful: possible risk of irreversible effects through inhalation.
R40/20/21—Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R40/20/21/22—Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R40/20/22—Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R40/21—Harmful: possible risk of irreversible effects in contact with the skin.
R40/21/22—Harmful: possible risk of irreversible effects in contact with skin and if swallowed.
R40/22—Harmful: possible risk of irreversible effects if swallowed.
R41—Risk of serious danger to eyes.
R42—May cause sensitization by inhalation.
R42/43—May cause sensitization by inhalation and skin contact.
R43—May cause sensitization by skin contact.
R44—Risk of explosion if heated under confinement.
R45—May cause cancer.
R46—May cause heritable genetic damage.
R47—May cause birth defects.
R48—Danger of serious damage to health by prolonged exposure.
R48/20—Harmful: danger of serious damage to health by prolonged exposure through inhalation.
R48/20/21—Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/20/21/22—Harmful: danger of serious damage to health by prolonged through inhalation, in contact with skin and if swallowed.
R48/20/22—Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/21—Harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R48/21/22—Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R48/22—Harmful: danger of serious damage to health by prolonged exposure if swallowed.
R48/23—Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R48/23/24—Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/23/24/25—Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R48/23/25—Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R48/24—Toxic: danger of serious damage to health by prolonged exposure in contact with skin.
R48/24/25—Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R48/25—Toxic: danger of serious damage to health by prolonged exposure if swallowed.
R49—May cause cancer by inhalation.
R50—Very toxic to aquatic organisms.
R50/53—Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R51—Toxic to aquatic organisms.
R51/53—Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R52—Harmful to aquatic organisms.
R52/53—Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R53—May cause long-term adverse effects in the aquatic environment.
R54—Toxic to flora.
R55—Toxic to fauna.
R56—Toxic to soil organisms.
R57—Toxic to bees.
R58—May cause long-term adverse effects in the environment.
R59—Dangerous to the ozone layer.
R60—May impair fertility.
R61—May cause harm to the unborn child.
R62—Possible risk of impaired fertility.
R63—Possible risk of harm to the unborn child.
R64—May cause harm to breast-fed babies.
R65—Harmful: may cause lung damage if swallowed.
R66—Repeated exposure may cause skin dryness or cracking.

R67—Vapors may cause drowsiness and dizziness.
R68—Possible risk of irreversible effects.
R68/20/21—Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R68/20/22—Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R68/20/21/22—Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R68/21/22—Harmful: possible risk of irreversible effects in contact with skin and if swallowed.

(List of S-phrases) Safety Precautions

S1—Keep locked up.
S1/2—Keep locked up and out of the reach of children.
S2—Keep out of the reach of children.
S3—Keep in a cool place.
S3/7—Keep container tightly closed in a cool place
S3/7/9—Keep container tightly closed in a cool, well-ventilated place.
S3/9—Keep in a cool, well-ventilated place.
S3/9/14—Keep in a cool well-ventilated place away from __?__(incompatible materials to be indicated by the manufacturer).
S3/9/14/49—Keep only in the original container in a cool, well-ventilated place away from __?__(incompatible materials to be indicated by the manufacturer).
S3/9/49—Keep only the original container in a cool, well-ventilated place.
S3/14—Keep in a cool place away from __?__ (incompatible materials to be indicated by the manufacturer).
S4—Keep away from living quarters.
S5—Keep contents under __?__(appropriate liquid to be specified by the manufacturer).
S6—Keep under __?__(inert gas to be specified by the manufacturer).
S7—Keep containers tightly closed.
S7/8—Keep container tightly closed and dry.
S7/9—Keep in a container tightly closed and in a well-ventilated place.
S7/47—Keep container tightly closed and at temperature not exceeding __?__°C (*to be specified by the manufacturer*).
S8—Keep containers dry.
S8/10—Keep container wet, but keep the contents dry.
S9—Keep containers in a well-ventilated place.
S12—Do not keep container sealed.
S13—Keep away from food, drink, and animal foodstuffs.
S14—Keep away from __?__(incompatible materials to be indicated by the manufacturer).
S15—Keep away from heat.
S16—Keep away from sources of ignition—No smoking.
S17—Keep away from combustible material.
S18—Handle and open containers with care.
S20—When using do not eat or drink.
S20/21—When using do not eat, drink, or smoke.
S21—When using do not smoke.
S22—Do not breathe dust.
S23—Do not breathe gas/fumes/vapor/spray (appropriate wording to be specified by the manufacturer).
S24—Avoid contact with skin.
S24/25—Avoid contact with the skin or eyes.
S25—Avoid contact with eyes.
S26—In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
S27—Take off immediately all contaminated clothing.
S27/28—After contact with skin, take off immediately all contaminated clothing, and wash immediately with plenty of __?__ (*to be specified by the manufacturer*).
S28—After contact with skin, wash immediately with plenty of __?__(to be specified by the manufacturer).
S29—Do not empty into drains.
S29/35—Do not empty into drains; dispose of this material and its container in a safe way.
S29/56—Do not empty into drains, dispose of this material and its container at hazardous or special waste collection point.
S30—Never add water to this product.
S33—Take precautionary measures against static discharge.
S34—Avoid shock and friction.
S35—This material and its container must be disposed of in a safe way.
S36—Wear suitable protective clothing.
S36/37—Wear suitable protective clothing and gloves.
S36/37/39—Wear suitable protective clothing, gloves and eye/face protection.
S36/39—Wear suitable protective clothing and eye/face protection.
S37—Wear suitable gloves.
S37/39—Wear suitable gloves and eye/face protection.
S38—In case of insufficient ventilation, wear suitable respiratory equipment.
S39—Wear eye/face protection.
S40—To clean the floor and all objects contaminated by this material, use __?__(appropriate wording to be specified by the manufacturer).
S41—In case of fire and/or explosion, do not breathe fumes.
S42—During fumigation/spraying wear suitable respiratory equipment (appropriate wording to be specified by the manufacturer).
S43—In case of fire, use __?__(indicate in the space the precise type of fire-fighting equipment. If water increases the risk, add “Never use water”).
S44—If you feel unwell, seek medical advice (show the label where possible).
S45—In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

S46—If swallowed, seek medical advice immediately and show this container or label.
S47—Keep at temperature not exceeding __?__ °C (to be specified by the manufacturer).
S47/49—Keep only in the original container at temperatures not exceeding __?__ °C (to be specified by the manufacturer).
S48—Keep wetted with __?__(appropriate material to be specified by the manufacturer).
S49—Keep only in the original container.
S50—Do not mix with __?__(to be specified by the manufacturer).
S51—Use only in well-ventilated areas.
S52—Not recommended for interior use on large surface areas.
S53—Avoid exposure—obtain special instructions before use.
S54—Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.
S55—Treat using the best available techniques before discharge into drains or the aquatic environment.
S56—Do not discharge into drains or the environment, dispose to an authorized waste collection point.
S57—Use the appropriate containment to avoid environmental contamination.
S58—To be disposed of as a hazardous waste.
S59—Refer to manufacturer/supplier for information on recovery/recycling.
S60—This material and/or its container must be disposed of as hazardous waste.
S61—Avoid release to the environment. Refer to special instructions/safety data sheet.
S62—If swallowed, do not induce vomiting; seek medical advice immediately and show this container or label.
S63—In case of accident by inhalation; remove casualty to fresh air and keep at rest.
S64 −If swallowed, rinse mouth with water (only if the person is conscious).

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

Hazard statements are an essential element under the GHS, and will eventually replace the currently used R-phrases. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will include, where necessary, the following: one or multiple pictograms, a signal word such as “Warning” or “Danger,” and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer.

Each hazard statement contains a four digit code, starting with the letter H (Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four digit code is for reference only; however, following the code is the exact *phrase* as it should appear on labels and MSDS.

Hazard Statements

Physical Hazards Codes and Statements

H200—Unstable explosive.
H201—Explosive; mass explosion hazard.
H202—Explosive; severe projection hazard.
H203—Explosive; fire, blast, or projection hazard.
H204—Fire or projection hazard.
H205—May mass explode in fire.
H220—Extremely flammable gas.
H221—Flammable gas.
H222—Extremely flammable material.
H223—Flammable material.
H224—Extremely flammable liquid and vapor.
H225—Highly flammable liquid and vapor.
H226—Flammable liquid and vapor.
H227—Combustible liquid.
H228—Flammable solid.
H240—Heating may cause an explosion.
H241—Heating may cause a fire or explosion.
H242—Heating may cause a fire.
H250—Catches fire spontaneously if exposed to air.
H251—Self-heating; may catch fire.
H252—Self-heating in large quantities; may catch fire.
H260—In contact with water releases flammable gases which may ignite spontaneously.
H261—In contact with water releases flammable gas.
H270—May cause or intensify fire; oxidizer.
H271—May cause fire or explosion; strong oxidizer.
H272—May intensify fire; oxidizer.
H280—Contains gas under pressure; may explode if heated.
H281—Contains refrigerated gas; may cause cryogenic burns or injury.
H290—May be corrosive to metals.

Health Hazards

H300—Fatal if swallowed.
H301—Toxic if swallowed.
H302—Harmful if swallowed.
H303—May be harmful if swallowed.
H304—May be fatal if swallowed and enters airways.
H305—May be harmful if swallowed and enters airways.
H310—Fatal in contact with skin.
H311—Toxic in contact with skin.
H312—Harmful in contact with skin.
H313—May be harmful in contact with skin.
H314—Causes severe skin burns and eye damage.
H315—Causes skin irritation.
H316—Causes mild skin irritation.
H317—May cause an allergic skin reaction.
H318—Causes serious eye damage.

H319—Causes serious eye irritation.
H320—Causes eye irritation.
H330—Fatal if inhaled.
H331—Toxic if inhaled.
H332—Harmful if inhaled.
H333—May be harmful if inhaled.
H334—May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H335—May cause respiratory irritation.
H336—May cause drowsiness or dizziness.
H340—May cause genetic defects.
H341—Suspected of causing genetic defects.
H350—May cause cancer.
H351—Suspected of causing cancer.
H360—May damage fertility or the unborn child.
H361—Suspected of damaging fertility or the unborn child.
H362—May cause harm to breast-fed children.
H370—Causes damage to organs.
H371—May cause damage to organs.
H372—Causes damage to organs through prolonged or repeated exposure.
H373—May cause damage to organs through prolonged or repeated exposure.

Environmental Hazards

H400—Very toxic to aquatic life.
H401—Toxic to aquatic life.
H402—Harmful to aquatic life.
H410—Very toxic to aquatic life with long lasting effects.
H411—Toxic to aquatic life with long lasting effects.
H412—Harmful to aquatic life with long lasting effects.
H413—May cause long lasting harmful effects to aquatic life.

Prevention Precautionary Codes and Statements

P201—Obtain special instructions before use.
P202—Do not handle until all safety precautions have been read and understood.
P210—Keep away from heat/sparks/open flames/hot surfaces—NO SMOKING.
P211—Do not spray on an open flame or other ignition source.
P220—Keep/Store away from clothing/. . ./combustible materials.
P221—Take any precautions to avoid mixing with combustibles.
P222—Do not allow contact with air.
P223—Keep away from any possible contact with water, because of violent reaction and possible flash fire.
P230—Keep wetted with __?__.
P231—Handle under inert gas.
P232—Protect from moisture.
P233—Keep container tightly closed.
P234—Keep only in original container.
P235—Keep cool.
P240—Ground/bond container and receiving equipment.
P241—Use explosion-proof electrical/ventilating/light/. . ./equipment.
P242—Use only non-sparking tools.
P243—Take precautionary measures against static discharge.
P244—Keep reduction valves free from grease and oil.
P250—Do not subject to grinding/shock/. . ./friction.
P251—Pressurized container—Do not pierce or burn, even after use.
P260—Do not breathe dust/fume/gas/mist/vapors/spray.
P261—Avoid breathing dust/fume/gas/mist/vapors/spray.
P262—Do not get in eyes, on skin, or on clothing.
P263—Avoid contact during pregnancy/while nursing.
P264—Wash __?__ thoroughly after handling.
P270—Do not eat, drink, or smoke when using this product.
P271—Use only outdoors or in a well-ventilated area.
P272—Contaminated work clothing should not be allowed out of the workplace.
P273—Avoid release to the environment.
P280—Wear protective gloves/protective clothing/eye protection/face protection.
P281—Use personal protective equipment as required.
P282—Wear cold insulating gloves/face shield/eye protection.
P283—Wear fire/flame resistant/retardant clothing.
P284—Wear respiratory protection.
P285—In case of inadequate ventilation wear respiratory protection.
P231 + 232—Handle under inert gas. Protect from moisture.
P235 + 410—Keep cool. Protect from sunlight.

Response Precautionary Codes and Statements

P301—IF SWALLOWED −.
P302—IF ON SKIN −.
P303—IF ON SKIN (or hair) −.
P304—IF INHALED −.
P305—IF IN EYES −.
P306—IF ON CLOTHING −.
P307—IF exposed −.
P308—IF exposed or concerned −.
P309—IF exposed or you feel unwell −.
P310—Immediately call a POISON CENTER or doctor/physician.
P311—Call a POISON CENTER or doctor/physician.
P312—Call a POISON CENTER or doctor/physician if you feel unwell.
P313—Get medical advice/attention.
P314—Get medical advice/attention if you feel unwell.
P315—Get immediate medical advice/attention.
P320—Specific treatment is urgent (see __?__ on this label).

P321—Specific treatment (see __?__ on this label).
P322—Specific measures (see __?__ on this label).
P330—Rinse mouth.
P331—Do NOT induce vomiting.
P332—If skin irritation occurs −.
P333—If skin irritation or a rash occurs −.
P334—Immerse in cool water/wrap in wet bandages.
P335—Brush off loose particles from skin.
P336—Thaw frosted parts with lukewarm water. Do not rub affected areas.
P337—If eye irritation persists −.
P338—Remove contact lenses if present and easy to do. Continue rinsing.
P340—Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P341—If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P342—If experiencing respiratory symptoms −.
P350—Gently wash with soap and water.
P351—Rinse continuously with water for several minutes.
P352—Wash with soap and water.
P353—Rinse skin with water/shower.
P360—Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P361—Remove/Take off immediately all contaminated clothing.
P362—Take off contaminated clothing and wash before reuse.
P363—Wash contaminated clothing before reuse.
P370—In case of fire −.
P371—In case of major fire and large quantities −.
P372—Explosion risk in case of fire.
P373—DO NOT fight fire when fire reaches explosives.
P374—Fight fire with normal precautions from a reasonable distance.
P375—Fight fire remotely due to the risk of explosion.
P376—Stop leak if safe to do so.
P377—Leaking gas fire—do not extinguish unless leak can be stopped safely.
P378—Use __?__ for extinction.
P380—Evacuate area.
P381—Eliminate all ignition sources if safe to do so.
P301 + 310—IF SWALLOWED—Immediately call a POISON CENTER or doctor/physician.
P301 + 312—IF SWALLOWED—Call a POISON CENTER or doctor/physician if you feel unwell.
P301 + 330 + 331—IF SWALLOWED—Rinse mouth. DO NOT induce vomiting.
P302 + 334—IF ON SKIN—Immerse in cool water/wrap in wet bandages.
P302 + 350—IF ON SKIN—Gently wash with soap and water.
P302 + 352—IF ON SKIN—Wash with soap and water.
P303 + 361 + 353—IF ON SKIN (or hair)—Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + 312—IF INHALED—Call a POISON CENTER or doctor/physician if you feel unwell.
P304 + 340—IF INHALED—Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P304 + 341—IF INHALED—If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + 351 + 338—IF IN EYES—Rinse continuously with water for several minutes. Remove contact lenses if present and easy to do—continue rinsing.
P306 + 360—IF ON CLOTHING—Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P307 + 311—IF exposed—Call a POISON CENTER or doctor/physician.
P308 + 313—IF exposed or concerned—Get medical advice/attention.
P309 + 311—IF exposed or you feel unwell—Call a POISON CENTER or doctor/physician.
P332 + 313—If skin irritation occurs—Get medical advice/attention.
P333 + 313—If skin irritation or a rash occurs—Get medical advice/attention.
P335 + 334—Brush off loose particles from skin. Immerse in cool water/wrap in wet bandages.
P337 + 313—Get medical advice/attention.
P342 + 311—Call a POISON CENTER or doctor/physician.
P370 + 376—In case of fire—Stop leak if safe to do so.
P370 + 378—In case of fire—Use __?__ for extinction.
P370 + 380—In case of fire—Evacuate area.
P370 + 380 + 375—In case of fire—Evacuate area. Fight fire remotely due to the risk of explosion.
P371 + 380 + 375—In case of major fire and large quantities—Evacuate area. Fight fire remotely due to the risk of explosion.

Storage Precautionary Codes and Statements

P401—Store __?__.
P402—Store in a dry place.
P403—Store in a well-ventilated place.
P404—Store in a closed container.
P405—Store locked up.
P406—Store in a corrosive resistant/... container with a resistant inner liner.
P407—Maintain air gap between stacks/pallets.
P410—Protect from sunlight.
P411—Store at temperatures not exceeding __?__°C/ __?__ °F.
P412—Do not expose to temperatures exceeding 50°C/ 122°F.
P420—Store away from other materials.
P422—Store contents under __?__.
P402 + 404—Store in a dry place. Store in a closed container.

P403 + 233—Store in a well-ventilated place. Keep container tightly closed.

P403 + 235—Store in a well-ventilated place. Keep cool.

P410 + 403—Protect from sunlight. Store in a well-ventilated place.

P410 + 412—Protect from sunlight. Do not expose to temperatures exceeding 50°C/122°F.

P411 + 235—Store at temperatures not exceeding __?__ °C/ __?__ °F. Keep cool.

Disposal Precautionary Codes and Statements

P501—Dispose of contents/container to __?__.

Appendix 5: Synonym and Trade Name—Cross Index

Appendix 6: CAS Number-Cross Index

CAS Number and Record Number